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Critical Review

Mobility biographies: A review of achievements and challenges of the mobility biographies approach and a framework for further research

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ABSTRACT

In transport research, important changes in an individual's life, so-called key events, are of particular interest because changes in one's environment and surrounding context weaken routines, and a 'window of opportunity' opens up for behavioural change. In the framework of the mobility biographies approach, several studies have been undertaken to improve understanding of travel behaviour change in the last decade. This paper critically and systematically reviews emerging results from mobility biographies research, focusing on key events which potentially induce contextual and travel behaviour changes. The first step was to identify 25 of the most important studies for this approach and their related concepts. Next, notions other than key events in the literature are discussed and a theoretical framework for the longitudinal interaction of four dimensions of key events and other factors for travel behaviour change are identified: (i) life events in private and professional careers, (ii) adaptation of long-term mobility decisions, (iii) exogenous interventions, and (iv) other long-term processes which are not key events (e.g. socialisation). Furthermore, the understanding of key events, methodological challenges and further research gaps are critically discussed in this review.

1. Introduction

Since at least the 1990s, public and scientific interest in travel behaviour change programs has increased dramatically. For example, technological options alone (e.g. cleaner fuels, new technologies) will have limited impact for mitigating climate gas emissions from the transport sector if worldwide travel demand continues to grow at its current rate. Although some authors observe peak travel and the stabilisation of travel distances in industrialised countries (Millard-Ball and Schipper, 2011), globally the motorisation rate and motorised distances travelled continue to grow. Thus, it is frequently argued that transport climate change policies are expected to fail if no adequate travel demand management options are presented (Bongardt et al., 2013; IPCC, 2014; Schwanen et al., 2011).

However, for successful travel demand management policies, an improved understanding of individual travel behaviour is crucial. Although we have observed significant progress in travel behaviour research over recent decades, we still claim that there is a lack of a sound theoretical framework for behavioural change. While the human activity approach and, closely related, the key methodologies of econometric choice and simulation modelling still dominate travel behaviour research, relatively little work has been devoted to the development of an encompassing theoretical research framework. Disciplines focused on mathematical and econometric modelling usually tend to combine strong modelling assumptions, like *homo economicus*, and rational decision-making with only a limited number of spatial or socio-economic characteristics of choice situations for explaining travel behaviour. Thus, some important elements of decision-making, like habits and their formation, and underlying rationales are frequently neglected. Furthermore, the development of an advanced social theory of travel behaviour and its change is missing in this econometric context. Moreover, in most cases, models and related theories are limited to cross-sectional data sets and, thus, neglect the temporal and longitudinal dimensions of decision-making. In order to overcome these shortcomings of traditional theories, over the last decade several researchers have proposed a more comprehensive framework for travel behaviour research – frequently labelled as the "mobility biographies approach". Studies stemming from a broad variety of disciplines attempt to understand and explain everyday travel behaviour as a routine activity – changing due to key events such as residential relocation, the birth of a child or exogenous interventions (e.g. Klöckner, 2005; van der Waerden et al., 2003; Lanzendorf, 2003; Scheiner, 2007).

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In the last decade, several studies have analysed key events as a factor for travel behaviour change. It is therefore the objective of this paper to critically review existing theoretical and empirical studies relevant to the mobility biographies approach and to draw conclusions about the further theoretical development of this branch of research. To this end, we systematically reviewed published scientific work on the subject. As a first step of this review, we identified the 25 articles and studies most relevant to the mobility biographies approach and the related analysis of key events. We looked at (i) the notion and theoretical understanding of key events in these studies, (ii) the specific key events and travel behaviour indicators analysed, (iii) the data employed and (iv) important outcomes. From this review of studies, we developed a theoretical framework encompassing all types of key events in the studies selected and suggested a categorisation for these key events. Furthermore, we critically reviewed the understanding and methodological background of key events in the studies available and drew conclusions on the ongoing challenges faced by the approach. We therefore believe this framework to be helpful for guiding further research.

The paper is structured as follows. We first summarise the theoretical background of mobility biographies from the literature and, simultaneously, discuss the various alternative notions of key events we found in the studies analysed (Section 2). Next, we discuss the studies we found most important for this review of existing work, explaining the theoretical framework we suggest for the further development of this approach (Section 3). Then we critically review the future challenges facing the mobility biographies approach and, in particular, claim that the key events concept requires specification and methodological improvement, indicating further research gaps (Section 4). We end with some conclusions reflecting on the contribution of our framework to future research (Section 5).

2. Theoretical framework: the mobility biographies

In mobility research, the life course approach was originally introduced to explain long-term mobility decisions, such as residential relocation and migration (e.g. Mulder and Wagner, 1993; see Mortimer and Shanahan, 2003 for an overview). Later, short-term mobility decisions, such as travel mode decisions, were also considered using the life-span perspective (Scheiner and Holz-Rau, 2013a). The mobility biographies approach was developed to investigate travel behaviour stability and change over time by acknowledging the importance of routines. The concept posits the existence of key events in different life course trajectories that are relevant for mobility behaviour. Key events may influence and change travel behaviour to an important degree, and are followed by a period of relative stability until a new, relevant event occurs (Lanzendorf, 2003). Various aspects can impact on mobility behaviour such as trip frequency, covered distances, activity spaces and mode use, as well as mobility-related long-term decisions (like residential relocation, the purchase of a car, bicycle or season ticket) (Scheiner, 2007).

Although several studies based on the mobility biographies approach have been published, to our knowledge only two, Lanzendorf (2003) and Scheiner (2007), consider key events and their effects on mobility behaviour in a broader theoretical framework. Lanzendorf (2003) developed his framework based on the life-style concept by Salomon (1983) and distinguishes between three domains of individual longitudinal trajectories: (i) the life-style domain, (ii) the accessibility domain and (iii) the mobility domain. The life-style domain combines events in the context of demography, household composition, profession and leisure on an individual level. Events include characteristics such as changes in household composition or the birth of a child. The professional domain includes key events such as beginning, ending or changing a job. Children's activities, hobbies or other spare-time activities form the dimension of leisure. Lanzendorf (2003) argues that changes in the life-style domain often lead to consequences in the accessibility domain. The birth of a child might make it necessary to move to a larger apartment. As a consequence, residential location and distances to places of daily activities (e.g. job, recreation) change. Furthermore, this may impact on the availability and choice of travel mode as a consequence of changed needs and conditions. This reflects the domain of mobility, which refers to long-term decisions such as a car purchase or subscribing to a season ticket for public transport (PT). External factors in the spatial environment, such as road closures (Fujii et al., 2001) or the levying of a toll (Eliasson, 2014), are other examples of influences on the accessibility of locations. Changes in the domains can be a result of one another and are thus not hierarchical.

Scheiner (2007) divides mobility biographies and key events, which he postulates to be relevant in the context of mobility, slightly differently from Lanzendorf. He places them into three life domains: (i) events that belong to the household and family biography such as leaving home, the birth of a child, divorce and changes in household size; (ii) the employment biography comprising completion of training, changing of jobs, changes in income and retirement; (iii) the residential biography with residential relocations and other changes in the environment. Scheiner also recognises interrelations between the domains, but does not elaborate on them theoretically.

The interdisciplinary potential of the mobility biographies approach should be noted here. Drawing and relying on findings from sociology, psychology and geography, it allows for an integrated assessment of spatial contexts and accessibility, interacting with social, individual and subjective factors to analyse and understand the evolvement of travel behaviour change over time. Thus, it offers the opportunity to improve understanding of the various factors affecting travel behaviour change, and, ultimately, to design efficient and well-accepted policy intervention instruments.

In the mobility biographies approach triggers of behavioural change are called key events. However, in other publications these events are named and defined differently. Most common in the field of travel behaviour research are the terms "key event" (Lanzendorf, 2003, 2010; Scheiner, 2007; van der Waerden et al., 2003), (mode-related) "life (course) event" (De Groot et al., 2011; Klöckner, 2005; Schäfer et al., 2012), "disruptive event" (Marsden and Docherty, 2013), "life-cycle event" (Sharmeen et al., 2014), "turning point" (Beige and Axhausen, 2012) or simply "event" (Beige and Axhausen, 2008). Van der Waerden et al. (2003, p. 2) define key events as "major event[s] in a personal life that will trigger a process of reconsidering current behaviour" such as reaching the legal age for a driver's license and therefore considering using the car in the future. They distinguish such events from the so-called "critical incidents", which they define as "an event that has a major impact on one's attitude such as the involvement in an accident", and which usually and contrary to a key event, occur unexpectedly. Other authors have a broader understanding of key events. Klöckner (2005), for example, defines mode-related life events as all events in one's life course that, first, have a subjective connection to mode choice, second, can be limited in terms of time or at least have a certain starting point, and, third, have outstanding importance because of their rarity or uniqueness. Describing a disruptive event as impacting on the supply of transport or the costs of its use, Marsden and Docherty (2013) locate this kind of event on an aggregated level rather than on an individual one. Thus, common to these events is that either the context changes due to events beyond individual control, or that the individual changes the context him- or herself through intentional life events.

