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# Commuting behaviours and subjective wellbeing: a critical review of longitudinal research

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## ABSTRACT

The relationship between commuting behaviours and subjective wellbeing has been fascinating scholars of different disciplines. Especially in the last decade, longitudinal research designs have made great progress in identifying causality in the commuting-wellbeing relationship by focusing on within-individual variations over time. However, the results from longitudinal research are far from consistent and, therefore, questions remain unanswered regarding the association of motorised and long commuting journeys with subjective wellbeing in the long term. The aim of this literature review is to account for why these inconsistencies occur and to provide some avenues for future longitudinal research. We achieve this by developing theoretical conceptualisations of the commuting-wellbeing relationship from an interdisciplinary perspective, which drives the subsequent critical review of empirical longitudinal evidence based on nation/city-wide panel surveys, intervention experiments and relocation events. We recommend future research to distinguish and integrate different processes that lead to changes in commuting behaviours, including environmental changes, information or participatory interventions, and the event of residential relocation together with other life events and long-term processes in life. This processual thinking will enrich the temporal scope of longitudinal research and contribute to a better understanding of the interdependent relationship between daily commuting behaviours and long-term subjective wellbeing.

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Travel behaviour; well-being; causal relationships; mobility biographies; longitudinal designs; systematic review

## 1. Introduction

Transport and wellbeing have long been of interest to transport researchers and practitioners from the assertion that the ultimate goal of transportation planning and policies is public welfare and wellbeing (Ettema et al., 2010; Kitamura et al., 1997). According to the OECD (2013), subjective wellbeing (SWB) refers to “good mental states, including all of the various evaluations, positive and negative, that people make of their lives, and the affective reactions of people to their experiences”. Commuting between home and workplaces, as routinely repeated travel behaviour and an unavoidable life domain

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for many working populations, may well exert an adverse effect on SWB in the long term. Cross-sectional studies have consistently concluded that there is a negative association of long commuting time and motorised commuting modes with overall life satisfaction and satisfaction with sub-domains of life (e.g. commuting satisfaction; Chatterjee et al., 2020). However, such cross-sectional findings contribute little to understanding the causality of the commuting-SWB relationship.

In the past decade, longitudinal studies examining the commuting-SWB relationship have been burgeoning due to increasing availability of panel datasets that follow people's behaviours and behavioural outcomes (e.g. SWB) over time. By virtue of the longitudinal design, these studies aim to answer the question of how changes in daily commuting journeys result in changes in long-term SWB. Compared with cross-sectional studies, longitudinal studies represent a big step forward in terms of uncovering the commuting-SWB causality for at least three reasons (Suppes, 1970). First, they control for any factors that are idiosyncratic to the individual and less likely to vary over time, such as personality, so the commuting-SWB relationship will not be confounded by unobserved between-individual differences. Second, SWB is specific to each individual's experience. It is not clear whether someone's report on SWB can be directly compared to that by someone else. In this respect, longitudinal designs have the advantage of focusing on within-individual variations in SWB over time. Third, some longitudinal designs, such as the intervention experiment that informs participants of available commuting choices or asks them to initiate alternative commuting choices, give insight in the temporal precedence between commuting behaviours and SWB outcomes. In such designs, a low level of SWB does not constitute a reason for people to change commuting behaviours, which to some extent resolves the reverse causality issue.

Despite methodological advances in longitudinal studies, their results on the relationship between daily commuting journeys and long-term SWB are not consistent. Not all studies show that longer and motorised commuting journeys lead to worse SWB in the long term, indicating that extant cross-sectional evidence is not corroborated by longitudinal research. This inconsistency may come from an inadequate theoretical foundation of the commuting-SWB relationship and the variety of research designs and approaches that different longitudinal studies draw on. This presents a challenge when comparing different research designs, analysing the effect mechanisms, and critically evaluating findings on the commuting-SWB relationship.

Our study contributes to this emerging field by proposing a theory-driven conceptualisation of the commuting-SWB relationship and critically reviewing the longitudinal evidence on this relationship. We argue that longitudinal research should start with distinguishing and integrating different processes that lead to changes in commuting behaviours, including environmental changes, information/participatory interventions, and relocation events over the life course. Introducing this processual way of thinking will enrich the temporal scope of longitudinal research, and contribute to a better understanding of the interdependent relationship between commuting behaviours and subjective wellbeing appropriately situated in people's life courses and corresponding socio-spatial contexts.

We start our critical review by sketching the theoretical concepts and explanations of the relationship between commuting behaviours and SWB from an interdisciplinary perspective. The conceptual model that we derive from the interdisciplinary theories drives the following literature review of empirical longitudinal research. Finally, we outline an

agenda and potential avenues for future longitudinal research with the aim of better understanding the commuting-SWB interdependency.

## 2. Conceptualisation of the commuting-SWB relationship

This section draws from an interdisciplinary perspective to conceptualise the dynamics in commuting behaviours and SWB over time, as well as the interdependent relationship between the two. Most of the relevant theories are not based on transportation research but originate from economics, psychology, sociology and geography. Given the intention to identify whether and how repetitive daily commutes have a lasting impact on SWB, we focus on the relationship between commuting behaviours and long-term SWB, including affective reactions (e.g. happiness) and cognitive judgement (e.g. satisfaction) of specific life domain and overall life (Diener et al., 2009). Our interest in the long-term effect is motivated by Chatterjee et al. (2020), which claims that “a consistent link between commuting and life satisfaction overall has not been established”. Therefore, the synthesis of theories and longitudinal evidence is a viable way to clarify the mechanism underlying changes in commuting behaviours and to lend the causal inference on the commuting-SWB relationship.

### 2.1. Neo-classical and behavioural economics: the utility theory

Neo-classical economists understand commuting decisions within the framework of utility equilibrium. The precondition for utility equilibrium is that commuting acts as a source of disutility that demands the costs of, say, travel expenses, time loss and energy expenditure. Economically rational individuals would accept these commuting-related costs only if they could access more rewarding jobs or better living environments. The consequence is a spatial equilibrium in the job and housing market, where the disutility from commutes is fully compensated by job- and housing-related benefits (Alonso, 1964; Mills, 1967; Muth, 1969). Otherwise, individuals would search for long-term mobility strategies, such as job change and residential relocation, to leave the utility invariant among them.

