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Life events and their association with changes in the frequency of transport use in a large UK sample

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ABSTRACT

From a mobility biographies perspective, and in line with the habit discontinuities literature, consistency in travel behaviours is context dependent and as such, will be more amenable to change following changes in context that disrupt habitual travel behaviour. Using the UK Household Longitudinal Study (UKHLS), a large-scale, longitudinal, national survey, this study investigates associations between disruption (in the form of life events and transport specific events) and changes in the frequency of car, bus, train, and bicycle use over a two-year period. The analysis extends previous research in this area by considering changes in the frequency of travel for all purposes, not only for commuting. Further, the study tested the self-activation hypothesis through an interaction between experiencing a life event and environmental concern. The results show that residential relocation and parenthood were associated with significant changes in frequency of travel mode use. Relocation showed the most consistent pattern away from car, bus, train, and cycling, while parenthood showed a consistently lower likelihood of increasing use of these modes (except car), but no greater likelihood of decreasing. Transport specific events often accounted for greater likelihood of change in travel mode use – for example, obtaining a driving license, changing the number of cars in the household, and changing to/from urban settings had large associations with changes in travel behaviours – although these were not consistent across modes. Overall, this suggests that changes in the use of the different transport modes were differentially susceptible to the life event and transport specific events.

1. Introduction

As there is an urgent need to address the environmental, social, and economic problems associated with the ongoing dominance of personal car use (Whittle et al., 2019; Woodcock et al., 2007), it is of interest to explore under what circumstances existing, habitual travel behaviours either change or become more amenable to change, such that more sustainable forms may be promoted through transport policies and interventions (Thompson et al., 2011). Reducing overall personal car use and/or replacing it with shared transport modes, such as trains and buses, has the potential to deliver improvements in air quality and reduced congestion (Beaudoin et al., 2015). Likewise, increasing active forms of transport, such as cycling, has further environmental (Brand et al., 2021) and health (Woodcock et al., 2007) benefits.

Drawing upon mobility biographies, habit discontinuity, and self-activation concepts, this study addresses the potential for life events and transport specific events to disrupt transport behaviours by investigating the association between experience of the events (e.g. residential relocation and birth of a child) and the likelihood of changes in transport behaviour. It investigates the frequency of car, bus, train, and bicycle use[1] from a longitudinal perspective, using two time points. In particular, it examines whether life events and transport specific events can be associated with changes in the frequency of travel mode use. Furthermore, the study investigates the self-activation hypothesis (Verplanken et al., 2008) through an interaction between the life events and environmental concern.

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[1] Frequency of walking is not measured in the UKHLS survey and so could not be investigated.

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1.1. Mobility biographies, habitual transport behaviour, and context disruption

The mobility biographies approach has been adopted as a way of understanding and investigating both stability and change in travel behaviours over the course of people's lives (Chatterjee & Scheiner, 2015; Lanzendorf, 2003; Müggenburg et al., 2015). In particular, the importance of context and life events is emphasised for both consistency and change in travel behaviours. Context, here, encompasses the physical environment, the infrastructure, and the spatial, social and time cues within which individual transport decisions and behaviours take place (Müggenburg et al., 2015), with life events being transitional situations in the life course that may trigger behavioural change (ibid; Klöckner, 2005).

The mobility biographies literature posits that stability in an individual's context encourages consistency in travel behaviour (Chatterjee et al., 2013; Lanzendorf, 2003). It is only when an aspect of the context is disrupted (e.g., by a life event), a change in travel behaviour may be expected. This argument is based on research on habitual behaviour, showing that repeated behaviours in a stable context can become automatic, unconscious, and maintained by that stable context (Wood & Neal, 2007). Travel behaviour often meets these characteristics, with a range of destinations (e.g., shops and work) being repeatedly travelled to in a stable context (e.g. from a particular place, at a particular time, on particular days etc.). Although the choice of transport may initially be a conscious and deliberative decision, these destinations may become associated with the particular mode, and, as a result, automatically selected when the goal to reach that destination is activated (Aarts et al., 1998; Ouellette & Wood, 1998; Verplanken et al., 1997; Wood & Neal, 2007). The automatic, unconscious, and context-triggered nature of transport behaviours means they are often resistant to change (Thøgersen & Møller, 2008), with those who have strong habits paying less attention to information about alternative travel modes (Verplanken et al., 1997) and having weaker intentions towards and actual use of other modes (Gardner, 2009).

The *habit discontinuity hypothesis* (Verplanken et al., 2008) holds that habitual behaviours may be more amenable to change when the context in which they take place is (temporarily or permanently) disrupted. A sufficiently large change in context may weaken or even extinguish an existing habit (Davidov, 2007; Haggar et al., 2019; Kumagai & Managi, 2020; Verplanken & Roy, 2016; Walker et al., 2015). Major life events, such as relocating residence (Verplanken & Roy, 2016), or having a child (Thomas et al., 2018), may create a period in which existing travel behaviour is disrupted and thus provide a window of opportunity when transport behaviour is more amenable to change.

1.2. Context disruption and changes in transport behaviour

As noted, disruption to the context in which the transport behaviour is normally cued may occur due to the experience of life events, including residential relocation and having a child. It may also occur due to more specific, transport related events, such as acquiring a driving licence, which are sometimes referred to as mobility milestones (Rau & Manton, 2016). Broader life events, like residential relocation or the birth of a child have the potential to disrupt multiple aspects of a context and may also be related to the experience of further transport specific events (Scheiner & Holz-Rau, 2013a). In this section, evidence for how the experience of life events and transport specific events relate to changes in transport behaviour is presented.

1.2.1. Residential relocation

There is quantitative empirical evidence that residential relocation is linked to changes in transport behaviours (De Haas et al., 2018; Kroesen, 2014), increased public transport use (Laverty et al., 2018), and changes in choice of commute mode (Dargay & Hanly, 2007; Soltani et al., 2019). Descriptive evidence shows that, of those who had moved home/town, the majority had changed (increased or decreased) the frequency with which they used bicycles, public transport, car as the driver, and car as the passenger (Rau & Manton, 2016). However, evidence for changes in commute mode following residential relocation is less robust (Clark et al., 2016; Oakil et al., 2016a). Relatedly, residential relocation has been found to be associated with a greater chance of buying an extra car (Beige & Axhausen, 2012; Oakil et al., 2014; Wang et al., 2018), with additional car ownership being associated with greater car use (Van Acker & Witlox, 2010).

1.2.2. Birth of a child

Quantitative research shows that becoming a parent, whether for the first time or not, is also associated with changes in travel behaviour. In particular, becoming a parent has been linked to decreased public transport use (McCarthy et al., 2019; Rau & Manton, 2016; Scheiner & Holz-Rau, 2013b) and cycling (Oakil et al., 2016a; Rau & Manton, 2016; Scheiner & Holz-Rau, 2013a). Findings are more mixed for car use, with some studies suggesting an increase in car use following the birth of a child (Rau & Manton, 2016) and others not finding any significant changes (Scheiner & Holz-Rau, 2013a, 2013b). Other studies suggest that there may be gender (role) differences, with mothers being more likely than fathers to increase their car use with additional children (Scheiner, 2014a). In line with these mixed findings, McCarthy et al. (2019) concluded that not all parents develop a car orientated lifestyle, however, the largest proportion of their sample had declined in their use of public transport and increased their use of personal cars (c.f. De Haas et al., 2018). As with residential relocation, having a child has been associated with a greater chance of buying an extra (Oakil et al., 2014) or first (Oakil et al., 2016b) car.

1.2.3. Changes in urban/rural environment

Changes in travel behaviours may be due to changes in the type of environment and accessibility of public transport is an important factor in transport decision-making (Fraser & Lock, 2011; Polat, 2012; Tcymbal et al., 2020). Indeed, a move towards a more urban environment has been associated with a decreased frequency of car use (Scheiner & Holz-Rau, 2013a), and a greater likelihood of switching to non-car modes of commuting (Clark et al., 2016), including public transport (Scheiner & Holz-Rau, 2013a). Conversely, a move to a less urban environment has been associated with decreased frequency of public transport use, bicycle use, and walking, and an increase in frequency of car use (Scheiner & Holz-Rau, 2013a), although not always (Scheiner & Holz-Rau, 2013b). A change in the urban or rural nature of the residential location may come through a residential relocation. It is possible, therefore, that such changes may be one component in the potential for residential relocation to disrupt travel habits. As such, experiencing a change from a rural to an urban environment or vice versa was explored in addition to residential relocation (which by itself does not identify potential urban density change).

