ESRI Working Paper No. 745

February 2023

Using Behavioural Science to Design and Implement Active Travel Infrastructure: A Narrative Review of Evidence

Shane Timmons[a,b*], Ylva Andersson[a], Féidhlim McGowan[a,c] & Peter D. Lunn[a,c]

a) Economic and Social Research Institute, Dublin, Ireland
b) School of Psychology, Trinity College Dublin, Dublin, Ireland
c) Department of Economics, Trinity College Dublin, Dublin, Ireland

*Corresponding Author:
Dr Shane Timmons
Economic and Social Research Institute,
Whitaker Square, Sir John Rogerson's Quay,
Dublin, Ireland
Email: Shane.Timmons@esri.ie

Funding: This work represents a combination of two reports, individually supported by Fingal County Council and the National Transport Authority.

Abstract

Replacing car travel with walking and cycling lowers emissions, improves air quality and makes communities healthier. Rates of active travel typically increase when dedicated infrastructure is implemented. But policymakers in multiple countries regularly contend with two obstacles: designing infrastructure that people will make use of and securing public support for implementation. This paper reviews and synthesises relevant research from behavioural science that shed light on how these two obstacles can be overcome. We find that research on moderators of the success of active travel initiatives points to the importance of connectivity and safety perceptions, particularly among women and older adults. We then review empirical findings on how to design active travel infrastructure to ensure both safety and perceptions of safety, which are influenced by design decisions. With respect to public support, we review research from behavioural economics and psychology that may help to counter misperceptions of the effects of active travel infrastructure. We also draw on evidence regarding support for climate policy and opinion formation more generally. The paper offers an evidence-based guide for policymakers to design and implement active travel infrastructure, seen through the lens of behavioural science. It also highlights fruitful avenues for future research.

Keywords *(x6)*: active travel; cycling; safety; bikelash; public opposition; behavioural economics

Highlights

- Infrastructure change can help communities shift towards active travel modes
- Connectivity and safety perceptions predict the success of infrastructure change
- Safety perceptions are strongly influenced by design decisions
- There are multiple potential sources of bias when evaluating infrastructure change
- Behavioural science can help prevent biased reasoning about infrastructure change

Summary

- There is strong evidence from multiple countries that building active travel infrastructure leads to increases in the frequency with which people walk and cycle for transport.
- The strongest evaluations use objective measures of travel behaviour before and after scheme implementation, with comparisons made against control areas. Control areas should be matched in terms of baseline travel behaviour, active travel demand and socio-demographics.
- Active travel infrastructure that facilitates complete journeys boosts the effectiveness of infrastructural change. Complete journeys can be facilitated by ensuring there are no breaks in cycle lanes (i.e. stretches of road with no lane) and by considering routes with high numbers of intersections.
- People who live closer to active travel infrastructure use it more. Hence, new infrastructure plans should prioritise start-points near high-density residential areas, with end-points located near local amenities (with discontinuities in-between minimised). Secure bike-parking facilities at end-points can further motivate people to make use of infrastructure.
- Perceived safety is the strongest psychological predictor of active travel, particularly among women and older adults. Perceived safety can be increased through the design of cycle lanes: wide, segregated, painted, cycle-only lanes that use physical boundaries to separate from other traffic are preferred. Real safety can be increased through the design of intersections, with priority lights, advanced stop lines, traffic-slowing policies and raised cycle crossings.
- The gender gap in cycling, which typically favours men, exists only in low-cycling societies. Addressing barriers to cycling to increasing its share as a mode of transport can reduce the gap.
- Conditional on increasing rates of active travel, schemes have multiple environmental and health benefits for communities. Evaluations link changes in active travel infrastructure to reductions in greenhouse gas emissions, air pollution and noise, with associated physical and mental health benefits.
- The environmental and health benefits of active travel schemes can lead to large returns on investment, with strong aggregate economic benefits. These economic benefits may be difficult for people at the local level to observe directly, but there is evidence that boosting active travel can boost sales for local retailers.
- Evaluation of the effects of active travel infrastructure on car travel times and congestion provides mixed conclusions. Some studies find very small increases (on scales of under 5 minutes per journey), whereas others find null effects or decreases where there is a substantial shift from car dependency.
- The international literature supports anecdotal evidence that proposed active travel infrastructure often encounters local opposition. Retailers report concerns about turnover while residents report concerns about congestion and traffic safety. However, there is little systematic research on the predictors of opposition. Most studies rely on self-report, qualitative methods.
- Belief in the effectiveness of active travel schemes may be linked to trust in public institutions, as has been found for other climate policies such as carbon taxation. Communications that take an empathetic approach and strive to account for multiple perspectives can be a useful way to build trust compared to those that merely present determination to implement changes, although there is little direct evidence for communication methods.