However, decision utility inferred from observed choices is not always identical to the experienced outcome of choices (e.g. SWB), which contradicts the view of utility equilibrium. Neo-classical economists pay little attention to experienced utility even though it fits better with the original idea of utility, i.e. the experience of pleasure or pain (Bentham, 1789). Instead, behavioural economists account for the divergence between decision utility and experienced utility by the iterative process of utility anticipation, experience and retrospection (Kahneman et al., 1997; Kahneman & Thaler, 2006). Specifically, individuals reach the commuting decision before the behaviour actually takes place. To reach the decision, they need to predict and compare the experienced outcomes of available choices by reflecting on their former experience (De Vos et al., 2016; Ettema et al., 2016). In most cases, the anticipation of experienced utility is not accurate due to socio-psychological mechanisms such as memory distortion (e.g. overstating the intensity and duration of negative past experiences; Wilson & Gilbert, 2003) and the focusing illusion (i.e. assessing an experience according to the most memorable moments, such as the most intense and recent moment, i.e. the peak-end rule; Kahneman & Krueger, 2006).

Moreover, this inaccurate anticipation has roots in the hypothesis of individual rationality (Frey & Stutzer, 2014). In reality, however, individuals not only present heterogeneous preferences and assessments of choice outcomes but also reach commuting decisions under socio-spatial constraints or with limited mobile capability (e.g. unable to drive or cycle to work).

## **2.2. Social psychology: the attitude theory**

Attitude, a core concept of social psychology, refers to the evaluative structure that predisposes individuals to respond to certain stimuli and behave in a certain way (Ajzen, 2001). When applied to the travel domain, attitude can be operationalised as the preference for means of travel, travel time or overall travel experience (Van Wee et al., 2019). In contrast to the economists' perspective that commuting is a source of disutility, psychologists believe that travel can bring happiness in its own right by providing, among others, transition time (e.g. shifts between different social roles; Jain & Lyons, 2008), an opportunity of time-out (e.g. the escape from obligations; Lyons & Chatterjee, 2008) and a form of physical activity (e.g. walking or cycling to work; Ory & Mokhtarian, 2005). Especially, the coincidence between commuting behaviours and travel attitude, such as commuters who value exercise can walk or cycle to work, will engender a positive evaluation on commuting journeys and may benefit overall SWB in the long term.

Travel attitude is originally framed as a stable construct in well-established psychological theories, such as the theories of reasoned action and planned behaviour. In these theories, attitude, together with the subjective norm and perceived behavioural control, forms the intention that drives behaviours (Ajzen, 1991; Fishbein & Ajzen, 1975). Habit derived from past behaviours and experience, however, mediates the effect of behavioural intention on the occurrence of behaviours (De Vos & Witlox, 2017; Triandis, 1977). Under routine conditions, performing habitual behaviours is a more common way to reduce cognitive effort given that alternative commuting choices often involve high search costs and uncertain anticipated utility (Gärling & Axhausen, 2003; McInerney et al., 2013). In this case, individuals do not go through deliberate decision-making but repeat daily routines without seriously considering their attitude towards and satisfaction with commuting (De Vos et al., 2021a). Therefore, breaking travel habits often requires some events, such as temporary interventions on commuting behaviours and long-term relocation of residence or workplaces, to open up a window of opportunity for unfreezing habitual commuting routines (Van Acker et al., 2010).

Advances in attitude theories indicate that travel attitude is not entirely stable but varies under certain circumstances, which further complicates the relationship between travel attitude, behaviour and satisfaction (De Vos, 2022). De Vos et al. (2021a) describe this relationship as a cyclical process where travel mode choices not only condition but also are themselves conditioned by travel satisfaction through changes in travel attitude. Simply put, individuals who are satisfied with their commuting journeys will develop a preference and tend to follow this choice in the future. Van Wee et al. (2019) further summarise two theoretical explanations for changes in travel attitude. First, the learning theory underpins the cognitive process where individuals may shift their travel attitude at the time of exposing to a new travel environment or/and initiating a new travel choice (Bloom, 1956). Second, the cognitive dissonance theory concerns a mismatch

between travel behaviour and attitude incurring discomfort (Festinger, 1957). As an adaptive strategy, individuals adjust either the attitude or the behaviour to restore the cognitive balance and return to the psychological “set point” (Brickman et al., 1978; Frederick & Loewenstein, 1999).

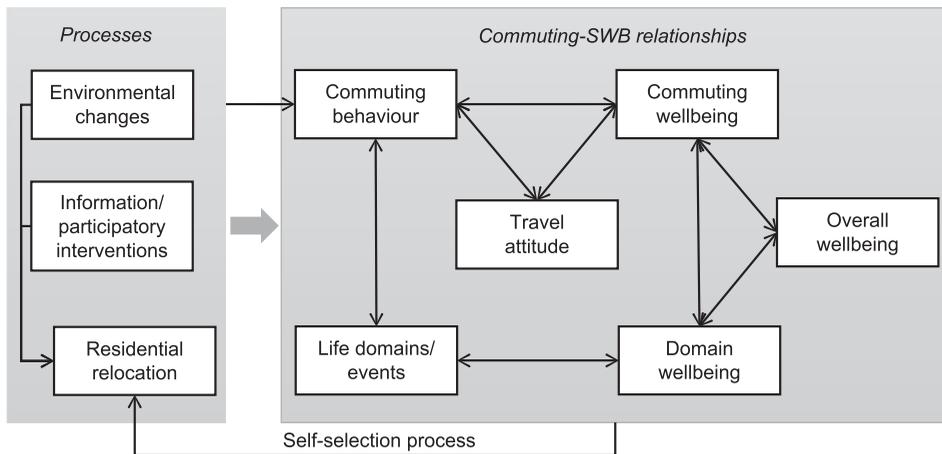
### **2.3. Social and transport geography: the relational perspective**

Social and transport geography connect travel behaviours with multifaceted life domains and underlying socio-spatial contexts from a relational perspective (Kwan & Schwanen, 2016; Muggenburg et al., 2015). This relational perspective situates the temporal scope of the commuting-SWB relationship in everyday life and the life course, respectively. From the perspective of everyday life, commuting behaviours are not only interrelated with commuting satisfaction but also linked to SWB in other life domains. Possible mechanisms at play include the inter-domain transfer and the resource drain model (Chatterjee et al., 2020; Sun et al., 2021). In inter-domain transfers, stress and dissatisfaction generated from commuting journeys spill over to negatively influence other life domains, such as job and family life (Calderwood & Mitropoulos, 2021). The resource drain model regards the resource, such as time and energy, allocated to different life domains to be limited. For example, an increase in commuting time indicates a corresponding decrease in time available for sleep, recreational exercise, social contact, et cetera, which are also significant contributors to long-term SWB (Delbosc, 2012).