1.2.4. Distance to work

In a UK sample, Clark et al. (2016) found that a change in commute distance to over two miles increased the likelihood of switching from non-car modes to car for commuting. Likewise, although a weaker effect size, distance to work decreasing to less than three miles increased the likelihood of switching from car to non-car modes (see also De Vos, Ettema, & Witlox, 2018; Li & Kamargiann, 2019). However, the longer the commute distance, the higher the probability that residents use public transport for commuting after relocation (Clark et al. 2016; Yang et al., 2017).

1.2.5. Driving licence

Compared to those without a driving licence, those who have a driving licence have a higher trip frequency and an average of 7% higher journey distance (Lucas et al., 2016). Acquiring a driving license is an identifiable mobility milestone (Klöckner, 2004; Rau & Manton, 2016) and is typically associated with increased car use as the driver (Van der Waerden et al., 2003), as well as increased likelihood of switching to a car for commuting (Clark et al., 2016). At the same time, there is a decreased use of public transport (Rau & Manton, 2016) and decrease in active transport (McDonald, 2006).

1.2.6. Number of cars in the household

The availability of cars in the household can have a bearing on use of multiple modes, not just car use. For instance, although increased and decreased availability of cars in the household were, respectively, associated with increased and decreased car use (as a driver), the availability of cars was also conversely associated with changes in public transport use and walking. Bicycle use was not significantly associated with the changes in car availability, however (Scheiner & Holz-Rau, 2013b). Further, Scheiner and Holz-Rau (2013a) found that an increased number of cars in the household was also associated with decreased public transport use, but was not associated with changes in walking or cycling.

1.2.7. Changes in income

Studies have shown that the number of cars owned, and fuel consumed increases following an increase in income (Goodwin et al., 2004). However, this association may be lagged, with the purchase of a car occurring a few years after the income increase (Dargay, 2001) and it may also be asymmetrical, with the likelihood of increased car ownership following an increased income being greater than the likelihood of decreased car ownership following a decreased income (Dargay, 2001; Prillwitz et al., 2006). This asymmetry has also been found for income and car travel, with increasing income having a stronger positive association with greater car travel than decreasing income had with less car travel (Dargay, 2007). Furthermore, car travel was found to be more responsive to changes in income than car ownership was (Dargay, 2007). However, a change in monthly income was not significantly associated with a change in commute mode, neither to or from car use nor to or from active modes (Clark et al., 2016).

Overall, the evidence indicates that residential relocation, birth of a child, and transport specific events are each associated with a greater likelihood of transport behaviour change, although whether it is an increase or a decrease in use depends on the mode and life event. As such, for the present analysis, it is expected that, across the four modes, experience of residential relocation, having a child, and context changes will be associated with a greater likelihood of a change in the frequency of use.

1.3. The self-activation hypothesis

Although there is evidence that life events can disrupt existing behavioural habits, this does not always motivate new patterns of behaviour (Chatterjee et al., 2012; Walker et al., 2015). As such, other considerations may be required to motivate a behaviour change. Values ("desirable, trans-situational goals, varying in importance, that serve as guiding principles in people's lives"; Schwartz et al., 2001: p. 521) are distal antecedents to pro-environmental action (Stern, 2000; Stern et al., 1993). Verplanken et al. (2008) argued that if a value is part of an individual's self-concept, then a change in context may provide an opportunity for the value to be cognitively activated, such that it influences behaviour. Accordingly, they found greater pro-environmental concern was associated with a lower likelihood of using a car for commuting, but only for those who had recently relocated residence (Verplanken et al., 2008).

To date, only two further studies have investigated the self-activation hypothesis in relation to habit-discontinuity and transport. Thomas et al. (2016) found that, in line with the self-activation hypothesis, those who expressed greater pro-environmental concern were significantly less likely to use a car for commuting in the time following residential relocation than those with lower concern. However, Haggar et al. (2019) found that the values of openness to change and self-transcendence (considered to be most associated with environmental concern; Schultz & Zelezny, 1999) did not moderate the relationship between residential relocation and the mode used to travel to university. However, this study investigated the role of pre-relocation planning, which was predictive of modal change and was itself predicted by environmental concern, suggesting that the contextual change may have enabled a planned change to be enacted (Haggar et al., 2019).

Within the self-activation research on transport, the focus has been on pro-environmental values and promoting more sustainable travel behaviours (Haggar et al., 2019; Thomas et al., 2016; Verplanken et al., 2008). This is in line with broader literature showing that environmental values and beliefs are correlates of compatible travel behaviours (Bouscasse et al., 2018; Hoffmann et al., 2017; Lanzini & Khan, 2017). As such, within the present analysis, it is expected that for the transport modes with lower environmental impact (i.e. bicycle, bus, and train), those who experienced a life event and have stronger pro-environmental concern will be more likely to have increased their use of those modes and less likely to have decreased them compared to those who did not experience a life event and compared to those with low concern. In contrast, for the transport mode with the higher environmental impact (i.e. car) those who experienced a life event and have stronger pro-environmental concern will be more likely to have decreased their use of this mode and less likely to have increased it compared to those who did not experienced a life event and compared to those with low concern. Note that only the two broader life events of residential relocation and birth of a child were investigated for the self-activation hypothesis as these events are not directly related to changes in transport behaviour, with any changes in transport behaviour likely to be a secondary outcome of the event (Rau & Manton, 2016). This may make the relationship between the life events and transport behaviour change more susceptible to moderating influences than the relationship between transport specific events and transport behaviour change[2].

1.4. Aims of this study

The reviewed literature shows that life events such as residential relocation and having a child are associated with changes in transport behaviour. Furthermore, there is evidence that experience of transport specific events is also associated with changes in transport behaviour. However, quantitative research in this field has mainly considered changes in travel mode for commuting purposes (Clark et al., 2016; Dargay & Hanly, 2007; Oakil et al., 2016a; Soltani et al., 2019; Yang et al., 2017; Zhao & Zhang, 2018). However, within England, the most common trip purpose in 2019 was for leisure (26%), followed by shopping (19%), and then commuting (15%; Department for Transport, 2020). As such, it is of value to consider changes in the overall frequency of travel mode use, and not only for commuting purposes. Furthermore, these different travel purposes are likely to be differentially impacted by life events; for example, childbirth may reduce commuting, but increase other trips (e.g. family visits). The current study therefore focuses on travel mode use for all purposes, not only for commuting. This is done for the four different transport modes of car, bus, train, and bicycle. In particular, the relationship between life events and changes in the frequency of these transport modes is investigated. The present study uses the UK Household Longitudinal Study (UKHLS), a large-scale, longitudinal, and nationally representative survey, to answer the following research questions (RQs):

[2] As income has an established relationship with transport use, including car use (Dargay, 2007), public transport use (Dargay & Hanly, 2002), and active modes (Keyes & Crawford-Brown, 2018), changes in income were considered to be transport specific events for the purposes of this paper.

1. Are life events associated with changes in the frequency of use of the four transport modes of car, bus, train, and bicycle use? (RQ1)
2. Are transport specific events associated with changes in the frequency of use of the four transport modes? (RQ2)
3. Are there indications that transport specific events may explain any associations between life events and changes in use of the four transport modes? (RQ3)
4. Do those with greater environmental concern show compatible changes in their transport use following a life event? (RQ4)

2. Method

2.1. The UK household longitudinal study data and sample characteristics

The UK Household Longitudinal Study (UKHLS), also known as the Understanding Society Survey (USS), is an annual, longitudinal survey of the members of approximately 40,000 UK households which is funded by the Economic and Social Research Council and various Government Departments, with scientific leadership by the Institute for Social and Economic Research, University of Essex (University of Essex, 2019). The UKHLS started in 2009, with overlapping fieldwork periods for subsequent waves of the study. Data for wave 1 of the study were collected between January 2009 and March 2011. The present study primarily used data from Waves 4, 5, and 6, which were collected in overlapping years from 2012/13, 2013/15, and 2014/16, respectively.