Context in this sense encompasses the physical environment, infrastructure and spatial, social and time cues.

Findings from social and environmental psychology suggest that daily behaviours are not the outcome of a unique decision-making process but manifest rather as frequently recurring patterns that rely mainly on rules of thumb based on former experience and activated by daily situational cues (Triandis, 1977; Oullette and Wood, 1998; Klöckner and Matthies, 2012). However, when the context and, thus, the situational cues change, formerly established habitual behaviour may no longer function, and conscious decision-making is required before the newly adjusted habits can be rebuilt (Klöckner, 2005). In such specific cases, behavioural intention may become more important for actual behaviour, and the attention of individuals to related information and their propensity for behavioural change increases. Verplanken et al. (2008, p. 122) describe this assumption as "habit discontinuity hypothesis: context change has the potential to make behaviour-relevant information more salient and influential, which may lead to new choices and decisions". Meanwhile, the concept of habitual behaviour and habit disruption has been widely recognised in mobility research (e.g. Aarts et al., 1997; Gärling and Axhausen, 2003; Klöckner and Matthies, 2004; Klöckner et al., 2003; Verplanken et al., 1994).

Looking at the origins of life course research in the field of psychology, the term life events is used for situations in the life course that trigger behavioural change and that can be either expected or occur very suddenly (Filipp, 1995). Initially, such situations cause stress by demanding a new orientation or inducing adaptation processes which may challenge the further development or the psychological well-being of an individual (Selye, 1984). Although the taxonomy of life events may differ between scientific (sub)disciplines (Montada, 2008; Filipp, 1995), life events are subjectively important for individual life and may be related to (i) age (marriage, childbirth, start of school, retirement), (ii) a historical period (war, technological change) and (iii) non-normative events (flood, temporary unemployment) (Filipp, 1995; Hultsch and Cornelius, 1995).

In line with van der Waerden's definition of key events (see above), we summarise that a life event turns into a key event if it has significant meaning for the individual and activates a re-evaluation of mobility behaviour, which might result in a behavioural change. Consequently, key events may not only be life events in the sense of definitions derived from psychology, but also exogenous interventions and long-term mobility decisions. Thus very different events, adaptations or interventions can be considered as key events, depending on individual subjective perspectives.

3. Key events and their influence on travel behaviour – a theoretical framework

In order to assess the findings, methodologies and potential challenges, we systematically gathered scientific publications on the subject of mobility biographies and related work. We included mainly English language publications from acknowledged scientific journals in our analysis and, due to their relevance to the field, in some cases also added some German language journal articles, PhD dissertations, articles in miscellanies and non-published reports. However, we have to admit that articles and reports in languages other than English and German have not been considered.

From the literature review we identified 25 studies we saw as most important for the systematic assessment of key events and related travel behaviour changes, and which we analysed in further detail. Of all the studies we became aware of that focused on key events and travel behaviour changes and were published in the last 14 years, we chose these 25 studies to cover a broad variety of (i) key events, (ii) research groups publishing the studies, (iii) underlying theoretical assumptions, (iv) data sets, and (v) regions worldwide.

Table 1 summarises, for each of the studies, the empirical method, characteristics of the data set used, the key events mentioned, and the dependent travel behaviour variable in the analyses. However, it should be noted that this list of publications is not meant to be exhaustive, but rather to give an overview of relevant studies and to support our findings presented subsequently.

Furthermore, referring to the theoretical findings presented in Section 2 and in combination with the analyses of the 25 studies above, we derived a theoretical framework for the further assessment of the impact of key events on daily mobility decisions. Four elements are considered here: three types of key events and further long-term processes that cannot be characterised as key events (see Fig. 1):

(i) Life events, separated into private and professional career.
(ii) Adaptations in long-term mobility decisions, which on the one hand serve as key events by themselves and, on the other hand, may be caused by preceding life events or external interventions, or may even lead to key events.
(iii) Exogenous interventions.
(iv) Long-term processes in life, which are rather insidious processes that are not perceived as one special event.

First, life events may be subdivided into private and professional careers. In the private career, changes in the number of household members are well-known for mobility behaviour changes. A rise in the number of adults of driving age in a household increases car ownership (Dargay and Hanly, 2004; Prillwitz et al., 2006) and car use (Prillwitz and Lanzendorf, 2006). The opposite trend decreases car ownership, for example when children move out of the parental home (Dargay and Hanly, 2004). The formation of a household with a partner leads to more car use as a passenger (Scheiner and Holz-Rau, 2013a). In contrast, a separation seems to decrease car use and increase PT and non-motorised mode use, although studies have found no significant effects (Scheiner and Holz-Rau, 2013a) or only a minor influence (Klöckner, 2005). This result supports the hypothesis of asymmetric development (Horeni et al., 2007). If an individual returns to a former status once a key event has taken place, one cannot assume a corresponding reversion in travel behaviour. So far, this asymmetry is mainly confirmed for car ownership: earning a higher income often results in the purchase of a car. Returning to the former income status, research results show, does not, however, necessarily lead to the disposal of a car (Beige, 2008; Dargay, 2001).

The birth of a child affects various areas of daily life and has an influence on travel behaviour: different shopping and transport needs arise, activities change and maintenance as well as leisure activities need to be rearranged. Often the birth of a child is accompanied by an interruption in an educational or professional career and therefore also leads to a change of destinations, trips or travel modes (Lanzendorf, 2010). This is especially true in the case of women (Heine et al., 2001). However, partially contradictory results have been found: a significant reduction in women's general travel demand after the birth of a child (Ottmann, 2010), less use of PT and bicycle (Scheiner and Holz-Rau, 2013a), an increase in car ownership (Prillwitz et al., 2006) and higher car use (Oakil et al., 2011; Heine and Mautz, 2000), although others could not confirm this with their data (Scheiner and Holz-Rau, 2013a; Clark et al., 2014). Children starting school often involves higher daily trip rates for parents, especially for mothers (Best and Lanzendorf, 2005; Skinner, 2003), as independent travel by

Table 1
Overview over important studies concerning key events.

Author(s) (year)	Observed key events							Dependent variable(s)	Method					Data				
	Life event		Exogenous intervention		Adaptation		Key event(s)		Quantitative	Qualitative	Panel data	Retrospective/ cross-sectional data	Pseudo panel data	Data used	*N* (individuals)	Year of data	Specifica of person sample	Country
	Private career	Professional career	Targeted	Non-targeted	Residential relocation	Long-term modal decision												
Bamberg et al. (2003), Bamberg (2006)			x		x		Intervention for movers: combination of information and a free public transport ticket	Travel mode choice (PT use, bicycle, walking), attitude, habit, further psychological constructs		x		x*		Own study	169	–	People planning to move within the next 6 months to Stuttgart, Germany	Germany
Beige and Axhausen (2008, 2012)	x	x			x	x	Changes in education or employment, relocation, childbirth, moving out of parents house	Car availability, season card ownership	x			x		Own study	1.166	2005 (1985–2004)	Households in Zürich region, predominantly those who moved within the last 5 years	Switzerland
Ben-Elia and Etema (2011)			x				Intervention: getting a reward by driving to work earlier or later, by switching mode or by teleworking	Commuting time and mode	x		x*			Own study	341	2006	Commuters to The Hague	Netherlands
Burbidge (2012)		x					Staying abroad	Use of PT, car, walking/ bicycling, car ownership, driving license	x			x		Own study	662	–	Students living abroad > 60 days (University in Utah)	USA
Chatterjee et al. (2013)	(x)	(x)		(x)	(x)	x	Reasons for turning point in cycling behaviour	Use of bicycle		x		x		Own study	144	2010–11	Inhabitants of "Cycling Cities and Towns" (programme)	UK
Clark et al. (2014)	x	x			x	x	Relocation, gain/loss of partner, childbirth, changes in household structure, change in employment, retirement, gain driving licence	Change of number of cars in household, commute mode of person to or from car	x		x			UK Household Longitudinal Study	32.151	2009/10	Representative sample of UK population (weighted)	UK
Dargay (2001)		x					Income change	Car ownership	x				x	UK Family Expenditure Survey	265	1970–1995	Random sample	UK
Dargay and Hanly (2004)	x	x			x		Relocation, number of household members, change of employer or employment status, income	Car ownership, commuting by car, commuting time	x		x			British Household Panel Survey	~5000/year	1991–2001	Representative sample of Great Britain (without Scotland, Wales, Northern Ireland)	England
De Groot et al. (2011)	x	x			x		Formation and break-up of unions, childbirth, change in job situation	Residential relocation	x		x	x		Housing Demand Survey 2002, enriched with longitudinal register data	61.075	2002, 1999–2005	–	Netherlands