From the perspective of the life course, mobility biographies are an instructive approach for linking changes in daily travel behaviours to life events along with changes in spatial context (Schoenduwe et al., 2015). Despite acknowledging travel behaviours as a routine practice, the mobility biographies approach has a particular interest in the dynamics of travel behaviours over the life course rather than extracting them from the context at a single time point (Muggenburg et al., 2015). In this approach, residential relocation acts as a key event linking life events in the family and job domains to changes in commuting behaviours. On the one hand, exposure to new residential environments evokes deliberate consideration for more desired commuting alternatives (Tao et al., 2021). On the other, people may proactively relocate to a neighbourhood that conforms to their travel attitude and preferences, which is termed (travel-related) residential self-selection (Cao et al., 2009). However, this self-selection process does not often take place because the decision-making of relocation involves a wide range of factors, such as dwelling quality, neighbourhood environment and social networks, over travel-related concerns (Chatman, 2009; Coulter et al., 2016; De Vos et al., 2021b). Besides, job-housing distances, limited budgets and transport opportunities, and varying preferences between family members constitute socio-spatial constraints that impede individuals’ choices of preferred residential locations and commuting behaviours (Cao & Ettema, 2014; De Vos et al., 2013; Tao et al., 2022). As a result, individuals may end up having to commute in an undesired way and stay stuck in suboptimal SWB statuses.

### **2.4. A conceptual model for the commuting-SWB relationship**

Figure 1 shows the conceptual model of commuting-SWB relationships. The model is developed based on the preceding theoretical conceptualisation and derives additional



**Figure 1.** A conceptual model for the commuting-SWB relationship.

inputs from several review articles (Ettema et al., 2010, 2016; De Vos et al., 2013, p. 2021a; Mokhtarian, 2019; Chatterjee et al., 2020). These inputs are assembled in the right module “commuting-SWB relationships” of Figure 1, where three interdependent relationships are specified. First, not only does commuting behaviour and its consistency with travel attitude affect commuting wellbeing, but also a positive commuting experience reinforces the commuting choice directly or through changing attitude towards the chosen commuting behaviour. Second, commuting behaviours are inter-related with other life domains (e.g. family and job domains) by emotional spill-overs and the allocation of time and energy resources, while changes in commuting behaviours often occur at the time of residential relocation or/and undergoing other life events. Third, the relationship between domain-specific and overall SWB involves a bottom-up effect where pleasures and pains gained from multiple life domains sum up to a global assessment of life satisfaction, as well as a top-down effect where overall satisfaction with life predisposes the way that people evaluate specific life domains.

Our study contributes to the conceptual model by differentiating and integrating three upstream processes that lead to changes in commuting behaviours, i.e. environmental changes, information/participatory interventions, and relocation events over the life course. The first process, environmental changes, describes changes in built environment and transport systems over time. In this regard, environmental changes are exogenous to people’s commuting choices so the unidirectional impact of commuting behaviour on SWB outcomes can be tentatively inferred. Note that environmental changes not only concern gradual processes such as the evolution of land uses and traffic congestion over time, but also include abrupt changes such as the operation or closure of transportation infrastructure and the changes caused by disruptive events (e.g. natural disasters and pandemics). In the former case, changes in the environment are often too subtle to be noticed so people tend to repeat habitual commuting routines and do not deliberately think about commuting wellbeing. Despite a significant environmental change in the latter case, anticipated commuting changes may not take place if people are not

well-informed of environmental changes or are uncertain whether commuting changes will benefit SWB.

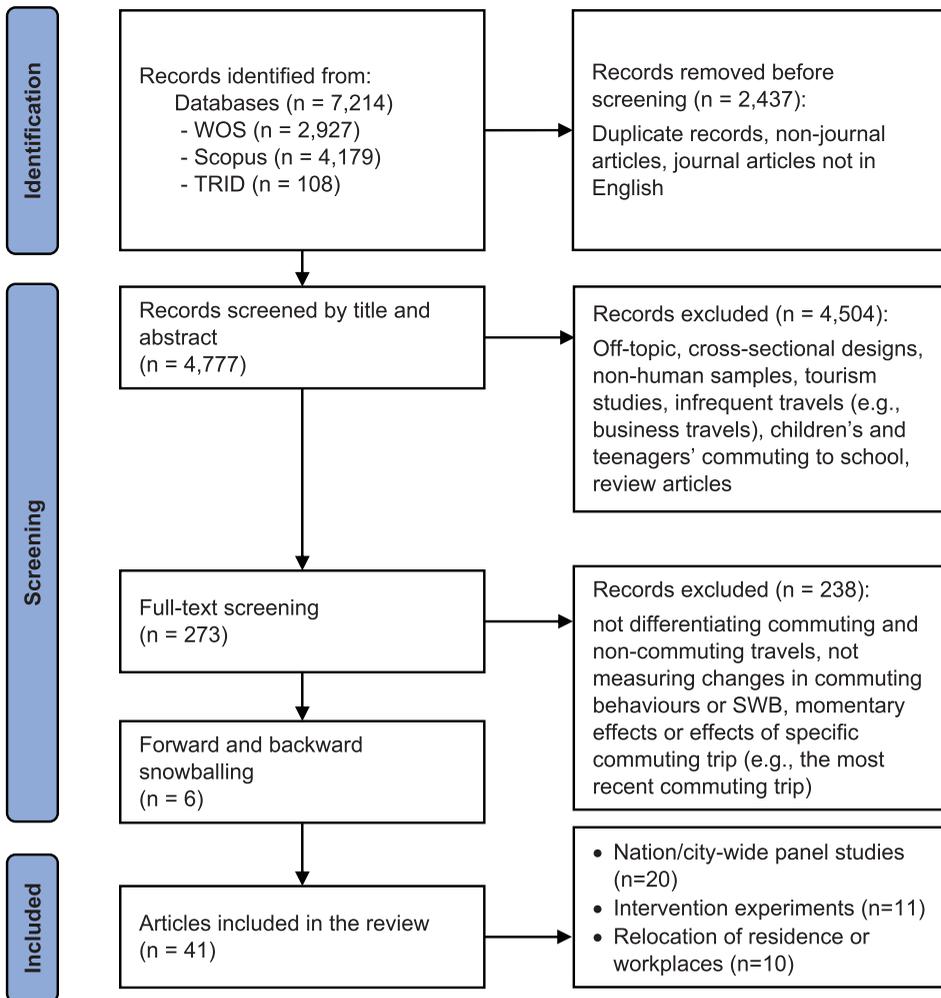
To simulate deliberate decision-making and unfreeze travel habits, information or participatory interventions are introduced as another exogenous source of commuting changes. Interventions on commuting behaviours are often designed as a temporary experiment. In the intervention experiment, informational strategies (e.g. tailored travel information on public transport routes and timetables) or participatory strategies (e.g. free tickets issued to new public transport users) are used to keep people informed of, or ask them to initiate, commuting alternatives. By doing so, people will reconsider habitual commuting routines and proactively compare the experienced utility of different commuting choices. Moreover, the original attitude towards the intervened commuting behaviour will be corrected by the information gained or by direct experience.