First, data from waves 1 to 6 were merged (n = 81,041). Then only those who had completed full interviews at Waves 4, 5, and 6 were kept (n = 31,083). From those, only those who had completed the self-completion component of the survey at Wave 4 were kept (n = 28,581). In the UK, people may learn to drive and take a driving test from when they are 17 years old. As having a driving license is likely to be an important factor in transport decision making (Clark et al., 2016), participants under the age of 17 (n = 363) were removed giving an unweighted sample of 28,218. Some of the variables of interest had very small amounts of missing data (<1%), while environmental concern had 329 (1.2%), having a child between waves had 316 (1.1%), and change in distance to work had 729 (2.6%). More detail on the missing data can be found in Appendix E. Those with missing data on the variables of interest were excluded on an analysis by analysis basis with listwise deletion.

As multiple members from the same household participate in the UKHLS, it is necessary to specify the primary sampling cluster and stratification variables provided by Understanding Society to account for the survey design. Furthermore, Understanding Society provides longitudinal survey weights to account for the unequal selection probability, nonresponse at wave 1, monotonic sample attrition at subsequent waves, and sampling error correction (further information about the provided survey weight used, f_indscub_lw, and the PSU, and Strata can be found in the user manual; Institute for Social and Economic Research, 2019). This gave an overall, weighted sample of 19,251.44. Each model's unweighted sample size and weighted sample size following listwise deletion and specification of the survey design are reported in Tables 6 and 7 (the models in table 8 have the same respective samples as those in Table 6).

The UKHLS dataset has previously been used to test the habit discontinuity hypothesis in relation to travel behaviour (Clark et al., 2016; Thomas et al., 2016). However, both studies, focused on the choice of transport for commuting only. In contrast to those two studies, we examine overall transport use rather than for commuting only, and consider changes in four different modes of transport (i.e., car, bus, train and bicycle use).

2.2. Items in the UKHLS and models

Variables used or derived from the UKHLS are summarised in Table 1. Further information on all the variables is available in Appendix

Table 1
Variables used in the analyses.

Variable	Type	Role	Logic
Change in frequency for the mode	Categorical	DV[1]	Three categories for frequency between Waves 4 and 6; stayed the same, increased use, and decreased use.
Context change variables			
Life event			
Residential relocation	Binary	IV[2]	Relocated residence between Waves 4 and 6? Yes/No (variable derived from a change in self-reported location between Waves 4 and 5 and/or between Waves 5 and 6).
Birth of a child	Binary	IV	Had a child between Waves 4 and 6? Yes/No (variable derived from self-reported parenthood between Waves 4 and 5 and/or between Waves 5 and 6).
Transport specific event [a]			
Change in monthly income	Categorical	IV	Monthly total net personal income stayed the same, increased (reference category) or decreased.
Change to/from rural/urban	Categorical	IV	Stayed either rural or urban (reference category); relocated from a rural to an urban environment; relocated from an urban to a rural environment.
Change in distance to work	Categorical	IV	Did not have a commute (either due to being unemployed or working from home – reference category), distance to work stayed the same; distance to work increased; distance to work decreased.
Acquiring a driving license	Categorical	IV	Did not have a driving license (reference category); had a driving licence; acquired a driving licence.
Change in number of cars in household	Categorical	IV	Number of cars in the household stayed the same (reference category), increased or decreased.
Change in commute mode	Categorical	C[4]	Changes in commuting by car, bus, train, or bicycle. Four categories: 1) Did not have a commute (reference category); 2) Stayed commuting by….; 3) Stopped commuting by….; or 4) Started commuting by…..
Baseline variables[b]			
Residential environment	Binary	C	Whether the participant lived in a rural or urban (reference category) area. Classification provided by UKHLS. Urban = over 10,000 inhabitants.
Driving license	Binary	C	Whether participant had a driving license (reference category) or did not (reference category) have a driving license.
Commute distance	Categorical	C	Distance between residence and workplace categorised as 1) Did not have a commute (either due to being unemployed or working from home – reference category); 2) Less than 3 miles; 3) Greater than 3 miles.
Age	Continuous	C	Participant age in years.
Gender	Binary	C	Participant's gender (male as reference category).
Education	Binary	C	Highest qualification attained categorised as 1) Does not have a degree or higher (reference category) and 2) Has a degree or higher.

(continued on next page)

Table 1 (*continued*)

Variable	Type	Role	Logic
Income	Continuous	C	Participants' monthly total net personal income.
Health limits moderate activities	Binary	C	"Yes, limited a lot" and "Yes, limited a little" responses combined into one category of "Health limits activity" and compared to "Health does not limit activity" (reference category)
Environmental concern	Continuous	M[3]	Nine items from Wave 4 relating to environmental beliefs with a 5 point Likert response scale (see Appendix A). Averaged to form a scale of environmental concern (weighted Cronbach's $\alpha = 0.77$). Weighted mean centered.

[1] Dependent variable; [2]Indpendent variable' [3]Moderator; [4]Covariate. [a] Unless otherwise stated, for change variables, responses from Waves 4 and 6 were compared to from the respective change variable; [b] Unless otherwise stated, for the baseline variables, responses from Wave 4 were used.

A.

The dependent variables were based on single-item self-report measures of how frequently the participants had typically used a car, bus, train, and bicycle in the UK in the prior year. For each mode, participants selected one category out of eight: 1) At least once a day; 2) Less than once a day; 3) Once or twice a week; 4) Less than that, but more than twice a month; 5) Once or twice a month; 6) Less than that, but more than twice a year; 7) Once or twice a year; 8) Less than that or never. By comparing the participants' responses at wave 4 to at wave 6, a categorical variable with three categories was created for each mode; 1) stayed the same (reference category) 2) increased use, and 3) decreased use (Clark et al., 2016).

For the life event variables, the UKHLS provide a variable to indicate whether participants had changed residence since the previous wave. This is primarily based on a change in the postcode provided by participants at each the wave, as such it will not capture relocations within the same postcode, and it will not capture multiple relocations between waves. Participants are also asked if they have given birth or fathered a child since the previous wave. For each life event, the responses to from waves 5 and 6 were combined to create a binary variable to indicate if the participant had experienced the life event between waves 4 and 6 (i.e. in the last two years) or not. The relatively small number of instances where the participant had relocated residence or had a child between both waves 4 and 5 and then 5 and 6 (unweighted $n = 332$ and $n = 41$, respectively), were not given a separate code to those who only relocated or had a child between one of the waves. As such, these variables indicate the most recent life event.

Socioeconomic factors established as important predictors of transport behaviour change (Clark et al., 2016) were included from Wave 4 as covariates. In all three models, these were age, gender, formal education, number of people in the household, whether their health limits moderate activities, number of cars in the household, and monthly personal income. Additionally, in models 1 and 3 only, whether they lived in a rural or urban environment and whether they had a driving licence or not; these two variables were removed from model 2 due to heterogeneity with their corresponding change variable. In contrast to the independent variables, which investigated changes in the participants' responses between Waves 4 and 6, these covariates were from Wave 4 only and as such represented baseline characteristics of the individual. Environmental concern was also a single time point variable from Wave 4 and used as the moderator of life-events to test the self-activation hypothesis. The change in commute mode between Waves 4 and 6 was also important to control for in all models, because for those with a commute, commuting will have a large impact on the frequency of their transport use, as well as itself being associated with the life events and context change variables (Beige & Axhausen, 2017; Oakil et al., 2011).

2.3. Statistical analysis

As noted in section 2.1, it is necessary to specify the primary sampling cluster and stratification variables provided by Understanding Society to account for the survey design. The *svyset* command in Stata 14 ME was used to specify the survey design and the longitudinal weighting. Strata with a single PSU were centered at the grand mean.

As described in section 2.2., the dependent variables consisted of three, nominal categories: "stayed the same", "increased frequency" and "decreased frequency" for each of the four modes. As such, a series of multinomial logistic regressions were used to estimate the relative likelihood of category membership compared to the baseline category of "stayed the same". The estimated relative risk ratios (RRR) indicate how many times more (an estimate greater than one) or less (an estimate less than one) likely the participants were to have "increased use" of each mode as opposed to "stayed the same", or "decreased use" of each mode as opposed to "stayed the same".

To address the four research questions, each of the four modes' frequency of use dependent variable (i.e., car, bus, train, and bicycle) was regressed on three consecutive sets of independent variables. The first set (included in models 1 to 4) consisted of the two independent life events (i.e. residential relocation and having a child) variables and the covariates (see Table 1) only. These models were used to examine whether life events are associated with changes in the frequency of use of the four transport modes (RQ1). The second set of independent variables (included in models 5 to 8) included the life event, control, and transport specific event variables (i.e. rural/urban environment, distance to work, driving license, and number of cars). These models were used to examine whether changes in context are associated with changes in the frequency of use of the four transport modes (RQ2), and whether these contextual changes may explain any associations between life events and changes in use of the four transport modes (RQ4). The latter was achieved by comparing the parameters for the two life event variables in models 5–8 as compared to those reported in models 1–4. The third set of independent variables (included in models 9 to 12) comprised the life event and control variables, as well as an interaction terms for each of the two life events with environmental concern. The interaction terms were used to examine whether greater environmental concern show compatible changes in their transport use following a life event (RQ4).