Table 1 (*continued*)

Author(s) (year)	Observed key events						Key event(s)	Dependent variable(s)	Method					Data				
	Life event		Exogenous intervention		Adaptation				Quantitative	Qualitative	Panel data	Retrospective/ cross-sectional data	Pseudo panel data	Data used	*N* (individuals)	Year of data	Specifica of person sample	Country
	Private career	Professional career	Targeted	Non-targeted	Residential relocation	Long-term modal decision												
Eriksson et al. (2008)			x				Intervention: home-visit to the participants discussing possibilities to reduce car use	Car use (week diary), car habit, moral motivation to reduce car use	x		x*			Own study	71	–	Car users	Sweden
Evandrou et al. (2010)	x	x			x		Change in partnership status or employment status, retirement, health status	Residential relocation	x		x			British Household Panel Study	17 waves; total sample 71.356 person years	1991–2007	People aged ⩾ 50	UK
Fujii and Gärling (2003) *[Study 1]*		x					University graduation	Mode use (car, PT)	x		x			Own 2-wave panel study	53	2000	Students graduating university	Japan
Fujii and Gärling (2003) *[Study 2]*				x			8-day freeway closure	Mode use (PT, car)	x		x			Own 2-wave panel study	240	1998/9	Car drivers	Japan
Garvill et al. (2003)			x				Intervention: increasing awareness to alternatives to car use and forcing deliberate decision making when planning a trip	Car use (week diary), car habit, car attitude	x		x*			Own study	115	1999	Participants with driver's license, car in household, less than 20 km to work, living in the inner city of Umeå/Sweden	Sweden
Harms (2003)	(x)	(x)	(x)		(x)	x	Self-reported reasons for joining car pooling, including changes in personal life situation and of surrounding mobility conditions	Joining car pooling	x			x		Own study	626	2000	New customers at or interested people in joining car pooling organisations and a random sample of Swiss	Switzerland
Hjorthol et al. (2010)		x					Retirement	Number of car trips, number of leisure and shopping/ service trips and mode use, driving licence, car in household	x				x	National travel surveys	See text for details	First cohort between 1981–85, second 2005–06	Comparison of two cohorts for each country, 20 years perspective	Denmark, Norway, Sweden
Klöckner (2005)		x			x	x	Self-reported key events, such as getting a drivers licence, starting at university/ apprenticeship, moving to a new city, buying a car, changing to secondary school, starting to work	Degree of influence on mode choice, strength of car use habit	x			x		Own study	91	2003	Online survey, participants were invited via snowballing, newsgroups, mailinglists	Questionaire on a German website
Lanzendorf (2010)	x	(x)			(x)	(x)	Child birth	Mode use for activities, ownership of car, seasonal ticket or bicycle, travel patterns		x		x		Own study	20	2003/4	Parents of small children	Germany
Oakil et al. (2011)	x	x			x		Leaving parental home, childbirth, separation, start cohabitation, change in employment status or employer, relocation, empty nest; also anticipated events	Car use as commute mode	x			x		Own study	"less than 200"	2010	–	Netherlands

(*continued on next page*)

Table 1 (*continued*)

Author(s) (year)	Observed key events						Key event(s)	Dependent variable(s)	Method					Data				
	Life event		Exogenous intervention		Adaptation				Quantitative	Qualitative	Panel data	Retrospective/ cross-sectional data	Pseudo panel data	Data used	*N* (individuals)	Year of data	Specifica of person sample	Country
	Private career	Professional career	Targeted	Non-targeted	Residential relocation	Long-term modal decision												
Ottmann (2010)	x	x				x	Childbirth, retirement, getting driving license	Car availability, car use, trip distance, number of trips	x		x			German national travel survey, mobility Panel, long distance travel panel	See text for details	Different data sets and waves between 1976 and 2007	–	Germany
Prillwitz et al. (2006)	x	x			x		Relocation, changes in household structure, childbirth, income change, change of employment status or increase of education level of household head	Increase or decrease in car ownership	x		x			German Socio-economic Panel	4698 households	1998–2003	–	Germany
Ryley (2006)	x	x				x	10 life stages: students, in-between jobs, mid earners, high earners without children, part timers without children, child minders, high earners with children, part-timers with children, retired couples, retired living on own	Related to motor car availability and use (ability to drive, household access to vehicle and vehicle type), and bicycle availability.	x		x		x	Edinburgh based Scottish Household Survey	2324	1999/2000	–	Scotland
Scheiner and Holz-Rau (2013a), Scheiner (2011)	x	x			x	x	Childbirth, formation of household, separation, child moving out, entering/ leaving labour market, change of workplace, retirement	Change in number of trips per day made by transport mode	x		x			German Mobility Panel	11,236 weeks from 6932 individuals	1994–2008	Sample organised in overlapping, three consecutive years enduring waves	Germany
Thøgersen (2009)			x				Intervention for car drivers: receiving a free month travel card/customised travel plan/planning intervention	Use of PT for commuting, car use habit, psychological constructs	x		x*			Own study	597	2002/2003	Copenhagen car owners	Denmark
van der Waerden et al. (2003)		x			x	x	Occured most frequently in the sample and therefore have been analysed: relocation, starting to work, change of work situation, getting a drivers license, getting a car	Changes in availability of transport mode alternatives, attitudes towards modes, mode choice	x			x		Own study	173	-	"Convenience sample"	NA

x* study was conducted before and after an intervention.
(x) key events have been observed, but only play a minor role in the investigation, the focus is on another event.

children has declined in recent decades (Pooley et al., 2005). Further life events in the private life-style dimension that influence travel behaviour, such as the death of a partner, are mentioned in the available literature but have not yet formed (to the best of our knowledge) the focus of any mobility studies.

Life events in the professional domain were investigated less often by transport and mobility researchers than those in the private domain. The main focus was on the event of retirement and that of entry into the labour market. As already mentioned, different life events are interconnected, for example, the birth of a child as a life event in the private career may lead to follow-up events in other trajectories, like parental leave in the professional career (Lanzendorf, 2010). Klöckner (2005) identifies life events that influence mode choice in a retrospective online survey. Among the six most frequently mentioned key events are starting university or an apprenticeship, changing to secondary school and the start of professional life. This shows that even if most studies focus on events in the life-style domain, events in the professional domain are an important factor as well.

One of the earliest and most cited studies focusing on educational life events is a Japanese panel survey conducted with graduates two months before and three months after they finished their university degrees and entered into the labour market. In many cases, a change in the commuting mode of respondents was observed (Fujii and Gärling, 2003). Most changes in the employment career happen between the ages of 20 and 35 years (Beige and Axhausen, 2008). A reduction in car use has been observed as a consequence of unemployment (Prillwitz et al., 2006). Oakil et al. (2011) report that modal shift is significantly affected by changing the employer, changing from full- to part-time work and resuming or starting full-time work. Prillwitz and Lanzendorf (2006) showed a correlation between the event "retirement" and the reduction of car kilometres, which does not come as a surprise, as commuting becomes no longer necessary. Although commuting and work-related trips decline after retirement, Hjorthol et al. (2010) assert that leisure and shopping trips do not immediately decline. A decrease in such trips is observed only for those aged 75 years and older. Retirement is sometimes associated with migration (Evandrou et al., 2010), which precipitates additional changes and, therefore, further opportunities for changing travel behaviour.

As a second element of our theoretical framework, we identified adaptations of long-term mobility decisions as another important group of key events affecting travel behaviour. These key events, such as changes in vehicle ownership, season ticket (Beige and Axhausen, 2008, 2012; Prillwitz et al., 2006) or residential relocations (De Groot et al., 2011; Kley, 2011), usually involve large acquisition costs (Beige and Axhausen, 2012; Simma and Axhausen, 2001).