In addition to interventions, relocation and related life events also mark a clear cut for people to consciously rearrange daily activity-travel behaviours. Particularly, residential relocation, as the third process of our interest, is endogenous to the commuting-SWB relationship. Apart from a window of opportunity for exposing to new travel-related environments, residential relocation may involve a self-selection process for realising preferred commuting behaviours. That is to say, dissatisfaction with daily commutes drives the decision-making of relocation so that people can initiate desired commuting choices, indicating the reverse causality from SWB to commuting behaviours. Moreover, relocation events are embedded in the long-term process of life (Müggenburg et al., 2015). With increases in age or after experiencing major life events, people may strive for long-term mobility (e.g. residential relocation) or/and daily mobility (e.g. changing commuting behaviours) to adapt to varying travel demands and preferences.

A final note is that the aforementioned three processes are not isolated but interrelated with each other, which further complicates the commuting-SWB relationship. For example, an intervention experiment may well achieve its potential at the time of abrupt environmental changes, such as issuing free tickets for a new public transport service. Residential relocation may take place when intervention and environmental changes discourage people's preferred commuting behaviours.

### 3. Review methodology

Based on the theoretical conceptualisation of the commuting-SWB relationship, we systematically collected empirical articles that repeatedly or retrospectively observe people's commuting behaviours and SWB to assess the methodologies used and their findings, as well as to identify potential challenges for existing longitudinal studies. Our particular interest in these longitudinal studies is the extent to which they differentiate upstream processes of commuting changes and identify the interdependent commuting-SWB relationship as illustrated in the conceptual model (Figure 1). The selection of relevant articles followed the guideline of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020. The final search was conducted in July 2022, using the databases of the Web of Science, Scopus and Transportation Research International Documentation (TRID), and including peer-reviewed journal articles in English. The search strategy was based on a combination of three word strings: longitudinal designs (i.e. longitudinal, panel, prospective, retrospective, cohort, relocation, experiment and



**Figure 2.** PRISMA 2020 flow diagram of the article selection process.

intervention), commuting behaviours (i.e. commuting, travel, mobility, trip, movement and transport), and SWB (wellbeing, life satisfaction, happiness, stress, health and quality of life).

The search strategy generated 7,214 raw records. After removing duplicate records across the three databases, screening by title and abstract, and full-text reading, there were 35 articles left. Six articles were further supplemented through forward and backward snowballing, resulting in a set of 41 longitudinal articles to be reviewed in our research. Figure 2 presents the PRISMA 2020 flow diagram of the article selection with detailed article exclusion criteria.

#### 4. Review results

The reviewed articles were classified into three categories, i.e. nation/city-wide panel studies, intervention experiments, and studies of relocation events. These three

categories of longitudinal research vary in their research designs, including the studied geographical areas, sampling schemes, methods of analysis, and especially, the differentiation of upstream processes of commuting changes. For space reasons, we leave the overview of the reviewed longitudinal articles in Table A1-3 in the Appendix. Notably, all but three longitudinal articles were published between 2011 and 2022, and all articles concerning changes in commuting behaviours and SWB before and after the relocation event were published in the last five years (2017-2022; Table 1). In this section below, we will review research designs and findings for these three categories of longitudinal research in detail.

#### 4.1. Longitudinal research based on nation/city-wide panel surveys

There are twenty longitudinal studies drawing from nation- or city-wide panel surveys (Table A1). These panels follow a large number of people across the nation or the city by means of multi-wave surveys over a long time period. Representative panels include the UK Household Longitudinal Study (or Understanding Society, UKHLS) and the German Socio-Economic Panel (GSOEP), both of which have recorded yearly behavioural and wellbeing information for over 10,000 people over three decades. Compared with the cross-sectional design that analyses between-individual variations at a single time point, these longitudinal studies examine how within-individual changes in commuting behaviours are associated with corresponding changes in SWB outcomes by means of a fixed-effects model or a difference-in-difference approach.

The results from nation/city-wide longitudinal studies are not as consistent as the results from cross-sectional studies. Some of the longitudinal studies find that longer commuting time or distance does not result in worse overall SWB within the individual (Clark et al., 2020; Dickerson et al., 2014; Lorenz, 2018). This finding conforms to the framework of utility equilibrium, which means that individuals can obtain equivalent benefits in the job and housing market to compensate for increased commuting costs, thereby cancelling the negative effect of long commutes on SWB. However, some other longitudinal studies do observe similar results as cross-sectional studies. For example, Stutzer and Frey's research in Germany indicates that individuals' life satisfaction decreases as

**Table 1.** Number of the reviewed articles by research designs and publication years.

Publication years	Nation/city-wide panel studies	Intervention experiments	Residential or workplace relocation
2005	0	1	0
2008	1	1	0
2011	1	1	0
2012	0	2	0
2013	0	0	0
2014	5	0	0
2015	0	0	0
2016	2	1	0
2017	1	1	1
2018	1	1	2
2019	4	2	4
2020	1	1	1
2021	3	0	2
2022	1	0	0
Total	20	11	10

commuting time increases (Frey & Stutzer, 2014; Stutzer & Frey, 2008). Given the contradiction to the utility equilibrium, this result is termed the commuting paradox and explained by the theory of behavioural economics. The explanation is that individuals adapt more easily to extrinsic attributes (e.g. gains in labour income) than intrinsic ones (e.g. losses from commuting time), resulting in the negative effect of commuting time on overall SWB (Frey & Stutzer, 2014). Moreover, Milner et al. (2017) and Ingenfeld et al. (2019) identify a non-linear effect of long commutes on general psychological well-being in Australia and life satisfaction in Germany, with a much larger magnitude for extremely long commuting journeys (weekly commuting time > 6 h in Australia and one-way commuting distance > 80 kilometres in Germany).