3. Results

3.1. Descriptive statistics

In the weighted sample for Model 1 ($N = 18{,}532.97$)[3], 52% of the sample were female and there was a mean age of 49.07 years ($SD = 17.93$), a mean monthly total net personal income of £1,429.03 ($SD = 1{,}394.55$), and a mean household size of 2.77 ($SD = 1.40$). These demographics, along with the frequencies for the context change variables split by changes in transport mode, are available in Appendix B and F.

As shown in Fig. 1, at Wave 4, the majority of participants (52%) in the overall weighted sample travelled by car (as either a driver or passenger) at least once a day with only low percentages travelling by car less than once or twice a week. In contrast, bus, trains, and bicycles were used much less frequently, with most participants using them once or twice a month and larger percentages using them less than once or twice a year or never (39%, 41%, and 72%, respectively). The percentages were comparable at Wave 6 (see Appendix C).

[3] The demographic makeup of each model was very similar. The demographic makeup for each model can be found in Appendix F.

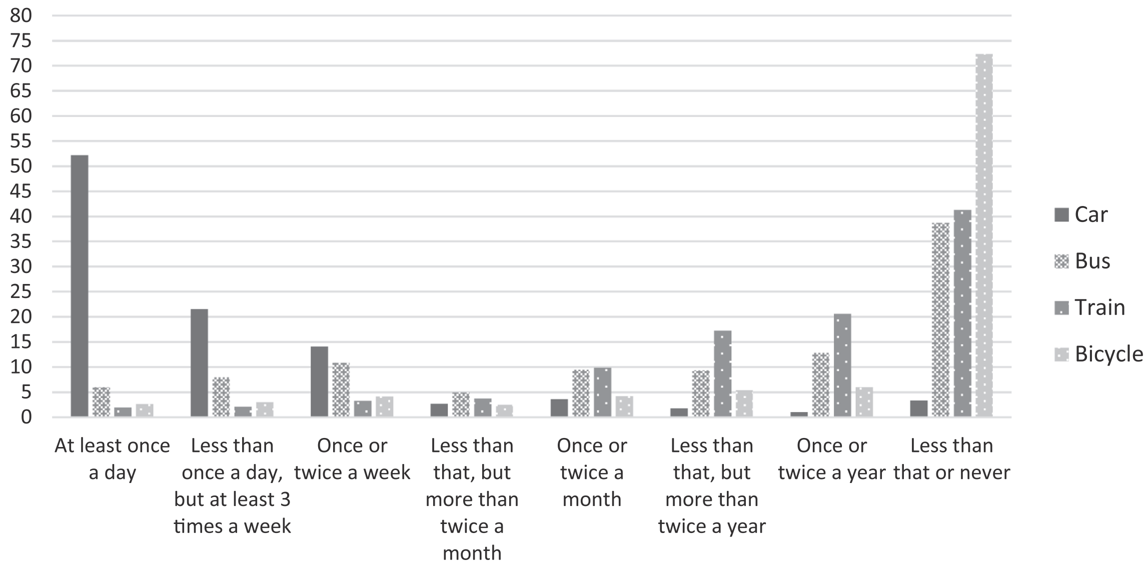

Fig. 1. Percentages for the frequency of use of each mode at Wave 4.

The frequencies of participants experiencing life events and changing the frequency of use for car, bus, train, and bicycle are shown in Tables 2–5, respectively. Across the modes, most participants' frequency of use stayed the same between Waves 4 and 6. Bus and train use showed the biggest percentage of participants changing frequency overall, whereas for car use and cycling had a greater proportion staying the same.

3.2. *Life events and changes in frequency of transport use*

In Table 6, models 1, 2, 3, and 4 are shown. These contain the life event variables, baseline context variables, and the covariates. Table 7 has models 5 to 8, which have the addition of the context change variables. Table 8 has models 9 to 12, which have the same variables as models 1 to 4, but with the addition of the life event and environmental concern interaction variables. Each table shows the relative risk ratios (RRR) from the multinomial models for the increased use of each mode and the decreased use of each mode relative to the frequency of use not changing. Due to listwise deletion, the sample sizes alter slightly in each model.

3.2.1. *Changes in frequency of car use*

In terms of the life events, when the other variables are held constant, model 1 (Table 6) shows that: (a) compared to those who did not relocate residence, those who did were 27% more likely to have increased their car use and 41% more likely to have decreased their car use; (b) compared to those who did not have a child, those who did have a child were no more or less likely to have changed the frequency of their car use.

In terms of the transport specific event variables in (model 5, Table 7) neither changes to monthly personal income, the urban/rural environment, nor changes in distance to work had statistically significant associations with changes to frequency of car use. However, acquiring a driving licence, and a change in the number of cars in the household did have some statistically significant associations with changes in frequency of car use showing that (a) compared to those without a driving licence, those who acquired a driving licence were 71% more likely to have increased the frequency of their car use; (b) compared to the number of cars in the household staying the same, those who increased their number of cars were 38% more likely to have increased their frequency of car use and 33% less likely to have decreased it. In contrast, those who decreased the number of cars in the household were 159% more likely to have decreased their frequency of car use, but were no more or less likely to have increased it.

Comparing the strength of associations for the life events between models 1 and 5, the addition of the transport specific event variables decreased the magnitude of the relative risk ratios of residential relocation, particularly for increased frequency of car use, which fell from 27% to 19% and became statistically non-significant. Decreased frequency of car use also fell from 41% to 24% more likely to have decreased, but remained statistically significant. Both decreases will be discussed.

In terms of the self-activation hypothesis, the interaction between environmental concern and the life events added to model 9 (Table 8) was statistically significant for increased car use frequency, suggesting that of those who relocated, those with a greater level of environmental concern were 32% more likely to have increased their car use, compared to those with greater environmental concern who had not relocated. The interaction was not statistically significant for decreased car use. Environmental concern by itself was associated with a 13% greater

Table 2
Weighted changes in Car use frequencies (rounded to whole number) and percentages by life events and context changes.

	Stayed the same $n = 11{,}283.30$		Increased $n = 3{,}608.65$		Decreased $n = 3{,}335.93$		Full sample[1] $n = 18{,}227.8$	
Life events	n	%	n	%	n	%	n	%
Residential relocation								
Did not relocate residence	9,991	63	3,076	19	2,821	18	15,888	100
Relocated residence	1,292	55	533	23	515	22	2,340	100
Having a child								
Did not have a child	10,774	62	3,452	20	3,165	18	17,392	100
Had a child	509	61	156	19	171	20	836	100

[1] Weighted sample size based on the Model 5 sample.

Table 3
Weighted changes in Bus use frequencies (rounded to nearest whole number) and percentages by life events and context changes.

	Stayed the same $n = 8{,}964.40$		Increased $n = 4{,}411.99$		Decreased $n = 4{,}843.04$		Full sample[1] $n = 18{,}219.43$	
Life events	*n*	%	*n*	%	*n*	%	*n*	%
Residential relocation								
Did not relocate residence	7,990	50	3,792	24	4,101	26	15,883	100
Relocated residence	975	42	620	27	742	32	2,337	100
Having a child								
Did not have a child	8,556	49	4,238	24	4,589	26	17,383	100
Had a child	408	49	174	21	254	30	836	100

[1] Weighted sample size based on the Model 6 sample.

Table 4
Weighted changes in Train use frequencies (rounded to nearest whole number) and percentages by life events and context changes.

	Stayed the same $n = 9{,}487.84$		Increased $n = 4{,}487.79$		Decreased $n = 4{,}244.11$		Full sample[1] $n = 18{,}219.75$	
Life events	*n*	%	*n*	%	*n*	%	*n*	%
Residential relocation								
Did not relocate residence	8,522	54	3,803	24	3,555	22	15,880	100
Relocated residence	965	41	685	29	689	29	2,340	100
Having a child								
Did not have a child	9,102	52	4,288	25	3,994	23	17,384	100
Had a child	386	46	200	24	250	30	836	100

[1] Weighted sample size based on the Model 7 sample.