Frequently, long-term mobility decisions are triggered by previous life events from the professional or private domain or by exogenous interventions. For instance, a residential move to a bigger apartment may follow the birth of a child as a life event. As a further example, Harms (2003) reports that joining a car club is often the consequence of another, previous key event. Still, it should be noted that such adaptations might also occur due to reasons other than previous life events or exogenous interventions. A residential relocation may be solely due to dissatisfaction with the current dwelling, and the purchase of a car may be founded merely on the wish to possess one. These types of key events should be seen as embedded parts of the mobility biography and not only as resulting from other key events, because a change in long-term mobility decisions might also impact everyday mobility behaviour.

The case of residential relocations is even more complicated, as individual preferences and attributes in the environment interact with each other. On the one hand, transportation characteristics and the built environment of a neighbourhood are taken into account in an individual's decision-making process when choosing a new neighbourhood. On the other hand, the transport options available in the new location affect travel behaviour and vice versa (Klinger and Lanzendorf, 2015). Recent research challenges the assumption that travel choices are affected solely by the built environment, pointing directly to the role of residents' attitudes in pre-determining residential choice, so-called residential self-selection (see for example Bagley and Mokhtarian, 2002; Bohte et al., 2009; Cao et al., 2009; Schwanen and Mokhtarian, 2005). However, due to the change of external transport options as well as changed requirements because of a key event, a change in travel behaviour is possible (Scheiner and Holz-Rau, 2013b). For this review, it is important to state that residential relocations are often accompanied or even induced by life events (e.g. change of workplace) and are therefore conceptualised in this framework as adaptations rather than as life events, as in most other studies.

The third element of our theoretical framework, the exogenous interventions, comprises key events that are induced externally. Such events provide the opportunity to gain new experience, for example, using a new travel mode. The conducting of interventions synchronised with life events may take advantage of the opening of a "window of opportunity" (Franke, 2001, p.17) for behaviour change. We distinguish between (i) interventions designed for travel behaviour change, and (ii) non-targeted interventions, which nevertheless affect travel behaviour. In the first group of interventions we summarise measures such as a free public transport ticket (Bamberg et al., 2003; Bamberg, 2006; Fujii and Kitamura, 2003; Thøgersen, 2009), a cheaper public transport ticket (Bamberg and Schmidt, 1998) and a public transport ticket given on a trial basis after residential relocation (Bamberg et al., 2008). Furthermore, the implementation of new intentions (Eriksson et al., 2008), increased awareness (Garvill et al., 2003) and incentives for behaviour change (Ben-Elia and Ettema, 2011) have been evaluated. The second group, non-targeted interventions, includes the (de)construction of transport infrastructure like the closure of a road (Fujii et al., 2001; Fujii and Gärling, 2003; Watling et al., 2012), increases in the cost of car use (Horeni et al., 2007; Wegener, 2013) and fuel shortages (Marsden and Docherty, 2013). This group also contains work by researchers conducting studies to investigate the effects of "disruptive events", such as extreme natural events like storms, floods (Marsden and Docherty, 2013) and volcanic eruptions (Guiver and Jain, 2011; Birtchnell and Büscher, 2011). (Rail-) strikes (van Exel and Rietveld, 2009) can be assigned to this group of interventions as well.

The fourth element of our framework recognises that, ultimately, long-term processes in life happen more gradually and are not perceived as a specific key event, such as the gradual change experienced in socialisation or in certain age groups. Travel behaviour during the childhood or adolescent phase is of special interest due to the ongoing debate on the effects of socialisation on travel behaviour (Baslington, 2008; Buliung et al., 2012; Haustein et al., 2009; Tully and Baier, 2011). Research on the mobility of the elderly takes another particular age group into consideration. In this context, the transition of a young old to an old old (Hjorthol et al., 2010) and the consequences for personal mobility are subjects of investigation (Flade, 2002; Rauprich, 2008; Ryley, 2006; Scheiner, 2006; Curl et al., 2013). Furthermore, historical context provides conditions that influence the individual as well: war or technological progress, such as the development of smartphones, reveal new opportunities or restrictions in daily mobility. Such gradual changes and historical contexts may affect the occurrence of life events and resulting mobility decisions. Furthermore, they influence means of intervention and the way in which they are perceived.

Based on the fundamental hypothesis presented at the beginning of this review, experiencing a key event implies the interruption of habits and the beginning of active decision-making strategies as described by different models of action, such as the theory of planned behaviour (Ajzen, 1991) or the norm-activation model (Schwartz, 1977). Thus, active decision-making with its implied constructs, such as attitudes, norms and perceived behavioural control, is triggered and may be changed. Mobility requirements or needs, opportunities and abilities are also taken into consideration (influence on everyday mobility decisions in Fig. 1). Conversely, the activated decision-making process might in return influence factors in the scheme, such as the adaptation of long-term mobility decisions or the perception of exogenous interventions.

We assume that these key elements are not hierarchical. Adapting a long-term mobility decision may also lead to a life event, even if the probability is lower than the other way around. For instance, the purchase of a car may be the reason for getting a new job. Also, the above mentioned influence of private on professional events and vice versa may be direct or may be mediated by the adaptation of long-term mobility decisions, therefore leading to changes in everyday mobility.

4. Challenges in researching key events – a critical view of previous studies

When examining and comparing previous research in the field of key events, a number of content-related characteristics and methodological issues become apparent. In the following, we identify the challenges mobility behaviour research will have to face when studying key events. First, we take a closer look at problems arising from deficits in the definition and theoretical foundation of the term key events and its temporal and spatial dimension (4.1). Second, methodological implications will be discussed in terms of dealing with data structure and the operationalisation of the research (4.2). Finally, we identify gaps requiring further research on key events and their effects on mobility behaviour (4.3).

4.1. Challenges for understanding key events and their temporal, spatial and contextual aspects

Reviewing the literature on key events in the context of mobility, it becomes evident that the term key event or related notations such as life (course) event or turning point often lack a solid and clear definition. We assume the reason for this is a neglect of the theoretical foundation of the term. Various terms and underlying concepts exist which partly focus on one of the summarising categories shown in Fig. 1. Other approaches concentrate on more comprehensive factors and consider, for example, lifestyles as a concept that embeds key events as well (Van Acker et al., 2014). As key events are a matter of subjective perception, we cannot determine on an aggregated level which concrete event serves as a key event and which does not. However, we believe it is essential to use a clear definition of the term based on a sound theoretical concept that comprises at least five essential dimensions: the (i) temporal frame, (ii) causal directions, (iii) the spatial context, (iv) further influencing factors, and (v) a holistic perspective.

First, a central issue is that theoretical concepts do not clarify the temporal frame of key events. Time-lagged effects resulting from key events are often assumed (e.g. Lanzendorf, 2003; Scheiner and Holz-Rau, 2013a), but are considered in only few studies (Oakil et al., 2011). Beige and Axhausen (2008) show that adaptations resulting from key events generally take place within one year, although a larger time period may also be possible, albeit with rapidly decreasing probability. In the same way, adaptations may occur in anticipation of an event, such as the birth of a child or forthcoming residential relocation, might happen before the actual event takes place (Oakil et al., 2011; Stanbridge et al., 2004). Similarly to the discussion of the start and end point of key events, the duration of the triggered decision-making process is discussed. Instead of taking place at only a delimited point in time, it has recently been hypothesised that the decision-making process covers a period of time (McCormack and Schwanen, 2011; Scheiner and Holz-Rau, 2013b). It follows that in some cases it is difficult to distinguish between life events and long-term processes, such as socialisation (Tully and Baier, 2011), aging (Hjorthol et al., 2010) or lifestyles (Van Acker et al., 2014).

Second, we see uncertainty about the causal direction of key events: which change is the event itself and which one the resulting effect? As an illustration, residential relocation is conceptualised as a key event in most studies, although it might represent an adaptation process to a previous event such as the birth of a child as well. In order to determine the causal direction and thus enhance the theoretical concepts, quantitative research should focus more on this issue and methods should be expanded to include more qualitative studies.

Third, apart from the neglect of temporal and causal directions, it seems that the impact of spatial aspects, such as altered distances or the available infrastructure and its quality, which may have changed due to a key event, are underestimated. Although some such aspects are picked up in the debate on residential self-selection, mobility behaviour research often disregards the objective spatial environment. The argument for not considering spatial aspects lies in the strong focus on the individual. Spatial aspects and further contextual factors are included indirectly due to the subjective perception of the individual, for instance in the psychological construct of perceived behavioural control, attitudes or sometimes in the observation of changed needs and opportunities after a key event.