To specify the commuting-SWB relationship, several longitudinal studies investigate the spill-overs of commuting journeys to other life domains, and furthermore, analyse how the domain-specific SWB mediates the relationship between commuting behaviours and overall SWB. For example, analysis of UKHLS data shows that the longer the commuting time, the lower the satisfaction with jobs and leisure time, and the higher the level of affective strain (Clark et al., 2020). By using the GSOEP data, Lorenz (2018) similarly indicates that longer commuting distance is linked to lower satisfaction with leisure time and family life, but less with affective SWB, such as frequent feelings of anger and worry. Based on the inter-domain spill-overs, Ingenfeld et al. (2019) account for the weak impact of long commutes on overall SWB by the fact that commuting journeys impose competing benefits and threats on different life domains. Specifically, longer commuting distance is related to higher satisfaction with work, income and housing on the one hand, and lower satisfaction with leisure time and health on the other, thereby causing the total effect on life satisfaction towards the null.

Commuting-SWB relationships also differ between social groups, with gender and occupational groups discussed the most by existing longitudinal studies. Five studies using the UKHLS data uniformly conclude that women experience greater disutility from increased commuting time than men, evidenced by worse general psychological wellbeing (Feng & Boyle, 2014; Jacob et al., 2019; Roberts et al., 2011), greater dissatisfaction with commuting time, leisure time (Wheatley, 2014) and social life (Nisic & Kley, 2019). The rationale includes women's dominant responsibility for household tasks and child-care, lower occupational status and wage rates in the job market, limited commuting mode choices, and involuntary residential relocation for male partners' occupational careers. In a household-level analysis, Hirte and Illmann (2019) demonstrate a cooperative commuting decision within the family, given that changes in couples' commuting distance do not influence their joint life satisfaction. Regarding occupational status, marginal dissatisfaction with longer commuting journeys comes from low job controls (Milner et al., 2017), fixed and long working hours (Wheatley, 2014), full-time jobs (Nisic & Kley, 2019), and thin labour markets (Roberts et al., 2011).

Apart from commuting time and distance, commuting mode choices exert an independent effect on SWB. Specifically, the switch to active mode (i.e. walking and cycling) is shown to be more beneficial to general psychological wellbeing compared with maintaining public transport or car use (Martin et al., 2014; Mytton et al., 2016; Jacob et al., 2021). In contrast to the benefits of active commuting, there is no consensus regarding the effect of switching between car and public transport on long-term SWB, partly due to various contextual exposures across research areas (Jacob et al., 2021; Stutzer & Frey, 2008; Wang

et al., 2021). For example, research in Chinese cities shows that prevalent air pollutants to some extent aggravate the negative effect of long commuting time because of the prolonged exposure to air pollution, and mitigate the loss in life satisfaction for public transport commuters possibly due to lower risks of traffic accidents and fewer on-road air pollutants of commuting by underground compared with commuting by car (Wang et al., 2021). Focusing on day-to-day variations of SWB outcomes in the car-dominant city of San Francisco, the US, Le and Carrel (2021) find that public transport commuting results in worse travel happiness than car commuting, while a happy public transport journey on the previous day is predictive of satisfaction with operational service quality on the following day. Also, evidence from Bristol, the UK shows that partial car commuters (who do not use cars on all workdays) are more likely to give up car use when they are satisfied with an alternative travel mode, suggesting the feedback effect of commuting satisfaction on mode choices (Chatterjee et al., 2016).

Notably, most nation/city-wide longitudinal studies mix different upstream processes of commuting changes, including environmental changes, relocation events, or changes in age and life stages. To isolate the role of relocation and the self-selection for preferred commuting behaviours, some studies exclude observations of those who change housing or job locations between survey waves so that any changes in commuting behaviours come from the source exogenous to individual choices (Roberts et al., 2011; Martin et al., 2014; Jacobs et al., 2019, 2021). Instead, only a few studies focus on housing and job movers. Stutzer and Frey (2008) conduct a subgroup analysis of relocated residents whose commuting time is negatively related to life satisfaction in a smaller magnitude, suggesting the existence of residential self-selection. Lorenz (2018) differentiates between involuntary and voluntary job changes, and concludes that the negative effect of commuting distance on life satisfaction only applies to individuals who involuntarily change jobs. Besides the relocation event, these multi-year panel studies elaborate little on the results of other long-term processes in life, even though relevant time-varying confounders (e.g. age and age squared, and events of cohabitation and childbirth) are controlled for in their fixed-effect analyses of SWB outcomes. Only four studies have analysed the extent to which commuting-SWB relationships vary for people at different life stages. Specifically, Wheatley (2014) and Jacob et al. (2019) find that mothers are disproportionately influenced by longer commutes by showing worse leisure time satisfaction and general psychological wellbeing, respectively. By regressing the interaction term of commuting time and age groups on multiple SWB outcomes, Robert et al. (2011) and Clark et al. (2020) both show that age does not moderate the commuting-SWB relationship.

Another interesting study that makes clear the upstream process of commuting changes is based on the exogenous shock of the COVID-19 pandemic. Kroesen (2022) draws upon three-wave panel data in the Netherlands to examine how workers reflect on their previous commuting journeys after they are mandated to work from home during the COVID-19. The results show that the relationship between working from home and life satisfaction does depend on the pre-COVID-19 commuting time. Workers, especially female workers, who commuted 1 h or more to work report better life satisfaction after switching to homeworking. In addition, some recent studies indicate a declining uptake of public transport for commuting throughout the pandemic (Beck & Hensher, 2021; Hensher et al., 2022). However, longitudinal evidence is lacking to account

for this decline by changes in attitude towards and satisfaction with public transport commuting. It is possible that people care more about social distancing and are reluctant to use public transport during, and even after the COVID-19 pandemic.

In summary, evidence from nation/city-wide longitudinal studies is robust because of large sample sizes, multi-wave follow-up observations, and representative geographic areas for study. However, findings for these longitudinal studies are not consistent, especially regarding the relationship between long commuting journeys and overall SWB in the long term. To account for this inconsistency, some studies have examined the inter-domain spill-overs and trade-offs, conducted subgroup analyses on gender and occupational groups, and differentiated the contextual exposure among travel modes. Even so, most of the nation/city-wide longitudinal studies mix the endogenous and exogenous sources of commuting changes, and especially overlook residential self-selection and the role of long-term processes in life, which may also constitute a reason for coming to inconsistent commuting-SWB relationships.