Table 5
Weighted changes in Bicycle use frequencies (rounded to nearest whole number) and percentages by life events and context changes.

	Stayed the same $n = 13{,}056.20$		Increased $n = 2{,}418.95$		Decreased $n = 2{,}749.03$		Full sample[1] $n = 18{,}224.15$	
Life events	*n*	%	*n*	%	*n*	%	*n*	%
Residential relocation								
Did not relocate residence	11,528	73	2,006	13	2,351	15	15,886	100
Relocated residence	1,528	65	413	18	398	17	2,339	100
Having a child								
Did not have a child	12,496	72	2,308	13	2,583	15	17,388	100
Had a child	560	67	111	13	166	20	836	100

[1] Weighted sample size based on the Model 8 sample.

likelihood of decreased car use.

3.2.2. Changes in frequency of bus use

In terms of the life events, when the other variables are held constant, model 2 (Table 6) shows that: (a) compared to those who had not relocated residence, those who had relocated residence were 17% more likely to have increased and 27% more likely to have decreased their bus use; (b) compared to those who had not had a child, those who had had a child were 30% less likely to have increased their bus use, but were no more or less likely to have decreased their use.

In terms of the transport specific event variables in (model 6, Table 7) neither changes to the urban/rural environment, nor commuting distance had statistically significant associations with changes to frequency of bus use. However, changes in income, driving licence, and number of cars did have significant associations showing that: (a) Compared to those who had an increase in income, those who experienced a decrease in income were 10% more likely to have increased their frequency of bus use; (b) compared to those without a driving licence, those who acquired a driving licence 133% more likely to have decreased their bus use, relative to staying the same; (c) compared to the number of cars in the household staying the same, those who increased their number were 14% less likely to have increased their frequency of bus use and 23% more likely to have decreased it. Those who decreased the number of cars in the household were 44% more likely to have increased their frequency of bus use.

Comparing the strength of associations for the life events between models 2 and 6, the addition of the transport specific event variables mainly decreased the magnitude of the relative risk ratio for residential relocation and increased frequency of bus use, which fell from 17% to 11% and became statistically non-significant.

In terms of self-activation, the interaction between environmental concern and the life events added to model 10 (Table 8) was not statistically significant for changes frequency of bus use. Environmental concern by itself was associated with changes in bus use frequency in this model, however; with each one point increase in environmental concern score, they were 7% more likely to have increased and 9% more likely to have decreased their bus use.

3.2.3. Changes in frequency of train use

In terms of the life events, when the other variables are held constant, model 3 (Table 6) shows that: (a) compared to those who did not relocate, those who had experienced residential relocation were 20% more likely to have increased and 34% more likely to have decreased their train use; (b) compared to those who had not had a child, those who had were 31% less likely to have increased their train use, but no more or less likely to have decreased their use.

In terms of the transport specific event variables in model 7 (Table 7) neither changes in monthly personal income nor acquiring a driving license were statistically significant for changes in frequency of train use. However, it was found that: (a) compared to those who did not change their environment, those who changed from a rural to an urban environment were 129% times more likely to have increased their train use and 91% more likely to have decreased their train use; (b) compared to those who did not have a commute, those whose commute distance decreased were 41% more likely to have increased and 43% more likely to have decreased their frequency of train use. Those whose commute

Table 6
Models 1 to 4: Relative risk ratios (RRR) from multinomial regressions for increasing and decreasing frequency of use the different modes compared to no change in frequency.

	Car (Model 1)				Bus (Model 2)				Train (Model 3)				Bicycle (Model 4)			
	Increased		Decreased		Increased		Decreased		Increased		Decreased		Increased		Decreased	
	RRR	*SE*	*RRR*	*SE*	*RRR*	*SE*	*RRR*	*RRR*	*RRR*	*SE*	*RRR*	*SE*	*RRR*	*SE*	*RRR*	*SE*
Relocation [a]																
Relocated	1.27**	0.10	1.41***	0.11	1.17*	0.09	1.27***	0.09	1.20*	0.09	1.34***	0.09	0.95	0.08	0.85	0.07
Having a child [b]																
Had child	0.88	0.12	1.17	0.14	0.70**	0.08	0.85	0.09	0.69**	0.08	0.96	0.11	0.54***	0.07	0.85	0.10
Income	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00***	0.00	1.00	0.00
Lived in rural area [c]	1.06	0.06	1.00	0.06	0.78***	0.04	0.86***	0.04	0.81***	0.04	0.76***	0.04	1.25***	0.08	1.33***	0.08
Number of cars in household [d]																
One	0.39***	0.03	0.60***	0.05	1.01	0.08	1.00	0.07	0.92	0.08	0.99	0.09	1.12	0.12	1.34**	0.15
Two	0.26***	0.02	0.46***	0.04	0.87	0.08	0.82*	0.07	1.05	0.10	1.03	0.10	1.46***	0.17	1.85***	0.22
More than two	0.24***	0.03	0.42***	0.05	0.88	0.10	0.81	0.09	1.03	0.12	1.26**	0.14	1.31	0.19	1.82***	0.25
Distance to work [e]																
3 miles or less	1.16*	0.08	1.05	0.08	1.03	0.06	0.86*	0.05	1.13*	0.07	1.01	0.06	1.18*	0.09	1.10	0.08
Over 3 miles	0.97	0.08	0.90	0.08	0.88*	0.05	0.83**	0.05	1.07	0.06	1.11	0.06	1.12	0.08	1.14	0.08
Did not have driving license [f]	1.40***	0.10	1.80***	0.14	1.26**	0.09	1.48***	0.10	1.05	0.07	1.17*	0.08	0.61***	0.06	0.70***	0.07
Environmental concern	1.08	0.04	1.13**	0.05	1.08*	0.04	1.12**	0.04	1.10**	0.04	1.13***	0.04	1.21***	0.06	1.17***	0.05
Constant	1.44*	0.24	0.94	0.16	0.96	0.14	1.12	0.16	1.03	0.15	0.87	0.14	0.89	0.17	0.72	0.13
	$F(38, 3337) = 64.33$***				$F(38, 3375) = 16.29$***				$F(38, 3339) = 21.20$***				$F(38, 3{,}375) = 43.72$***			
Unweighted sample size	27,304				27,302				27,302				27,298			
Weighted sample size	18,532.97				18,525.15				18,525.47				18,526.61			
PSU	5,131				5,133				5,134				5,132			
Strata	1,757				1,758				1,758				1,757			

***$p < .001$ **$p < .01$ *$p < .05$; Robust standard errors (SE; in parentheses) adjusted for PSU clusters and Strata.
Estimates adjusted for age, gender, education, household size, monthly income, health limits activity, and change in commute mode. Full results available in Appendix D.
[a] reference: did not relocate;
[b] reference: did not have a child;
[c] reference: lived in an urban area;
[d] reference: Zero cars;
[e] reference: does not have a commute;
[f] reference: has a driving license.

Table 7
Models 5 to 8: Relative risk ratios (RRR) from multinomial regressions with transport specific events.