Fourth, in the same way and perhaps due to similar reasoning, further contextual factors are not yet a research focus. Contextual factors are sometimes controlled for, such as age, income, modal availabilities or the influence of the social environment, but their causal directions are rarely discussed or analysed. For instance, a higher income functions as an explanatory factor for both the birth of a child and the purchase of a car, but the explanatory effect of the birth of a child for car purchase may be weak or non-existent. In the same way, a certain lifestyle that subsumes different attitudes and behaviour patterns may serve as an underlying explanatory factor.

Fifth, given these underrepresented debates on the dimension of time and spatial and contextual factors and the resulting uncertainty of causal directions, the interaction of both biographical dimensions, the private and the professional domain, should be the object of more discussion. Commonly, it is assumed that key events have less effect on travel behaviour in isolation, but that these different events are rather intertwined (Beige and Axhausen, 2012). The question is, however, which life dimensions are connected with each other in terms of key events occurring in temporal proximity, and whether one event improves the probability of the occurrence of another (Mulder and Wagner, 1993). Especially, the connection of residential relocation with events in the private dimension (Schoenduwe et al., 2015) or in interaction with education and family dimensions could already be demonstrated (Birg and Flöthmann, 1992; Rashidi et al., 2011). Zhang et al. (2014) show an interaction of household structure and employment/education biography with residential biography when explaining car ownership. But if residential relocation is considered rather as an adaptation consequent to the experience of a life event, then investigating the connection between different life dimensions seems to be an additional important aspect.

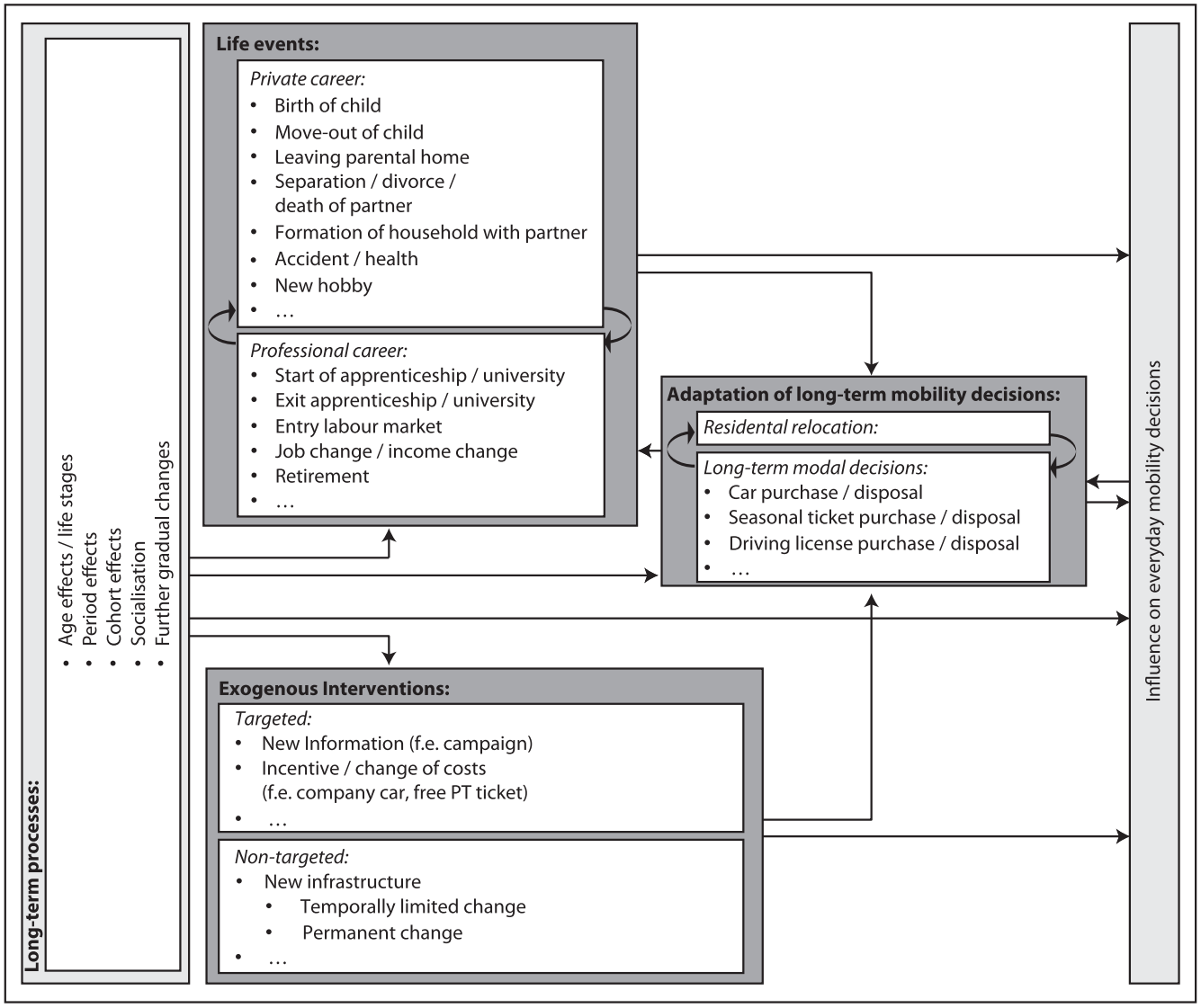

Fig. 1. The interaction of long-term processes, life events, interventions and long-term decisions with daily mobility decisions.

4.2. Methodological implications: data structure and operationalisation of studies

Research dealing with key events requires that methods be carefully applied. In part due to the above mentioned deficits in the definition and theoretical foundation of key events, we identified several problems in methodological implementations dealing with (i) the data set, (ii) the method of data collection, (iii) the applied method, (iv) the variety of the dependent variables, (v) the operationalisation of mobility behaviour, (vi) specialities of the sample characteristics, and (vii) the temporal or cultural frame of the studies.

First, due to the very different structure and operationalisation of studies considering key events and their influence on travel behaviour, comparing results and making generalising statements in order to draw overall conclusions is challenging. A large number of studies are secondary data analyses as the acquisition of data on mobility behaviour and key events is costly and time-consuming. The use of secondary data, however, often implies that studies are planned to suit data requirements and not vice versa. As many studies have applied secondary data mainly from national data sets (see Table 1, although due to the selection criteria we included many studies that collected their own data in order to be able to focus on their choice of life events), we assume that key event research has reached a point where national data sets reach their limits and it would be more interesting to focus on more detailed, in-depth studies. We therefore recommend conducting surveys tailored to the particular requirements of researching key events, where research questions can be transferred into the operationalisation of the survey and not the other way around.

Second, however, data acquisition is often based on surveys regarding only the time span shortly before and after a key event is experienced, in contrast to a life-span perspective. This entails restrictions as regards adaptations that have been undertaken in anticipation of a planned event as well as time-lagged changes. Research regarding a longer time span, but also many other studies on key events, rely on retrospective surveys with all the methodological weaknesses of behavioural and attitudinal recall. To better fit the needs of researching key events, we propose increasing the observed time span. The use of panel data incorporates both aspects. It reveals time-lagged effects on the one hand and shows less retrospection bias. But the conducting of such research seems

to be something of an exception (see e.g. Fujii and Gärling, 2003; Thøgersen, 2009), probably due to high expenditures of cost and time.

Third, as shown in Table 1, most studies analysing key events use quantitative data to prove effects. However, the situation during key events is very complex and the pure analysis of quantitative data may show effects that can be explained by other factors, as described above (4.1). Qualitative data much better captures underlying and new, not hypothesised factors and helps in understanding the complexity of multiple factors, whereas quantitative approaches often simplify such interrelations. We therefore emphasise the recent efforts that have been made in conducting qualitative approaches (see e.g. Chatterjee et al., 2013; Lanzendorf, 2010) or, even better, recommend a combination of both qualitative and quantitative methods.

Fourth, the variety of theoretical concepts of key events leads to different operationalisations and consequently to inconsistent and incomparable results. The problem becomes apparent when looking at the different concepts of the dependent variable that are applied in the studies under consideration. The measuring units concerning car use, for example, vary between number of trips, frequency of use (always, often, never) and covered distance, besides differences in trip purposes such as commuting and private use.