#### **4.2. The intervention experiment**

Our review contains eleven longitudinal studies that implement an intervention experiment to prompt participants to initiate commuting alternatives and observe resultant changes in SWB outcomes (Table A2). The experiments often employ soft interventions, including deliberation (e.g. imparting information on newly established bus routes), commitments (e.g. making commitments to commuting by public transport), and incentives (e.g. issuing pre-paid public transport tickets). According to the type of intervention strategies, deliberation is an informational strategy, while commitment and incentive strategies are participatory in nature and sometimes combined with each other. Despite the difference in intervention strategies, these studies are similar in research designs and methods. After stratifying intervention groups and controls groups who share similar modal choices at pre-intervention, the intervention experiment compares their changes in commuting mode and SWB pre-post intervention. Considering the small sample size and temporary intervention periods, the analysis of variance (ANOVA) is often used to compare within-individual differences in SWB pre-post intervention, as well as between-individual differences for intervention and control groups at post-intervention.

Intervention on the active mode, especially bicycle and e-bicycle, shows positive effects on commuting satisfaction and overall SWB. For example, company cycling programmes conducted in Flanders and Germany similarly find that workers improve their general psychological wellbeing after they participate in the programme and start cycling to work (De Geus et al., 2008; Synek & Koenigstorfer, 2019). Also, the benefit of e-bicycle use is manifested as greater commuting satisfaction in North-Brabant, the Netherlands, and better general psychological wellbeing in the UK (De Kruijf et al., 2019; Page & Nilsson, 2017). In particular, e-bicycle users' psychological wellbeing marginally increases when they commute with a longer duration (Page & Nilsson, 2017). There is only one intervention study comparing the wellbeing effect of different active modes (Neumeier et al., 2020). The results suggest that cycling to work is more beneficial to general psychological wellbeing than walking (from and to public transport stops) as a part of commuting journeys.

Public transport, as a potential alternative to cars for long-distance commuting journeys, is another focus of intervention studies. In effect, however, findings for public transport interventions are mixed across research contexts and designs. On the one hand, providing information on public transport routes or stations does not suffice to leverage a wider gain in SWB for populations from the neighbourhoods served. Wener et al. (2005) and Lionjanga and Venter (2018) both indicate that participants benefit from the opening of a new public transport service (e.g. by showing less job strain and greater satisfaction with free time) only after they actually switch to public transport for commuting. On the other hand, the commitment and incentive designs are more effective to improve commuting wellbeing but do not necessarily result in better overall SWB and new commuting habits. By combining pre-paid 1-month public transport tickets and the commitment to frequent public transport use, Pedersen et al. (2011) find that switching from cars to public transport leads to greater commuting satisfaction in a medium-sized city of Sweden. Abou-Zeid et al. (2012) and Abou-Zeid and Ben-Akiva (2012) conduct a comparable research design in three educational institutions, Switzerland and the Massachusetts Institute of Technology (MIT), the US, respectively. During the intervention period, participants from both studies show more positive attitude towards public transport and greater commuting satisfaction after switching to public transport. However, only in the US case, a certain amount of participants maintain public transport commuting and sustain high levels of commuting satisfaction several months after the intervention. This discrepancy is explained by the contextual difference between Switzerland and the US, such as higher parking permit costs and public transport subsidies in the US case (Abou-Zeid & Fujii, 2016).

Two notable concerns for intervention research are the validity of the sampling scheme and the time period for follow-up investigations. In the eleven intervention studies, four of them do not incorporate a control group, so the impact of commuting changes on SWB cannot be isolated from time-varying attributes (e.g. changes in traffic volume) other than the intervention itself. Moreover, sampling of the intervention group may be selective in the first place; that is, people who are stimulated by the intervention incentives or are open to the post-intervention change are more likely to accept the intervention. This selection bias is more of a concern if people who have already been unhappy with commutes are willing to participate in the intervention, thereby overstating the intervention effect on SWB outcomes. Therefore, it needs caution to extrapolate the results from an intervention experiment to the general population and to a different socio-spatial context.

Regarding the time period of intervention experiments, research participants are followed ranging from two weeks to one year in the eleven intervention studies, among which only five studies further compare changes in commuting behaviours and SWB at different post-intervention timestamps. The short time period for follow-up investigations restricts the scope for examining SWB outcomes from commuting satisfaction to overall SWB in the long term. In terms of e-bicycle interventions, De Geus et al. (2008) suggest that the positive effect of switching to e-bicycle on affective wellbeing lasts for six months and moderately weakens after one year. De Kruijf et al. (2019) come to a surprising finding that commuting satisfaction by e-bicycle is even higher six months later than one month after the intervention, possibly due to the monetary incentive design (i.e. cycling more and earning more). Regarding the temporal effect of public transport

interventions, Pedersen et al. (2011) indicate that habitual car users significantly improve commuting satisfaction after switching to public transport, and two weeks later, their commuting satisfaction sustains. In contrast, Abou-Zeid et al. (2012) find that compared to the level at pre-intervention, participants rate higher levels of satisfaction with car commuting in the week following public transport use because they start to value the punctuality and flexibility of car use. Several months later, however, both the frequency of and satisfaction with car commuting return to the pre-intervention level.

In summary, intervention experiments are limited in sample size, geographical scale and time periods for study compared with nation/city-wide longitudinal research. Even so, the intervention design contributes to the commuting-SWB causality by reinforcing people's intention to break travel habits and clarifying the temporal precedence between changes in commuting behaviour and changes in SWB outcomes. Evidence from intervention experiments corroborates the wellbeing effect of switching to an active travel mode as found in nation/city-wide research, and further indicates the benefit of some emerging commuting practices, such as e-bicycle use and the company-led programme of active commuting to work, in improving commuting wellbeing. For public transport intervention, the participatory strategy seems more effective in increasing commuting satisfaction than the informational strategy, and in some cases, people who are satisfied with the alternative commuting mode will develop it as a new habitual routine.

#### **4.3. The event of residential and workplace relocation**

We finally reviewed ten longitudinal studies that focus on the effects of relocation events, including the relocation of residence and workplaces (Table A3). Most relocation studies retrospectively investigate participants' commuting behaviours and SWB before and after they move houses or change job locations, and then, use the difference-in-difference approach or ANOVA to examine the commuting-SWB relationship. Notably, relocation studies make explicit the geographical perspective by taking into account the spatial characteristics of relocation origins and destinations (e.g. urban-to-suburban relocation). Furthermore, residential relocation research incorporates the self-selection process, that is, relocating to match travel attitude and preferences.