	Car (Model 5)				Bus (Model 6)				Train (Model 7)				Bicycle(Model 8)			
	Increased		Decreased		Increased		Decreased		Increased		Decreased		Increased		Decreased	
	RRR	*SE*	*RRR*	*SE*	*RRR*	*SE*	*RRR*	*RRR*	*RRR*	*SE*	*RRR*	*SE*	*RRR*	*SE*	*RRR*	*SE*
Relocation [a]																
Relocated	1.19	0.11	1.24*	0.11	1.11	0.09	1.25**	0.10	1.12	0.09	1.28**	0.10	0.93	0.09	0.80*	0.08
Having a child [b]																
Had child	0.91	0.13	1.11	0.14	0.67***	0.08	0.89	0.09	0.72**	0.09	1.01	0.11	0.56***	0.08	0.87	0.10
Income change [c]																
Decreased	1.04	0.05	0.99	0.05	1.10*	0.05	1.04	0.05	1.10*	0.05	1.02	0.05	1.11	0.06	0.95	0.05
Stayed the same	1.21	0.30	1.16	0.26	0.85	0.18	1.08	0.21	1.19	0.23	0.94	0.20	1.11	0.28	0.79	0.21
Change in environment [d]																
Urban to rural	1.00	0.22	0.92	0.23	0.69	0.16	0.89	0.17	0.86	0.19	0.78	0.17	1.25	0.29	1.26	0.28
Rural to urban	1.11	0.34	1.18	0.29	1.28	0.30	0.90	0.21	2.29***	0.56	1.91**	0.45	1.43	0.40	1.84*	0.47
Distance to work [e]																
Stayed the same	1.07	0.15	0.84	0.13	0.93	0.11	0.94	0.11	1.24	0.15	1.26	0.15	1.15	0.17	1.32*	0.18
Decreased	1.22	0.17	1.02	0.15	1.00	0.12	1.02	0.11	1.41**	0.17	1.43**	0.17	1.08	0.15	1.26	0.17
Increased	0.95	0.11	0.90	0.11	0.92	0.09	1.12	0.11	1.38***	0.14	1.33**	0.13	1.07	0.13	1.22	0.14
Driving license acquisition [f]																
Had a license	0.77***	0.06	0.63***	0.05	0.84*	0.07	0.74***	0.05	0.99	0.07	0.85*	0.06	1.60***	0.17	1.56***	0.16
Acquired a license	1.71**	0.33	1.11	0.24	1.23	0.26	2.32***	0.39	1.22	0.23	1.27	0.21	0.87	0.21	1.64**	0.31
Number of cars in household [g]																
Increased	1.38***	0.09	0.67***	0.07	0.86*	0.06	1.23***	0.07	0.97	0.07	1.17**	0.08	1.09	0.09	1.20*	0.09
Decreased	1.20	0.12	2.59***	0.22	1.44***	0.11	1.17	0.09	1.14	0.09	1.03	0.08	0.84	0.09	0.97	0.09
Constant	1.72***	0.28	1.79***	0.31	1.27	0.19	1.33	0.20	0.92	0.14	0.88	0.14	0.53***	0.10	0.40***	0.07
	F(56, 3355) = 43.71***				*F*(56, 3,300) = 12.57***				*F*(56, 3,301) = 14.58***				*F*(56, 3,301) = 30.71***			
Unweighted sample size	26,996				26,992				26,992				26,993			
Weighted sample size	18,227.83				18,219.43				18,219.75				18,224.15			
PSU	5,107				5,107				5,108				5,108			
Strata	1,752				1,752				1,752				1,752			

***p <.001 **p <.01 *p <.05; Robust standard errors (SE) adjusted for PSU clusters and Strata.
Estimates adjusted for age, gender, education, household size, monthly income, health limits activity, and change in commute mode. Full results available in Appendix D.
[a] reference: did not relocate;
[b] reference: did not have a child;
[c] reference: increased;
[d] reference: stayed urban or rural;
[e] reference: did not have a commute;
[f] reference: did not have a driving license;
[g] reference: number of cars stayed the same.

Table 8
Models 9 to 12: Relative risk ratios (RRR) from multinomial regressions with interaction between environmental concern and experience of life events.

	Car (Model 9)				Bus (Model 10)				Train (Model 11)				Bicycle (Model 12)			
	Increased		Decreased		Increased		Decreased		Increased		Decreased		Increased		Decreased	
	RRR	*SE*	*RRR*	*SE*	*RRR*	*SE*	*RRR*	*RRR*	*RRR*	*SE*	*RRR*	*SE*	*RRR*	*SE*	*RRR*	*SE*
Relocation [a]																
Relocated	1.25**	0.10	1.41***	0.11	1.17*	0.09	1.27***	0.09	1.20*	0.09	1.33***	0.09	0.95	0.08	0.84*	0.07
Relocated × Env. Con.	1.32*	0.17	1.07	0.13	1.05	0.13	1.13	0.13	1.03	0.11	1.05	0.13	1.04	0.14	1.18	0.16
Having a child [b]																
Had child	0.86	0.12	1.17	0.14	0.69**	0.08	0.84	0.09	0.69**	0.09	0.93	0.11	0.54***	0.08	0.85	0.10
Had a child × Env. Con.	1.29	0.27	0.92	0.17	1.27	0.25	1.24	0.22	0.80	0.17	1.25	0.23	1.03	0.22	1.10	0.21
Env. Con.	1.03	0.05	1.13**	0.05	1.07	0.04	1.09*	0.04	1.11**	0.04	1.11**	0.04	1.20***	0.06	1.14**	0.05
Constant	1.45**	0.24	0.94	0.16	0.96	0.14	1.12	0.16	1.03	0.15	0.87	0.14	0.89	0.17	0.72	0.13
	$F(42, 3333) = 58.56$***				$F(42, 3{,}334) = 14.81$***				$F(42, 3{,}335) = 19.32$***				$F(42, 3{,}334) = 39.79$***			

***$p < .001$ **$p < .01$ *$p < .05$; Robust standard errors (SE) adjusted for PSU clusters and Strata.
Estimates adjusted for age, gender, education, household size, monthly income, health limits activity, and change in commute mode. Full results available in Appendix D.
[a] reference: did not relocate;
[b] reference: did not have a child.

distance increased were 38% more likely to have increased and 33% more likely to have decreased their frequency of train use; (c) compared to the number of cars in the household staying the same, those who increased their number were 17% more likely to have decreased the frequency of their train use, but no more or less likely to have increased it. Decreasing the number of cars had no statistically significant associations with frequency of train use.

Comparing the strength of associations for the life events between models 3 and 7, the addition of the transport specific event variables mainly decreased the magnitude of the relative risk ratio for residential relocation and increased frequency of bus use, which fell from 20% to 12% and became statistically non-significant.

In terms of self-activation, the interaction between environmental concern and the life events added to model 11 (Table 8) was not statistically significant for changes in frequency of train use. Environmental concern by itself was associated with changes in train use frequency in this model, however; with each one point increase in environmental concern, they were 11% more likely to have increased and 11% more likely to have decreased their train use, relative to staying the same.

3.2.4. *Change in frequency of bicycle use*

In terms of the life events, when the other variables are held constant, model 4 (Table 6) shows that: (a) compared to those who had not relocated residence, those who had relocated residence were not significantly more or less likely to have increased or decreased their bicycling; (b) compared to those who had not had a child, those who had were 46% less likely to have increased their bicycle use, but no more or less likely to have decreased their use.

In terms of the transport specific event variables in (model 8, Table 7), neither changes in monthly personal income nor distance to work had statistically significant associations with changes in the frequency of bicycle use. However, it was also shown that: (a) changing from urban to rural (as opposed to staying in either a rural or urban area) had no statistically significant associations, but those changing from rural to urban were 84% more likely to have decreased their bicycle use; (b) Those who acquired a driving licence were 64% more likely to have decreased their bicycle use; (c) compared to the number of cars in the household staying the same, those who increased their number were 20% more likely to have decreased their bicycle use, relative to staying the same. However, decreasing the number of cars in the household had no statistically significant associations with changes in frequency of bicycle use.

Comparing the strength of associations for the life events between models 4 and 8, the addition of the transport specific event variables only caused a small decrease in the associations of the life events with frequency of bicycle use. However, the relative risk ratio of those who had experienced a residential relocation became statistically significant, indicating that those who experienced a relocation were 20% less likely to have increased their bicycle use, when the context change variables were in the model. These changes will be discussed.

In terms of self-activation, the interaction between environmental concern and the life events added to model 12 (shown in Table 8) was not statistically significant for changes frequency of bicycle use. Environmental concern by itself was associated with changes in bicycle use frequency in this model, however, with each one point increase in environmental concern, they were 20% more likely to have increased and 14% more likely to have decreased their bicycle use.

4. Discussion

Within the mobility biographies approach, and habit discontinuities literature, travel behaviour is expected to remain stable so long as the context remains stable. However, it will then be more amenable to change following a life event or context change (Chatterjee & Scheiner, 2015; Lanzendorf, 2003; Müggenburg et al., 2015; Verplanken et al., 2008). Using an existing, longitudinal, UK national survey, the associations between life events and changes in the frequency of car, bus, train, and bicycle use over a two-year period was investigated and compared to changes in context. Further, the self-activation hypothesis was tested with an interaction between experiencing a life event and level of environmental concern. Overall, residential relocation and birth of a child were associated with significant changes in frequency of mode use. Relocation showed the most consistent pattern away from bus, train, and cycling, while parenthood showed a consistently lower likelihood of increasing use of these modes. Other transport specific events often accounted for a greater likelihood of change in travel mode use - for example, obtaining a driving license, car buying, and changing to/from urban settings had large effects on travel behaviours, although not consistently across modes. Overall, this suggests that changes in the use of the different transport modes were differentially susceptible to the life event and transport specific events. These findings will now be discussed in relation to the four research questions.