Fifth, at the same time, the previous example demonstrates the relatively narrow focus on travel mode choice as the primary dependent variable, representing a very restricted indicator that disregards other factors of mobility behaviour. Nevertheless, first efforts have been made to link different concepts that widen the focus to include factors such as the scope of social networks and time allocation to different activity types (Sharmeen et al., 2014). Some researchers analyse mobility biographies in the context of social networks in space (Ohnmacht et al., 2008; Axhausen, 2008). They examine individuals' biographies to focus on the effect of migration on the expansion of social linkages. Frändberg (2006, 2008, 2009) investigates long-distance travel and transnational mobility from a biographical perspective using time–space paths inspired by Hägerstrand's time-geography (1970). It is conceivable that further insights can be gained by including additional factors concerning the perception of personal mobility such as perceived mobility options, satisfaction or the closer inspection of possible changes in transport demands.

Sixth, concerning sample characteristics, the choice of respondents is in many cases limited to small target groups. Notably, people in older age groups are only rarely considered. In Klöckner's explorative online study (2005), for example, the underrepresentation of older respondents may have led to the neglect of retirement as a mobility-relevant life event. When drawing conclusions from these studies, the results should therefore be interpreted, compared and generalised with care.

Lastly, there are to date only a few studies that deal with key events in different cultural contexts (Behrens and Mistro, 2010; Belgiawan et al., 2014). For instance, Western countries form the main focus of research (see Table 1). The influence of key events on travel behaviour may differ with culture, values or framing conditions. This also holds true for the historical frame, which should be kept in mind when analysing, comparing and transferring conclusions. Key events may have had a different impact on mobility behaviour fifty years ago than they have nowadays, and the current impact may also vary from that in future generations.

4.3. Gaps for further research: investigating specific key events and interventions

From our analysis, we conclude that several groups of key events are underrepresented in research. This necessitates further work, especially in two fields. We therefore suggest prioritising studies that deal with (i) specific key events that have been neglected by researchers for several reasons, and (ii) interventions that show the practical impact measurements may have, for example, in the case of travel demand management.

First, recent studies mention many key events as theoretically having an influence on travel behaviour. In contrast to this assumption, only a small range of key events is actually investigated. In particular, key events which usually happen at a later phase of life, such as the death of the partner, health constraints or retirement, are presented as important turning points in theory, but are rarely the focus of studies. Furthermore, within the key events investigated there is a focus on residential relocation. This key event has been very thoroughly researched and implications are already being applied in practice (travel demand management, such as temporary free PT ticket for movers). This provides new fuel for a necessary debate about the role of residential relocation as a key event (e.g. changes in attitudes, re-evaluating current behaviour) versus the sole change of spatial context during the adaptation process (e.g. having better access to public transport) as a causal reason for travel mode change: Are spatial conditions the crucial factors?

Second, the research of life events is important and of high practical relevance, especially with respect to travel demand management and opportunities to support the increased use of green transport modes. The underlying principle is to derive benefit from the disruption of habits and to offer new transport opportunities in situations where attentiveness for alternatives is increased. At the present time, few intervention studies have been conducted or published in international English-language journals that aim to verify the assumption of a vulnerable phase being caused by key events. This again impedes comparison and overall conclusions. However, initial studies deal with the topic of "disruptive events", concentrating on the effects of extreme natural events or other occurrences that disturb daily travel, like strikes (van Exel and Rietveld, 2009). A further exception is represented by Burbidge (2012), who analyses changes in mode choice during and after studying abroad. As presented above, most studies focus on key events as interventions in daily travel behaviour. This has to be distinguished from interventions that take place simultaneously with key events. Studies focusing on this research area mainly study interventions, such as evaluating information campaigns and special PT tickets offered to movers new in a city (Bamberg, 2006, 2007), and their influence on consequent daily mode choice. In order to verify the influence of key events on travel behaviour and to evaluate the effectiveness of intervention for the further development of travel demand management, we encourage conducting more research in this area.

5. Conclusion

In many policy documents, travel behaviour change programs play a crucial role for developing a more sustainable transport system. However, theoretical understanding of individual and household motivations and abilities to change travel behaviour has remained somewhat limited. Following the acknowledgement of the central role of habits for daily travel choices and the relatively high stability of travel behaviour over longer time periods, researchers' interests now focus on rather instable phases of travel behaviour with a higher probability of travel behaviour change. With the mobility biographies approach, a theoretical framework for analysing these behaviour changes exists and has been put forward over the last decade. However, theoretical understanding of the way in which key events in an individual's travel biography affect mode choice or other travel-related decisions needs further development.

The first aim of this paper was to compare existing mobility biographies approaches and to disentangle their key elements for further theoretical consideration. We discussed recent findings about the effects of key events on travel behaviour and developed a theoretical framework for further research which shows four key elements strongly interacting and affecting daily travel behaviour: first, life events in the private career and professional career; second, the adaptation of long-term mobility decisions (e.g. residential relocations, car ownership, public transport season ticket) frequently triggered by private or professional life events; third, exogenous interventions either intended to change travel behaviour or not intended for that purpose; and, fourth, other long-term processes not related to key events (e.g. socialisation, period and cohort effects, age effects).

With our findings we developed a theoretical framework for understanding travel behaviour changes in a longitudinal perspective, both encompassing earlier research and guiding future investigation. Although these processes in everyday life are very complex, we believe that our theoretical framework may guide further research to better understand the interaction of relevant factors over time.

As future research in this theoretical framework emerges, the role of specific events, interventions and their overall impact, and especially their interrelations, need to be further clarified. Moreover, in our discussion of recent challenges for research on mobility biographies we identified the need for the clarification of the term key events in further studies. At present the concepts employed are relatively vague and undefined. The temporal and causal directions of key events are often unclear and not explicitly mentioned. Further dimensions of key events and a holistic consideration are neglected. The comparison of methodologies employed revealed that increased analysis of non-secondary panel studies would be helpful to examine such dimensions and a broader variety of key events. Furthermore, it was possible to identify a neglect of qualitative or combined methods that could allow more intensive investigation of complex interrelations. The current clear focus on mode choice as a dependent variable could be widened to include further aspects of travel patterns. Finally, we recognised that only a limited set of key events, target groups and countries have been investigated, as well as only a few intervention projects; this reveals various dimensions for further research.