Given that enterprise expansion and relocation are often beyond the control of individual employees, workplace relocation research views changes in job locations as an exogenous event. For workplace relocation from suburban to urban areas, specifically, Von Behren et al. (2018) and Schneider and Willman (2019) similarly find that afterwards employees are more satisfied with commuting journeys because of shorter commuting time and a mode switch from car to other means of travel (e.g. bicycle). Conversely, suburban relocation of workplaces often involves longer commuting distances, but its influence on SWB depends on transportation infrastructure and traffic conditions in the suburb. For example, an involuntary workplace relocation to the suburbs of Beijing, China leads to greater commuting dissatisfaction and increased turnover intention for government staff (Qu et al., 2021). Moreover, longer commuting journeys to the suburbs not only lead to commuting dissatisfaction but also affect other life domains and cause lower attachment to workplaces and neighbourhoods, ultimately resulting in lower levels of overall SWB (Rau et al., 2019). Counterintuitively, a study in Montreal,

Canada shows that workplace relocation to a peri-central location reduces employees' commuting time and improves their commuting satisfaction and workplace attachment (Gerber et al., 2020). Their justification is that the new workplace is located in a planned suburban centre integrated with an efficient transport system, including a regional rail station, a metro station and a highway interchange.

Similar to workplace relocation, residential relocation exposes people to a new travel-related environment that provides opportunities for, or imposes constraints on, initiating commuting alternatives. For example, a cluster analysis of relocated residents in Ghent, Belgium suggests that reduced commuting time and increased use of car alternatives lead to greater commuting satisfaction (De Vos et al., 2019). Nicholls et al. (2018) find that people who relocate to a newly built suburban residential estate report worse commuting satisfaction from increased commuting time and more congested traffic. Gerber et al. (2017) also indicate that longer commuting journeys by car are the least satisfying aspect of daily life after workers in Luxembourg relocate to a neighbouring country to live. However, the worsening commuting circumstance does not undermine satisfaction with the neighbourhood and overall life, because people attach more weight to housing conditions than to the commuting situation when estimating overall SWB (Gerber et al., 2017; Nicholls et al., 2018).

Residential relocation may also involve residents' self-selection for better housing, jobs, or even travel experiences. Specific to travel-related self-selection, changes in commuting behaviours following the relocation may derive more from a realisation of travel preferences and the intention to improve suboptimal SWB than vice versa. To date, however, there is limited longitudinal evidence in this regard. Kent et al. (2019) investigate how residents who move to a suburban greenfield estate psychologically react to changes in commuting time after isolating the role of travel attitude. The results show that even though the pro-car attitude and the disregard for travel time result in better SWB outcomes, changes in commuting duration and the departure time for commuting still exert an independent effect on anxiety and life satisfaction. De Vos et al. (2021b) contribute the only longitudinal evidence that explicitly examines travel-related self-selection and its influence on commuting wellbeing. By retrospectively investigating residents who relocate to urban and suburban areas, this study indicates that residents' commuting mode choices tend to accord with their mode-specific attitude after the relocation, and furthermore, the behaviour-attitude consistency results in greater commuting satisfaction.

Two noteworthy features of relocation research are the retrospective survey design and the individual-level event analysis. Except for Nicholls et al. (2018) and Von Behren et al. (2018), eight out of ten relocation studies ask participants to retrospectively record their changes in commuting behaviours and SWB when participants have already settled down in the new residence or workplace, which inevitably introduces a recall bias and a consistency bias. Besides, the retrospective design regards travel attitude as stable over time, which neglects people's learning process and adaptability to new living environments not only by adjusting behaviours to match attitude but also by adjusting attitudes to match behaviours. If travel attitude does change after the relocation, the retrospective questioning on travel attitude is not reliable to approximate the pre-relocation travel attitude and estimate the effect of residential self-selection.

Another issue is that the individual-level event analysis not only disregards the balancing and compromising between family members in reaching the relocation decision, but also disconnects the relocation event with other life events that jointly shape commuting choices (e.g. concurrent changes in job and housing locations, and childbirth as a common reason for suburban relocation and car use). There is limited, if any, household-level evidence from the perspective of trip chaining behaviours and the gender gap at different life stages. It shows that employees with shorter commutes incorporate more family-oriented trips (e.g. grocery shopping) into the commuting trips, which improves their satisfaction with family life (Rau et al., 2019; Von Behren et al., 2018). Besides, after commuting distance increases, female employees and employees with school-aged children are under a greater threat of involuntary suburban relocation and report a higher intention to quit jobs (Qu et al., 2021).

In summary, compared with nation/city-wide studies and intervention experiments, relocation research refines the geographical perspective and leads to a better understanding of self-selection processes in the commuting-SWB relationship. Findings for involuntary workplace relocation are context-dependent. Relocation from suburban to urban areas stimulates shorter and less motorised commuting journeys that result in greater commuting satisfaction, whereas the wellbeing benefit for the reverse urban-to-suburban relocation depends on the supportive suburban environment with easy-access transport links to home locations. In contrast, the commuting-SWB relationship following residential relocation is more complicated, concerning not only the stimulus exercised by the new residential environment but also the self-selection for realising preferred commuting behaviours.

## 5. Agenda for future longitudinal research

Longitudinal research designs are important to validate the results from cross-sectional studies which consistently found that longer commutes lead to worse SWB outcomes. Our synthesis of existing longitudinal evidence, however, comes to inconsistent findings, especially for the impact of long commuting distance/time and switching between public transport and car on overall SWB in the long term. To address these inconsistencies, research has applied the utility equilibrium theory to substantiate the impact of longer commutes on worse commuting satisfaction and the inter-domain effects between commuting satisfaction and satisfaction with other life domains. To further bridge the gap between theoretical conceptualisations (Section 2) and longitudinal research (Section 4), in this section, we integrate theories from social psychology and transport geography to advocate a processual way of thinking on the nature of the commuting-SWB relationship. Specific avenues for future longitudinal designs and research are followed with the aim of better understanding the interdependent relationship between commuting behaviours and SWB.