- Perceived unfairness of the consultation process is frequently cited by opponents after implementation, although most evidence shows that (often less vocal) majorities support active travel infrastructure when changes are made. Consultation processes should hence occur early, before design decisions are made, be widely advertised and openly accessible. Data on the opinions of representative samples would be helpful.
- Perceived unfairness is also affected by anticipated distributional effects. Consultations should hence aim to understand the perceived costs and benefits to different groups within communities.
- Self-interest likely plays a key role in determining support, but self-interested perspectives are unlikely to be presented as such. For example, individuals may oppose schemes based on their own self-interest (e.g. anticipated reductions of convenience for themselves) but report a justification that is more socially acceptable (e.g. elderly access to parking). Research undertaken within localities to understand potential self-interested perspectives, such as perceived personal or household impact as well as individual and contextual characteristics, is likely to be helpful when considering support or lack thereof.
- There are multiple potential psychological barriers to support. These include loss aversion, forecasting errors, false beliefs, NIMBY-ism and place attachment. Systematic research in an Irish context is needed to provide potential interventions to overcome these biases.
- The broader behavioural science literature points to the “status quo bias” (i.e., the tendency for individuals to prefer things to stay as they are, even if change may be beneficial) as a strong driver of opposition to active schemes. However, there is limited direct research determining its strength or ways to overcome it.
- The evidence that the public generally support active travel changes after they are implemented point to the potential of trial periods or sunset clauses, where feasible, to result in lasting change.
- “Pre-bunking” misperceptions about the impacts of proposed plans with early and accurate information is likely to be more effective than attempts to correct them after-the-fact. Communications should be mindful of relevant cognitive biases with respect to opinion formation, including primacy effects, messenger effects and motivated reasoning.
- The international literature supports communication of the measured benefits of active travel schemes, particularly using demonstration projects from similar areas, during very early stages of consultation processes. It would be worthwhile using controlled tests to identify optimal ways to communicate demonstration projects.

Introduction

Reducing car dependency in favour of active travel is at the core of the shift to healthier and more sustainable societies (European Commission, 2020). While the decision to travel by car is influenced by many individual and social factors, infrastructural elements such as the design of the built environment explain a substantial amount of variation in travel behaviour (Brand et al., 2021). Designing infrastructure to promote alternative modes of travel is particularly important in industrialised countries that contribute the greatest share of greenhouse gas emissions, meaning there are large potential gains from shifting towards more sustainable travel patterns. This paper reviews existing evidence on how to design and implement travel infrastructure from the perspective of behavioural science, with a view to reduce car dependency and encourage active travel.

Our review is narrative in nature, such that it gathers and analyses evidence relating to a broad scope of relevant research questions. These questions were informed by discussions with policymakers at a national transport authority and at a local council authority. As such, the review centres around two of the main challenges faced by those working at the coalface of active travel infrastructure implementation: how to design infrastructure that encourages behaviour change and how to secure public support for infrastructural changes. We reference individual academic studies, reviews, meta-reviews and 'grey literature' reports, spanning topics from the physical construction of cycle lanes to the psychology of opinion formation. The review is hence intended to be used as a guide for designing active travel infrastructure that is successful in promoting active travel, and implementing it in a way that avoids misperceptions of its effects, given current evidence offered by behavioural science.

At the outset, it is important to understand that our aim is not to suggest that behavioural science should be used to persuade people to support schemes that they may legitimately oppose. Democratic authorities act on behalf of the public they represent and consultation with local communities is vital. Importantly, individuals and communities have a right to object to and challenge schemes that they fear will harm their neighbourhoods. Nevertheless, the existing literature in behavioural science that we describe show that opinion formation can be subject to strong biases and misperceptions. Our aim, therefore, is to elucidate these effects in the context of active travel so that policymakers and stakeholders can recognise them, perhaps counter them and, in general, promote informed decision-making about active travel initiatives.

We note also that this review is not intended as a definitive how-to for designing infrastructure, which naturally relies on engineering and urban planning expertise. Instead, the review may help relevant stakeholders prioritise features of design where those features have implications for behaviour. Moreover, while active travel relates to all forms of purposeful travel in which the individual exerts physical effort in order to move, we focus primarily on increasing rates of cycling. However, this focus is mainly the result of greater attention paid to cycling relative to walking (and other forms of active travel) in the international literature to date (Cook et al., 2022). We also exclude literature on non-infrastructural interventions to encourage cycling. Comprehensive reviews of such interventions are available elsewhere, and in general point to the need for trials to be theoretically informed and more rigorously tested (Stewart et al., 2015; Yang et al., 2010).