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References

Aarts, H., Verplanken, B., van Knippenberg, A., 1997. Habit and information use in travel mode choices. Acta-Psychol. 96, 1–14.
Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50, 179–211.
Axhausen, K.W., 2008. Social networks, mobility biographies, and travel: survey challenges. Environ. Plan. B 35 (6), 981–996.
Bagley, M., Mokhtarian, P., 2002. The impact of residential neighborhood type on travel behavior: a structural equations modeling approach. Ann. Reg. Sci. 36, 279–297.
Bamberg, S., 2006. Is a residential relocation a good opportunity to change people's travel behavior? Results from a theory-driven intervention study. Environ. Behav. 38 (6), 820–840.
Bamberg, S., 2007. Using a residential relocation as starting point for breaking car use habits: The Munich Dialogue Marketing Campaign for New Citizens. In: Proceedings: SCP cases in the field of Food, Mobility and Housing. Workshop of the Sustainable Consumption Research Exchange (SCORE!) Network, Paris/France. 4./5.06.07, pp. 365–374.
Bamberg, S., Schmidt, P., 1998. Changing travel-mode choice as rational choice: results from a longitudinal intervention study. Ration. Soc. 10, 223–252.
Bamberg, S., Rölle, D., Weber, C., 2003. Does habitual car use not lead to more resistance to change of travel mode. Transportation 30, 97–108.
Bamberg, S., Nallinger, S., Heipp, G., Heller, J., 2008. Multimodales Marketing für Münchener Neubürger: Entwicklung, Evaluation, Ausblick. Internationales Verkehrswesen 60 (3), 73–76.
Baslington, H., 2008. Travel socialization: a social theory of travel mode behavior. Int. J. Sustain. Transport. 2 (2), 91–114.
Behrens, R., Mistro, R.D., 2010. Shocking habits: methodological issues in analyzing changing personal travel behavior over time. Int. J. Sustain. Transport. 4 (5), 253–271.
Beige, S., 2008. Long-term and mid-term mobility decisions during the life course. Dissertation, ETH Zürich.
Beige, S., Axhausen, K.W., 2008. Long-term and mid-term mobility decisions during the life course: experiences with a retrospective survey. IATSS Res. 32 (2), 16–33.
Beige, S., Axhausen, K.W., 2012. Interdependencies between turning points in life and long-term mobility decisions. Transportation 39 (4), 857–872.
Belgiawan, P.F., Schmöcker, J.-D., Abou-Zeid, M., Walker, J., Lee, T.-C., Ettema, D.F., Fujii, S., 2014. Car ownership motivations among undergraduate students in China, Indonesia, Japan, Lebanon, Netherlands, Taiwan, and USA. Transportation 41 (6), 1227–1244.
Ben-Elia, E., Ettema, D., 2011. Changing commuters' behavior using rewards: a study of rush-hour avoidance. Transport. Res. Part F: Traff. Psychol. Behav. 14 (5), 354–368.
Best, H., Lanzendorf, M., 2005. Division of labour and gender differences in metropolitan car use. J. Transp. Geogr. 13 (2), 109–121.
Birg, H., Flöthmann, E., 1992. Biographische Determinanten der räumlichen Mobilität. In: Birg, H. (Ed.), Forschungs- und Sitzungsberichte, Hannover, pp. 27–52.
Birtchnell, T., Büscher, M., 2011. Stranded: an eruption of disruption. Mobilities 6 (1), 1–9.
Bohte, W., Maat, K., van Wee, B., 2009. Measuring attitudes in research on residential self-selection and travel behaviour: a review of theories and empirical research. Transport Rev. 29 (3), 325–357.
Bongardt, D., Creutzig, F., Hüging, H., Sakamoto, K., Bakker, S., Gota, S., Böhler-Baedeker, S., 2013. Low-carbon Land Transport: Policy Handbook. Routledge, Abingdon, Oxon, New York.
Buliung, R., Sultana, S., Faulkner, G., 2012. Guest editorial: special section on child and youth mobility – current research and nascent themes. J. Transp. Geogr. 20 (1), 31–33.
Burbidge, S.K., 2012. Foreign living experience as a predictor of domestic travel behavior. J. Transp. Geogr. 22, 199–205.
Cao, X., Mokhtarian, P.L., Handy, S.L., 2009. Examining the impacts of residential self-selection on travel behaviour: a focus on empirical findings. Transport Rev. 29 (3), 359–395.
Chatterjee, K., Sherwin, H., Jain, J., 2013. Triggers for changes in cycling: the role of life events and modifications to the external environment. J. Transp. Geogr. 30, 183–193.
Clark, B., Chatterjee, K., Melia, S., Knies, G., Laurie, H., 2014. Examining the relationship between life transitions and travel behaviour change: new insights from the UK household longitudinal study: 46th Universities' Transport Studies Group Conference, Newcastle University, 6–8 January 2014. <http://eprints.uwe.ac.uk/22312/1/Clark-Chatterjee-LifeTransitions.pdf> (accessed 17.03.14).
Curl, A.L., Stowe, J.D., Cooney, T.M., Proulx, C.M., 2013. Giving up the keys: how driving cessation affects engagement in later life. Gerontol. 54 (3), 423–433.
Dargay, J., 2001. The effect of income on car ownership: evidence of asymmetry. Transp. Res. Part A 35, 807–821.
Dargay, J., Hanly, M., 2004. Volatility of car ownership, commuting mode and time in the UK. In: Paper presented at the World Conference on Transport Research, Istanbul, Turkey, July 2004.
De Groot, C.D., Mulder, C.H., Das, M., Manting, D., 2011. Life events and the gap between intention to move and actual mobility. Environ. Plan. A 43 (1), 48–66.
Eliasson, J., 2014. The role of attitude structures, direct experience and reframing for the success of congestion pricing. Transport. Res. Part A: Policy Pract. 67, 81–95.
Eriksson, L., Garvill, J., Nordlund, A.M., 2008. Interrupting habitual car use: the importance of car habit strength and moral motivation for personal car use reduction. Transport. Res. Part F: Traff. Psychol. Behav. 11 (1), 10–23.
Evandrou, M., Falkingham, J., Green, M., 2010. Migration in later life: evidence from the British Household Panel Study. Popul. Trends 141 (1), 77–94.
Filipp, S.-H., 1995. Kritische Lebensereignisse. Beltz, Weinheim.
Flade, A., 2002. Städtisches Umfeld und Verkehrsmittelnutzung älterer Menschen. In: Schlag, B., Megel, K. (Eds.), Mobilität und gesellschaftliche Partizipation im Alter. Kohlhammer, Stuttgart, pp. 116–129.
Frändberg, L., 2006. International mobility biographies: a means to capture the institutionalisation of long-distance travel? RCIT 9 (4), 320–334.

