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Does exposure to new transport infrastructure result in modal shifts? Patterns of change in commute mode choices in a four-year quasi-experimental cohort study

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ABSTRACT

Background: Intervention studies suggest that changing the built environment may encourage a modal shift from car travel towards active travel. However, little is known about the detail of patterns of changes in travel behaviour.
Method: Adult commuters working in Cambridge (UK) completed annual questionnaires between 2009 and 2012. Commuting was assessed using a validated seven-day travel-to-work record. The intervention consisted of the opening of a guided busway with a path for walking and cycling in 2011. Exposure to the intervention was defined as the negative of the square root of the shortest road distance from home to the busway. We investigated the association between exposure to the intervention and specific modal shifts and patterns of change, along with individual mode choice patterns over the entire four-year period.
Results: Five groups of patterns of change were found in our in-depth explorations: (1) no change, (2) a full modal shift, (3) a partial modal shift, (4) non-stable but patterned behaviour, and (5) complicated or apparently random patterns. A minority of participants had a directed change of either a full modal shift or, more commonly, a partial modal shift, whereas a large proportion showed a highly variable pattern. No significant associations were found between exposure to the intervention and specific modal shifts or patterns of change.
Conclusion: Our analyses revealed a large diversity in (changes in) travel behaviour patterns over time, and showed that the intervention did not result in one specific pattern of behaviour change or produce only full modal shifts. These insights are important for improving the measurement of travel behaviour, improving our understanding of how changes in travel behaviour patterns occur, and fully capturing the potential impacts of interventions.

1. Introduction

Active travel can provide a sufficient level of physical activity to improve health and well-being (Department of Health, 2011). People who walk or cycle to work have been found to have lower cardiovascular risk than individuals who do not. Active travel may particularly be

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beneficial in the form of commuting as it is a repetitive journey and relatively easily incorporated in daily life (Hamer and Chida, 2008). As a result, modal shifts towards active travel are often encouraged.

Several recent studies have investigated patterns of travel behaviour change using panel data. For example, Clark et al. (2016) explored the prevalence and predictors of changes in commute mode choice in the United Kingdom Household Longitudinal Study. They showed that a third of the individuals who cycled or used the bus to travel to work, a quarter of those who walked, and a tenth of those who drove to work in 2009/10 had changed their commute mode in the next annual survey. These changes appeared to be primarily driven by changes in commute distance. Another study by Panter et al. (2011) investigated changes in commute mode choice among 655 commuters in Cambridge, UK between 2009 and 2010, and tested the socio-economic, spatial and psychological predictors of changes in time spent cycling and walking for commuting purposes in a one-week period. The majority of the participants reported the same usual mode of transport in both waves, whereas 6% of the respondents switched to the car in the given timeframe and a similar share switched away. The average duration of walking for commuting purposes increased by 3 min, and the average time cycling decreased by 5.3 min. The changes in time spent active commuting were largest in those groups who had shifted towards or away from the car use as the mode of transport.

Other studies have focussed more on the variability of individual travel behaviour and transitions within the mixture of modes used. Kroesen (2014), for example, investigated the predictors of transitions between data-derived travel behaviour clusters using latent class and latent transition models and showed that individuals who used multiple modes were more likely than those who relied on a single mode to change from one travel behaviour cluster to another over time. Chatterjee et al. (2016) also analysed transitions in commute mode choice patterns using one-week travel data collected every three-months. They found large variations between individuals in terms of their commute patterns. Almost 40% of the respondents only used a car, a similar percentage never used a car, and the remainder sometimes used a car. The data also revealed the presence of some transitions in car use, in which most changes occurred towards or away from occasional car use and fewer between the two more 'extreme' groups. These studies show that, over time, changes in commute mode choice may occur 'naturally', potentially driven by life events. However, they have not investigated changes resulting from interventions, nor have they provided a full picture of all individual mode choices in the modal mix and the transitions within them.

One approach to stimulating a shift towards active travel is to make the built environment more supportive for the use of these modes of transport. Cross-sectional studies have found associations between the built environment and mode choice (e.g. Handy et al., 2005; Ewing and Cervero, 2010; Handy et al. 2002; Saelens et al., 2003). More recently, several natural experimental studies have provided some evidence that interventions in the built environment, such as the introduction of new high-quality infrastructure, may encourage an increase in active travel. Heinen et al. (2015) showed that the opening of a guided busway, a separate guided track for buses which allows them to reach a high speed with an adjacent high quality walking and cycling path, produced a change in commute mode choice among those living nearby, in that individuals who lived closer to the new infrastructure were more likely to reduce their car use and more likely to increase their share of trips involving active travel. Using the same data, Panter et al. (2016) showed that individuals who lived closer to the intervention were also more likely to increase the time spent cycling in their weekly commutes. Goodman et al. (2014) analysed the impact of new walking and cycling routes on 1796 residents in three municipalities in the UK. They concluded that proximity to new infrastructure did not predict change in active travel after one year. However, after two years, living closer to the new infrastructure predicted an increase in weekly minutes spent walking and cycling.

Although these studies provide new support to the hypothesis that interventions in the built environment can change travel behaviour in a societally favourable direction, the patterns of change have not yet been explored in detail. The measured associations may be a result of small changes in travel behaviour in most individuals, or may be a result of large changes of fewer individuals. Moreover, the existing studies mainly show whether modal shifts took place towards (or away from) active travel. Changes in travel behaviour for individuals whose active travel mode share or active travel time remained stable are mostly unexplored. To illustrate this with an example: suppose an individual changes from commuting by bicycle only to the combined use of public transport and walking. This change may not necessarily affect the overall active commuting time, neither would it result in a change in the share of trips involving active travel. Nonetheless, large changes in individual travel behaviour *have* occurred in terms of (a) the primary mode (from bicycle to bus) as well as (b) the form of active travel (from cycling to walking). Neither of these changes are fully captured in most existing intervention studies. It is important to glean a deeper understanding of such changes in order to project consequent impacts (e.g. on air pollution, congestion or physical activity) and longer-term behavioural changes (e.g. the development or breaking of habits, self-efficacy to use certain modes) as well as to estimate the potential modal shift impacts of similar interventions in the future.

In this paper, we will characterise patterns of change over time using data from the four-year *Commuting and Health in Cambridge* quasi-experimental study cohort, and test whether exposure to the intervention is associated with certain individual behavioural patterns. We will pay particular attention to all modes used in the modal mix and explore the modal shifts, the patterns of mode choice and the patterns of changes in mode choice. To this end, we will analyse individual one-week commuting records collected annually over four years. This will allow us to explore shorter- and longer-term patterns of behaviour in general, as well as the modal shifts associated with a particular intervention.

2. Method

2.1. Setting and study: Cambridgeshire Guided Busway

The *Commuting and Health in Cambridge* study aimed to understand the impacts of a major transport infrastructural intervention in Cambridgeshire, UK, on travel behaviour, physical activity and related health outcomes (Ogilvie et al., 2016). The city of Cambridge (123,900 inhabitants) has a comparatively affluent and well-educated population. In 2011, 45% of its commuting population travelled to work by car or taxi, 28% by bicycle, 15% on foot, and 9% by public transport (ONS, 2011).

The physical intervention comprised the Cambridgeshire Guided Busway, a 25-km guideway (separate off-road track) for specially adapted buses, with a parallel service path that offers high-quality segregated infrastructure for non-motorised transport such as walking and cycling.