4.1. *Are life events associated with changes in the frequency of use of four transport modes?*

The findings of models 1–3 indicate that residential relocation was associated with a greater likelihood of both increased and of decreased frequency of car, bus, and train use compared to those who did not relocate. Although this analysis is not able to distinguish what determines whether the disruption of the relocation will be associated with greater likelihood of increased or decreased use of cars, buses and trains, it does broadly support the mobility biographies and habit disruption literature (Dargay & Hanly, 2007; De Haas et al., 2018; Kroesen, 2014; Laverty et al., 2018; Soltani et al., 2019) by suggesting that residential relocation is associated with a greater likelihood of changes in frequency of transport use compared to those who do not relocate residence. However, residential relocation was not significantly associated with changes in bicycle use in model 4, which contradicts some previous evidence (Chatterjee et al., 2013; Rau & Manton, 2016), but supports other evidence showing that previous cycling behaviour can be sustained following a residential relocation (Morgan, 2020). This sustaining of cycling behaviour is further evidenced when the contextual variables are added to the model (model 8) and is discussed in section 4.3.

Across the models, the findings for birth of a child suggest that those who had a child were less likely to have increased their bus, train, or bicycle use compared to someone who had not recently had a child. Given the cognitive and resource (time, money) demands of new parenthood (Nyström & Öhrling, 2004) and the potential demands of deliberating and executing a change in transport modes, it is perhaps to be expected that identifying and utilising previously unused/lesser used forms of transport would not have been prioritised by those who had recently had child. It is noteworthy, however, that those who recently had a child were no more or less likely to have decreased their use of these modes, as might have been expected from previous findings on the perceived challenges of public transport use (Lanzendorf, 2010) and safety concerns of cycling with a young child (Bonham & Wilson, 2012) being barriers to public transport and bicycling, respectively. As such, having a child may be associated with maintenance of the status quo with regards to how frequently trains, buses, and bicycles are used (albeit, in this study, at a low frequency). This perhaps suggests that interventions for sustainable forms of travel could be more effective before parenthood (or conceivably, when the child is older) to establish sustainable transport habits before or after the most disruptive early years of parenthood.

In contradiction to some findings of increased car use (Rau & Manton, 2016), but supporting of others (Scheiner & Holz-Rau, 2013a, 2013b), having a child was not found to be significantly associated with either an increase or a decrease in the frequency of car use. This may be due to prospective parents having already purchased and begun using a car in anticipation of having a child (Oakil et al., 2016a). It may also be that the nature of the car trips changed (e.g. destination, mileage and duration; Scheiner, 2020), but the actual frequency of car use was not affected. An important consideration, however, is that our analysis did not distinguish between first time parents and non-first-time parents, and so it is possible that those who already had children had already changed their car use in response to the first child.

4.2. Are transport specific events associated with changes in the frequency of use of the four transport modes?

The transport specific event variables had different patterns of associations across the modes. As would be expected, those who had acquired a driving licence were more likely to have decreased their bicycle use, representing the shift from bicycle to car use once driving licences are obtained (McDonald, 2006). The lack of associations from changes in income and changes in frequency of use of any of the modes, except bus use, is perhaps indicative of other explanatory variables in the model covarying with income changes, such as changes in the number of cars in the household (Prillwitz et al., 2006). For bus use, the decreased income was associated with increased bus use, which may be due to a lowered income reducing the viability of more expensive modes, such as private vehicles or trains for the participant. This is in line with Dargay and Hanly (2002) who found a negative association between income and bus use in England. Changes in distance to work were primarily associated with changes in frequency of train use (discussed further in section 4.3). Overall, the findings suggest that, in terms of context, changes in access to – or availability of – different modes (changes which Rau and Manton (2016) may refer to as mobility milestones) are important for frequency of use.

4.3. Are there indications that transport specific events may explain any associations between life events and changes in use of the four transport modes?

The addition of the transport specific event variables primarily affected the association between residential relocation and changes in car, bicycle, and train use (models 5–7). For car use, residential relocation was no longer significantly associated with an increase in car use, but was still significantly associated with a decrease in the frequency of car use. This is partially in line with Clark et al. (2016) and supports residential relocation as a life event which is likely to co-occur with changes in car use (Larouche et al., 2020) and as such, remains an important event to consider in transport policy formation and travel interventions (e.g. Bamberg, 2006; Larouche et al., 2020). However, the weakened associations suggests that the transport specific events may be important in avoiding increasing, and for promoting decreasing car use when relocating. For instance, of the added transport specific event variables, increasing and decreasing the number of cars were both strongly associated with increased and decreased car use, respectively. Although further analysis would be needed to explore this, it could suggest that there is a covariance between residential relocation and changing the number of cars in the household, perhaps due to moving out from a shared or family residence or a reassessment of transport needs preceding or following relocation (Chatterjee et al., 2013). It is noteworthy that the reduction in number of cars in the household had a stronger association with decreased car use than the increased number of cars had with increased car use. As such, interventions to reduce car use could intervene at the point of considering to buy a car/an additional car for the household to avoid an increase in usage, but also aim to encourage the reduction in the number of cars owned when relocating residence (e.g. Lin et al., 2018) as this is then most strongly associated with decreased use.

The association between residential relocation and increased bus use also weakened. In contrast to car use, here, as could be expected (Goodwin, 1993), a decrease in the number of cars in the household was positively associated with increased frequency of bus use, whilst an increase in the number of cars was negatively associated. This suggests bus use is more likely to be replaced by car use than trains or bicycles are, which is perhaps because buses have the potential to fulfil the same trip purposes as a car, but can be less preferred (Anable, 2005; Stradling et al., 2007). This is further highlighted by the strong positive association between gaining a driving license and decreased bus use, which is in line with previous findings (Rau & Manton, 2016). However, residential relocation remained positively associated with a decrease in bus use, despite an increase in the number of cars in the household and gaining a driving license both having a positive association with the decrease in bus use.

With the transport specific event variables in the model, the association between residential relocation and increased train use also weakened. Supporting the interrelationships between residential relocation, distance to work, and commute mode (Dargay & Hanly, 2007; Prillwitz et al., 2007; Van Ommeren, 2018), changes in distance to work (either increased or decreased) were positively associated with both increased and decreased train use. However, as the switches in commute mode were controlled for, the significant, strong, positive association between moving from a rural to an urban area and increased frequency of train use[4] might have been the more important context change as it may be indicative of relocating to a place with greater train connections, which are then used for not only commuting, but for other activities and journeys as well. This move from rural to urban, was also associated with a decrease in train use, although not as strongly, which might indicate a new proximity to the amenities of urban areas reducing the need to travel distances for which a train may previously have been used (Scheiner & Holz-Rau, 2013b).

In contrast to changes in car, bus, and train use, changes in frequency of bicycle use were not associated with residential relocation prior to the transport specific event variables being added to the model. However, when the transport specific event variables were added to the model, it was found that those who relocated residence, but did not change from a rural to an urban area (or vice versa), were less likely to have decreased their bicycle use. This fits well with the Thomas and Walker (2015) finding that habits were stronger for active modes of commute than for car and for bus, which they then argue could be due to the active commuters' more favourable affective appraisal of their commute. This is also in line with a meta-analysis of habits which found that habits continue to be associated with behaviour if there is a positive attitude towards the behaviour (Gardner et al., 2020). It is different, however, for those who changed from a rural to an urban area. For these, bicycle use was more likely to have decreased.

A greater likelihood of decreased cycling when also moving to an urban area supports the wider literature on cycling behaviour in that it suggests the built environment is the important factor in bicycle use (Wang et al., 2016). Concerns for and perceptions of safety is a major barrier to bicycle use (Manaugh et al., 2017) and as such, positive attitude towards cycling may not be acted on and the habit disrupted. As such, transport policy and urban planning need to ensure that there is a safe environment for people to cycle in, such that existing bicycling behaviour is not lost when people move from a rural to an urban area. Infrastructural measures of segregated cycle lanes and low traffic neighbourhoods (Aldred et al., 2019; Crane et al., 2017; Goodman et al., 2020; Keall et al., 2018) could then be complimented with soft measures, such as personalised information about safer cycle routes (Yang et al., 2010) and cycling proficiency courses (see Sersli et al., 2019) for those moving into an urban environment.