Frändberg, L., 2008. Paths in transnational time-space: representing mobility biographies of young Swedes. Geografiska Annaler B 90, 17–28.
Frändberg, L., 2009. How normal is travelling abroad? Differences in transnational mobility between groups of young Swedes. Environ. Plan. A 41 (3), 649–667.
Franke, S., 2001. Car Sharing: Vom Ökoprojekt zur Dienstleistung: Berlin, edition sigma.
Fujii, S., Gärling, T., 2003. Development of script-based travel mode choice after forced change. Transp. Res. Part F 6 (2), 117–124.
Fujii, S., Kitamura, R., 2003. What does a one-month free bus ticket do to habitual drivers? Transportation 30, 81–95.
Fujii, S., Gärling, T., Kitamura, R., 2001. Changes in drivers' perceptions and use of public transport during a freeway closure: effects of temporary structural change on cooperation in a real-life social dilemma. Environ. Behav. 33 (6), 796–808.
Gärling, T., Axhausen, K.W., 2003. Introduction: habitual travel choice. Transportation 30, 1–11.
Garvill, J., Marell, A., Nordlund, A., 2003. Effects of increased awareness on choice of travel mode. Transportation 30, 63–79.
Guiver, J., Jain, J., 2011. Grounded: impacts of and insights from the volcanic ash cloud disruption. Mobilities 6 (1), 41–55.
Hägerstrand, T., 1970. What about people in regional science? Papers in Regional Science 24 (1), 7–24.
Harms, S., 2003. Besitzen oder Teilen: Sozialwissenschaftliche Analyse des Carsharings. Rüegger, Zürich, Chur.
Haustein, S., Klöckner, C., Blöbaum, A., 2009. Car use of young adults: the role of travel socialization. Transp. Res. Part F 12, 168–178.
Heine, H., Mautz, R., 2000. Möglichkeiten und Grenzen des Autoverzichts. Die Wahl des Verkehrsmittels angesichts der Mobilitätszwänge und normativen Ansprüche der heutigen familiären Lebensweise. Abschlußbericht: Göttingen, 333pp. (accessed 26.10.12).
Heine, H., Mautz, R., Rosenbaum, W., 2001. Mobilität im Alltag. Warum wir nicht vom Auto lassen. Campus, Frankfurt/New York.
Hjorthol, R.J., Levin, L., Sirén, A., 2010. Mobility in different generations of older persons. J. Transp. Geogr. 18 (5), 624–633.
Horeni, O., Gärling, T., Loukopoulos, P., Fujii, S., 2007. An experimental simulation of adaptations to increased car-use costs. Transport. Res. Part F: Traff. Psychol. Behav. 10 (4), 300–320.
Hultsch, D., Cornelius, S., 1995. Kritische Lebensereignisse und lebenslange Entwicklung: Methodologische Aspekte. In: Filipp, S.-H. (Ed.), Kritische Lebensereignisse, third ed. Beltz, Weinheim, pp. 72–91.
IPCC, 2014. 5th Assessment Report "Climate Change 2014: Mitigation of Climate Change" – Final draft Report. Chapter 8: Transport. <http://report.mitigation2014.org/drafts/final-draft-postplenary/ipcc_wg3_ar5_final-draft_postplenary_chapter8.pdf> (accessed 15.04.14).
Kley, S., 2011. Explaining the stages of migration within a life-course framework. Eur. Sociol. Rev. 27 (4), 469–486.
Klinger, T., Lanzendorf, M., 2015. Moving between mobility cultures: what affects the travel behavior of new residents? Transportation, online first draft.
Klöckner, C.A., 2005. Können wichtige Lebensereignisse die gewohnheitsmäßige Nutzung von Verkehrsmitteln verändern? – eine retrospektive Analyse. Umweltpsychologie 9, 28–45.
Klöckner, C.A., Matthies, E., 2004. How habits interfere with norm-directed behaviour: a normative decision-making model for travel mode choice. J. Environ. Psychol. 24 (3), 319–327.
Klöckner, C.A., Matthies, E., 2012. Two pieces of the Same Puzzle? Script-based car choice habits between the influence of socialization and past behavior. J. Appl. Soc. Psychol. 42 (4), 793–821.
Klöckner, C.A., Matthies, E., Hunecke, M., 2003. Problems of operationalizing habits and integrating habits in normative decision-making models. J. Appl. Soc. Psychol. 33, 396–417.
Lanzendorf, M., 2003. Mobility biographies. A new perspective for understanding travel behaviour. In: Paper presented at the 10th International Conference on Travel Behaviour Research, Lucerne, 10th–15th August.
Lanzendorf, M., 2010. Key events and their effect on mobility biographies: the case of childbirth. Int. J. Sustain. Transport. 4, 272–292.
Marsden, G., Docherty, I., 2013. Insights on disruptions as opportunities for transport policy change. Transport. Res. Part A: Policy Pract. 51, 46–55.
McCormack, D.P., Schwanen, T., 2011. The space–times of decision making. Environ. Plan. A 43 (12), 2801–2818.
Millard-Ball, A., Schipper, L., 2011. Are we reaching peak travel? Trends in passenger transport in eight industrialized countries. Transport Rev. 31 (3), 357–378.
Montada, L., 2008. Grundlagen der Entwicklungspsychologie. Fragen, Konzepte, Perspektiven. In: Oerter, R., Montada, L. (Eds.), Entwicklungspsychologie, 6th ed. Beltz, Weinheim, pp. 3–48.
Mortimer, J.T., Shanahan, M.J., 2003. Handbook of the Life Course. Springer, Boston.
Mulder, C.H., Wagner, M., 1993. Migration and marriage in the life course: a method for studying synchronized events. Eur. J. Popul. 9, 55–76.
Oakil, A.T.M., Ettema, D., Arentze, T., Timmermans, H., 2011. A longitudinal analysis of the dependence of the commute mode switching decision on mobility decisions and life cycle events. In: Proceedings of the 16th International Conference of Hong Kong, China.
Ohnmacht, T., Andreas, F., Axhausen, K.W., 2008. Mobilitätsbiografie und Netzwerkgeografie : Wessen soziale Beziehungen sind räumlich dispers? Schweizerische Zeitschrift für Soziologie 34 (1), 131–164.
Ottmann, P., 2010. Abbildung demographischer Prozesse in Verkehrsentstehungsmodellen mit Hilfe von Längsschnittdaten. Dissertation: Karlsruhe.
Oullette, J.A., Wood, W., 1998. Habit and intention in everyday life: the multiple processes by which past behavior predicts future behavior. Psychol. Bull. 124 (1), 54–74.
Pooley, C., Turnbull, J., Adams, M., 2005. The journey to school in Britain since the 1940s: continuity and change. Area 37 (1), 43–53.
Prillwitz, J., Lanzendorf, M., 2006. The importance of life course events for daily travel behaviour – a panel analysis. 11th International Conference on Travel Behaviour Research Kyoto, 16.–20. August 2006.
Prillwitz, J., Harms, S., Lanzendorf, M., 2006. Impact of life-course events on car ownership. Transport. Res. Rec.: J. Transport. Res. Board 1985, 71–77.
Rashidi, T.H., Mohammadian, A., Koppelman, F.S., 2011. Modeling interdependencies between vehicle transaction, residential relocation and job change. Transportation 38 (6), 909–932.
Rauprich, D., 2008. Alltagsmobilität älterer Menschen im suburbanen Raum - Möglichkeiten und Grenzen einer ökologisch nachhaltigen Gestaltung durch eine geänderte Verkehrsmittelnutzung. Asgard Verlag, Sankt Augustin.
Ryley, T., 2006. Use of non-motorised modes and life stage in Edinburgh. J. Transp. Geogr. 14 (5), 367–375.
Salomon, I., 1983. Life styles – a broader perspective on travel behaviour. In: Carpenter, S., Jones, P. (Eds.), Recent Advances in Travel Demand Analysis. Brooklyn: Gower, Aldershot/Hants, pp. 290–310.
Schäfer, M., Jaeger-Erben, M., Bamberg, S., 2012. Life events as windows of opportunity for changing towards sustainable consumption patterns? J. Consum. Policy 35 (1), 65–84.
Scheiner, J., 2006. Does the car make elderly people happy and mobile? Settlement structures, car availability and leisure mobility of the elderly. Eur. J. Transport Infrastruct. Res. 6, 151–172.
Scheiner, J., 2007. Mobility biographies: elements of a biographical theory of travel demand. Erdkunde 61, 161–173.
Scheiner, J., 2011. Changes in travel mode choice: the impact of period, cohort, and life-course effects. In: Raum und Mobilität – Arbeitspapiere des Fachgebiets Verkehrswesen und Verkehrsplanung Nr. 24. Technische Universität Dortmund, Dortmund.
Scheiner, J., Holz-Rau, C., 2013a. A comprehensive study of life course, cohort, and period effects on changes in travel mode use. Transport. Res. Part A: Policy Pract. 47, 167–181.
Scheiner, J., Holz-Rau, C., 2013b. Changes in travel mode use after residential relocation: a contribution to mobility biographies. Transportation 40 (2), 431–458.
Schoenduwe, R., Mueller, M.G., Peters, A., Lanzendorf, M., 2015. Analysing mobility biographies with the life course calendar: a retrospective survey methodology for longitudinal data collection. J. Transp. Geogr. 42, 98–109.
Schwanen, T., Mokhtarian, P.L., 2005. What if you live in the wrong neighborhood? The impact of residential neighborhood type dissonance on distance traveled. Transport. Res. Part D: Transport Environ. 10 (2), 127–151.
Schwanen, T., Banister, D., Anable, J., 2011. Scientific research about climate change mitigation in transport: a critical review. Transport. Res. Part A: Policy Pract. 45 (10), 993–1006.
Schwartz, S., 1977. Normative influences on altruism. In: Berkowitz, L. (Ed.), Advances in Experimental Social Psychology. Academic Press, New York, pp. 221–279.
Selye, H., 1984. The Stress of Life. McGraw-Hill, New York u.a..
Sharmeen, F., Arentze, T., Timmermans, H., 2014. An analysis of the dynamics of activity and travel needs in response to social network evolution and life-cycle events: a structural equation model. Transport. Res. Part A: Policy Pract. 59, 159–171.
Simma, A., Axhausen, K.W., 2001. Structures of commitment in mode use: a comparison of Switzerland, Germany and Great Britain. Transp. Policy 8, 279–288.
Skinner, C., 2003. Running Around in Circles: Coordinating Childcare, Education and Work. Policy Press, Bristol.
Stanbridge, K., Lyons, G., Farthing, S., 2004. Travel Behaviour Change and Residential Relocation. In: Paper presented at the 3rd International Conference of Traffic and Transport Psychology, Nottingham, 5th Sept.
Thøgersen, J., 2009. Promoting public transport as a subscription service: effects of a free month travel card. Transp. Policy 16 (6), 335–343.
Triandis, H., 1977. Interpersonal Behavior. Brooks/Cole Publishing Company, California.
Tully, C.J., Baier, D., 2011. Mobilitätssozialisation. In: Schwedes, O. (Ed.), Verkehrspolitik. Eine interdisziplinäre Einführung. Wiesbaden: VS Verlag für Sozialwissenschaften, pp. 195–211.
Van Acker, V., Mokhtarian, P.L., Witlox, F., 2014. Car availability explained by the structural relationships between lifestyles, residential location, and underlying residential and travel attitudes. Transp. Policy 35, 88–99.
van der Waerden, P., Timmermans, H., Borgers, A., 2003. The influence of key events and critical incidents on transport mode choice switching behaviour: a descriptive analysis. In: Paper Presented at the 10th International Conference on Travel Behaviour Research, Lucerne, 10th–15th August.
van Exel, N.J.A., Rietveld, P., 2009. When strike comes to town. . .anticipated and actual behavioural reactions to a one-day, pre-announced, complete rail strike in the Netherlands. Transp. Res. Part A: Policy Pract. 43 (5), 526–535.

Verplanken, B., Aarts, H., van Knippenberg, A., van Knippenberg, C., 1994. Attitude versus general habit: antecedents of travel mode choice. J. Appl. Soc. Behav. 24, 285–300.
Verplanken, B., Walker, I., Davis, A., Jurasek, M., 2008. Context change and travel mode choice: combining the habit discontinuity and self-activation hypotheses. J. Environ. Psychol. 28, 121–127.
Watling, D., Milne, D., Clark, S., 2012. Network impacts of a road capacity reduction: empirical analysis and model predictions. Transp. Res. Part A: Policy Pract. 46 (1), 167–189.
Wegener, M., 2013. The future of mobility in cities: challenges for urban modelling. Transp. Policy 29, 275–282.
Zhang, J., Yu, B., Chikaraishi, M., 2014. Interdependences between household residential and car ownership behavior: a life history analysis. J. Transp. Geogr. 34, 165–174.