### 5.1. A processual thinking for the commuting-SWB interdependency

Commuting-SWB relationships are manifested as a process where commuting and SWB are interdependent with each other over time and, at a certain point, individuals' wellbeing statuses are shaped by their past experiences and situational contexts (Schwanen,

2018; Whitehead, 1929). To apply this processual way of thinking, the first and foremost agenda for future longitudinal research is to differentiate and integrate different processes of commuting changes, whether they occur spontaneously as the travel-related environment evolves over time or require an intervention to inform or direct alternative commuting choices, and whether they are exogenous or endogenous to the commuting-SWB relationship. In our conceptual framework (Figure 1), we identify three different but interrelated processes. Among them, two processes are exogenous to the commuting-SWB relationship: Environmental changes outline temporal variations in transportation infrastructure and physical environment, which have the potential to break people's habitual travel routines. In contrast, information/participatory interventions target the behaviour itself and directly reinforce people's intention to initiate commuting alternatives. The third process, residential relocation events, is endogenous to the commuting-SWB relationship since people may relocate to satisfy their desired commuting behaviours. In a nutshell, whilst processual thinking seems to take a step backwards in understanding the commuting-SWB relationship by retrieving the source of commuting changes, it actually makes a stride forwards by viewing the pathway to the occurrence of behaviours as equally important as behaviours and behavioural outcomes (e.g. SWB) themselves.

## ***5.2. Avenues for future longitudinal designs and research***

Based on the processual way of thinking, we suggest the first avenue for future longitudinal research to analyse how commuting-SWB relationships vary after taking into account different upstream processes of commuting changes. This recommendation concerns nation/city-wide longitudinal studies the most. As reviewed in Section 4.1, some nation/city-wide studies have isolated the process of exogenous environmental changes from residential self-selection by excluding workplace or residential movers. However, the analysis of non-movers introduces another selection issue; that is, relocation is not evenly distributed across the population. As a result, findings for the commuting-SWB relationship may be biased toward those who are not able to relocate when undesired environmental changes take place. Therefore, we recommend including and stratifying movers and non-movers in the longitudinal analysis to compare their differences in socio-economic characteristics, geographical distributions, and psychological reactions to environmental and commuting changes. In addition, other long-term processes in life deserve equal attention. Besides controlling for age effects and life events as time-varying confounders, future research can clarify the dynamics in commuting-SWB relationships by conducting subgroup analysis on people at different life stages, or path analysis on changes in life stages, commuting behaviours and SWB outcomes.

The second avenue is to refine the temporal aspect of the commuting-SWB relationship. This recommendation originates from the theory of travel attitude and habits, and concerns intervention experiments and nation/city-wide studies. Regarding the intervention experiments, the short time period for post-intervention investigations fails to track the long-term effect on SWB outcomes and the formation of new travel habits. Therefore, we suggest participants be followed for multiple waves over a longer time period after the intervention. These follow-up investigations can be realised by incorporating the information/participatory intervention into the appraisal of environment- and behaviour-

oriented programmes. For example, the long-term behavioural intervention after the operation of a new public transport service or a new residential estate can be promising in directing more sustainable commuting patterns as well as improving public health and wellbeing. As for nation/city-wide longitudinal studies, it is problematic that commonly used modelling techniques, such as fixed-effect models and the difference-in-difference approach, implicitly drop those observations that have no change in commuting behaviours between survey waves. The benefit or threat of maintaining certain commuting behaviour may take time to appear. Besides, psychological adaptation may occur in anticipation of or lagging behind commuting changes. In this regard, maintaining analysis (e.g. the effect of maintaining commuting behaviours on changes in SWB from wave 1 to wave 2) and cross-lagged panel analysis (e.g. the effect of commuting behaviour at wave 1 on SWB at wave 2 after controlling for baseline SWB at wave 1) are recommended to recognise these cumulative and time-lagged effects. Besides changes in commuting behaviours, travel attitude is also subject to change in the long run (De Vos, 2022; De Vos et al., 2021a). For this, latent class transition analysis is a viable way to study how people adjust commuting behaviours versus travel attitude, especially when they are exposed to a new travel-related environment or/and undergo suboptimal SWB statuses caused by the behaviour-attitude inconsistency.

The third avenue, built on the relational perspective and the mobility biographies approach, is to investigate the commuting-SWB relationship over the life course in a household context. This recommendation directs at integrating insights from relocation studies that usually draw upon small-scale retrospective surveys into nation/city-wide multi-wave panel studies. Currently, these nation/city-wide studies are limited by using the snap-shots of longitudinal data that assume unobserved variables as stable between survey waves (Coulter et al., 2016; Schoenduwe et al., 2015). Future research will benefit from regarding relocation as an adaptation to other life events (e.g. suburban relocation after childbirth) along with the travel-related concern (e.g. a greater preference and demand for car use after childbirth and suburban relocation), and examining how the three of them are relationally situated in the life course and jointly shape SWB outcomes. Moreover, the individual-level analysis of commuting-SWB relationships ignores possible trade-offs of commuting utility between family members. There is evidence that compared with men, women fare worse in health and SWB outcomes from longer commutes and less say in family car use (Shen et al., 2021; Ta et al., 2019). However, it is not clear how this gendered pattern of commuting-SWB relationships is shaped by medium- and long-term mobility decisions (e.g. household car-use allocation and housing location choices) and reshaped after the occurrence of life events. It is also interesting to study whether females' SWB outcomes are more influenced by changes in male partners' commuting behaviours than vice versa by means of joint decision analysis (e.g. using intertemporal collective models; Chiappori & Mazzocco, 2017).

The final avenue we recommend for future longitudinal research is to scrutinise the commuting-SWB relationship rooted in local socio-spatial contexts. Longitudinal research tends to achieve a general conclusion on the unidirectional impact of commuting behaviour on SWB outcomes, termed the commuting-SWB causality. Existing longitudinal evidence, however, often comes to "surprising" findings. Some instances, as stated in Section 4, are that public transport commuters report better life satisfaction than car commuters in air-polluted Chinese cities (Wang et al., 2021), a workplace relocation to the

suburb enhances employees' commuting satisfaction in Montreal, Canada (Gerber et al., 2020), and similar intervention strategies result in different levels of commuting satisfaction and mode switch in Switzerland and the US (Abou-Zeid et al., 2012; Abou-Zeid & Ben-Akiva, 2012). In this critical review, we further conceive the relationship between commuting behaviours and SWB as an interdependent and reciprocal process over time. To this end, more cross-country and cross-region comparisons that follow similar longitudinal research designs are welcome to identify this interdependency. When conflicting results arise, commuting-SWB relationships should be interpreted based on the contextual characteristics, including geographical environment, social atmosphere, cultural norms and past history, of local research areas (Schwanen, 2018).

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