It is noteworthy that the associations between having a child and the changes in frequency of transport use were only marginally affected by the addition of the transport specific event variables to the model. Further, residential relocation remained significantly associated with both increased and decreased car use, decreased bus use, and decreased train use even with the context variables in the model. This suggests that there may be further factors contributing to use of these modes either preceding or following the two life events, which could be investigated. For instance, residential relocation may lead to changes in social networks (Lin et al., 2018) or changes in satisfaction with the accessibility of the public transport (Scheiner & Holz-Rau, 2013a).

4.4. Do those with greater environmental concern show compatible changes in their transport use if a life event is experienced?

Environmental concern was significantly associated with a greater likelihood of changes in the frequency of use of car, bus, train, and bicycle. The association between environmental concern and the greater likelihood of increased use of the more environmentally sustainable modes of bus, train, and bicycle, as well as a decreased frequency of car use, is in line with what would be expected from previous research (Bouscasse et al., 2018; Hoffmann et al., 2017; Lanzini & Khan, 2017). However, these findings are made somewhat less clear due to the contrasting, and perhaps less compatible, findings of environmental concern also being associated with greater likelihood of a *decreased* use of the more environmentally sustainable bus, train, and bicycle. One explanation for this unexpected finding is that those with greater environmental concern may have been using buses, train, and bicycles more frequently than those with lower environmental concern at the first time point (Wave 4) and so had more scope to decrease their usage of these modes over the two years than those with less environmental concern who may have already been using them infrequently. Although contradictory, together, these findings suggest that being concerned about the environment seems to have an important relationship with changes in the frequency of use for these modes, however, further investigation will be required to identify the nature of – and the processes behind – these changes.

The self-activation hypothesis was explored as an explanatory mechanism for life events leading to changes in transport use. For car use, those who had relocated and held greater environmental concern, were more likely to have increased their car use than those who held greater environmental concern, but had not relocated; this was not seen for decreased car use. Across bus, train, and bicycle use, the interaction between environmental concern and changes in transport mode were not statistically significant. These findings are contrary to expectation (Verplanken et al., 2008), although the lack of significant associations do support Haggar et al. (2019).

In terms of the interaction being associated with a greater likelihood of increased car use, as with the main effects of environmental concern, this may be due to those with greater environmental concern having used the car less frequently than those with less environmental concern prior to relocating (i.e. at Wave 4). As such, they may have had more scope to increase their usage compared to those who were already using the car very frequently (i.e. once a day or more). Specific analyses could be conducted with this data to investigate this explanation. The lack of significant interactions, could be due to the fact that Verplanken et al. (2008) used a cross-sectional design and so participants' behaviour and beliefs may have been more congruent at that time, whereas the measure of environmental concern in the present study preceded the life events. Indeed, in Thomas et al. (2016), the initial lower use of a car for commuting shown by residential relocators with higher pro-environmental beliefs, became increasingly comparable to the residential relocators' with lower pro-environmental beliefs over time. A further explanation is that other values or concerns (e.g., health, family, finances) may be stronger predictors of travel choice than environmental concern, and these may instead become activated during life transitions (cf. Haggar et al., 2019; Whittle et al., 2019).

4.5. Strengths and limitations

Our analyses are distinct from previous quantitative studies on the association between life events and mobility in that we have combined: (a) the investigation of overall transport use and not just commuting, which means we are able to include multiple trip purposes and those who did not have a commute; (b) an investigation of a change in the frequency of use, as opposed to switching between modes; and (c) we investigated the four modes individually, rather than grouping modes into public transport or non-car. Although investigating changes in the frequency of mode use allowed for an investigation of how the use of different modes increased, decreased, or stayed the same, it did not enable the degree of change to be investigated, which would be of interest for determining the relative impacts of the events. Further, as these models are correlational, the direction of causality of life events and changes in transport behaviour cannot be established; this remains a challenge in the life events and transport behaviour literature (Ding et al., 2018). As such, our findings primarily support the co-occurrence of life events, transport specific events, and changes in the frequency with which modes are used in a two-year period. This is in line with conceptualisations within the mobility biographies literature

[4] It must be noted that the train use measure did not include underground, tram or light rail use, which are typically more common in urban areas.

(Chatterjee & Scheiner, 2015) and supports qualitative findings (Chatterjee et al., 2012) of life events and transport behaviour being interrelated, with the potential for bi-directional causality (Scheiner, 2007). Further longitudinal evidence investigating changes in frequency of use would be valuable for determining the causality (e.g. Scheiner, 2014b) as well as enabling the investigation of whether changes to transport behaviour are made in anticipation of or reaction to a life event, as investigated in Oakil et al. (2014) and Wang et al. (2018). In addition, the frequency of use questions relied on participants accurately reporting their use of the different modes in the past year. Such self-reported answers may be subject to unknowable recall errors or social desirability biases. This is a limitation of such survey data and more objective, more granular measures of mode use may yield different results and should be investigated in the future.

With the UKHLS being longitudinal, panel data, panel effects should be considered. Although the complex survey design ensured nationally representative data, by Wave 4 the participants would have been completing the annual survey for the previous four years (or more for those in the original BHPS survey). As such, there is a possibility that their responses were subject to panel effects (Van Landeghem, 2019). Most of the variables used in this analysis were about the provision of factual information (e.g. birth of a child, residential relocation, number of cars in the household). Other variables, such as environmental concern, are more subjective, and therefore potentially more vulnerable to panel effects. However, these questions had only been asked twice in the UKHLS by Wave 4, with approximately four years between the two measurements. This limits the possibility of repeated questioning influencing the responses. Furthermore, the UKHLS covers a wide range of topics, with no single topic dominating the survey, which may also limit the influence of participation on responses.

4.6. Theoretical, methodological and policy implications

Theoretically, our research points to a need for greater attention to dynamic contextual factors in predicting travel behaviours. Recent critiques of the environmental psychology literature highlight the undertheorisation of context within behaviour (change) models (Nielsen et al., 2021; Whitmarsh et al., 2021), and our findings here indicate that contextual factors are particularly important in the mobility context, while environmental concern is much less so. We also add to the growing literature on 'moments of change' and habit disruption, which provides a more temporal perspective on mobility behaviours than most previous research. Here, though, we not only show how behaviours can change with life events or wider context changes, but also how some behaviours may endure and resist disruption - and similarly how certain life events (e.g., childbirth) may mitigate habit change. This dual focus on stability *and* change indicates important theoretical but also practical implications.

Although having a child has been investigated as a potential opportunity to encourage new, more sustainable transport behaviour, it may be that the greater contextual disruption of residential relocation offers a comparatively better opportunity to intervene as there is already a likelihood that changes to transport usage are being made. The challenge will be preventing the decrease in more sustainable modes of bus and train whilst also preventing the increase in the less sustainable car use. Our findings that gaining a driving license, buying a car, and moving to/from an urban area are strong predictors of travel behaviour change suggests these are key intervention points for policy. For example, people learning to drive could be encouraged to join a car club or buy an electric vehicle; while, more generally, ensuring sustainable travel infrastructure is key. This research only examined naturally-occurring changes in travel behaviour following life events, but growing evidence base points to targeting interventions to these times for greater efficacy (Verplanken et al., 2008).

4.7. Conclusions

There is strong supporting evidence, from the present analyses, that life events are associated with changes in transport behaviour, as are changes in the transport context. However, the potential for differences in which modes are associated with change and to what extent are highlighted. For instance, on the one hand, relocation showed the most consistent pattern away from bus, train, and bike use, while on the other hand, parenthood showed a consistently lower likelihood of increasing use of these modes, but were not more likely to have decreased use of them. Transport specific events, however, often accounted for greater likelihood of change in travel mode use - for example, obtaining a driving license, car buying, and changing to/from urban settings stronger relationships with changes in travel behaviours, but then this was not consistent across the modes. This suggests that changes in the use of different transport modes were differentially susceptible to the life events and transport specific events. As such, policies intending to target periods of discontinuity may benefit from life events, or transport specific events, in which the use of the specific mode of interest is already more likely to be disrupted.

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CRediT authorship contribution statement

Colin Whittle: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Visualization, Project administration, Writing – review & editing. **Lorraine Whitmarsh:** Conceptualization, Writing – review & editing, Funding acquisition, Supervision. **Nicholas Nash:** Conceptualization, Writing – review & editing. **Wouter Poortinga:** Methodology, Writing – review & editing.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tbs.2022.04.007.

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