The remainder of the review is structured as follows. Section 2 outlines evidence concerning behaviour change following the implementation of active travel infrastructure. In this section we also reference empirical evidence surrounding the environmental, health and economic benefits of active travel, in addition to environmental, psychological, and socio-demographic predictors of infrastructure use. Section 3 tackles the problem of designing infrastructure in a way that encourages its use, in light of findings from Section 2. Section 4 tackles the problem of public opposition to infrastructure change, with a focus on identifying sources of potential misperception and bias. This section synthesises theory and evidence from behavioural economics and psychology. Section 5 discusses the implications of the available evidence and avenues for future research.

2. Use of Active Travel Infrastructure

In this section we review relevant research on predictors of use of active travel infrastructure. We first summarise the evidence on aggregate effects of infrastructural change (i.e., whether walking or cycling rates in a community change overall once infrastructure is implemented) as well as subsequent effects on health, the environment and the economy. We then focus on the environmental and individual-level characteristics that are associated with stronger effects on uptake.

2.1 Active Travel Infrastructure and Behaviour Change

There is strong evidence that active travel initiatives, in general, achieve their aim of increasing rates of active travel. The highest quality evidence is produced by longitudinal assessments of travel behaviour before and after schemes are implemented, with changes contrasted against measures taken at the same timepoints in comparable areas (for example, nearby towns of a similar size with similar levels of active travel prior to scheme implementation). Individual studies using this “pre-post quasi-experimental” (hereafter, PPQE) approach have recorded increases in the number of people cycling of about 30% in multiple countries, although there is considerable heterogeneity in effect sizes (Aldred et al., 2019; Halden & Anable, 2013; Heinen et al., 2015; Fell & Kivenen, 2016; Keall et al., 2015; Sloman et al., 2017; Song et al., 2017). For example, an evaluation of the “Cycle City Ambition Programme” in the UK showed increases in cycling levels of between 14 and 40% in five locations that implemented cycling infrastructure relative to comparable control areas. Effects on walking, however, tend to be lower and few studies consider other forms of active travel.

In addition to recent individual studies, we identified six systematic reviews on the effects of changes to active travel infrastructure. Each of the reviews supports the broad conclusion that infrastructural change leads to increases in cycling, with effects on walking that are less conclusive (Buehler & Dill, 2016; Foster et al., 2018; Pucher et al., 2010; Smith et al., 2017; Stappers et al., 2018; Yang et al., 2010). For example, Stappers et al. (2018) identified 19 studies that used a PPQE design to test the effect of infrastructural change on active travel and transport-related physical activity. The review showed strong effects of built environment changes on rates of cycling, particularly among individuals living close to the new infrastructure, with inconsistent results on walking. However, the review also highlighted the need to evaluate such initiatives using robust methods, as many studies were classified as having moderate-to-high risk of bias.

Conditional on boosting rates of active travel and reducing car journeys, active travel infrastructure has knock-on effects for communities related to the environment, health, car travel times and the local economy.

2.1.1 Environmental and Health Benefits

The environmental and health benefits of active travel are well established. Empirical evidence from multiple countries shows that as rates of active travel increase, mobility-related CO_2 emissions, other greenhouse gases and air pollution decline (Brand et al., 2021; Nieuwenhuijsen & Khreis, 2016). Some studies have linked emission reductions directly to changes in active travel infrastructure (Halden & Anable, 2013; Schepers et al., 2015; Woodcock et al., 2013; see also Mueller et al., 2017 for research in Spain; Chapman et al., 2018 for research in New Zealand). For example, the carbon savings over three years following the implementation of active travel infrastructure in six locations in Scotland were estimated to be as high as 16,374 tonnes,[1] based on the observed reductions in trips travelled in private vehicles (Halden, 2013).

The primary health benefits are estimated to come from the positive effects of decreased car use on physical activity, air and noise pollution and reductions in road traffic injuries (de Nazelle et al., 2011; Woodcock et al., 2013). Active travel itself reduces BMI, blood pressure and the incidence of diabetes (Laverty et al., 2015; Prince et al., 2022). Decreased car use reduces air pollution and traffic noise, which in turn are linked to lower levels of childhood obesity, mortality rates, birth complications and chronic disease, and improved mental health outcomes (Malacarne et al., 2022; Schmitz et al., 2021). The scale of the benefits depends on the design of the infrastructure. For instance, cyclist exposure to air pollutants decreases if cycle lanes are separated from traffic on major roads (Schepers et al., 2015). Note also that for population reductions in pollution exposure to occur, it is necessary for the schemes to produce a net reduction in traffic rather than traffic displacement, where traffic from the area with new infrastructure simply diverts to other areas of the community (de Nazelle et al., 2011).

2.1.2 Car Travel Times and Congestion

Anticipated increases in car travel times following the reduction in traffic lanes or displacement of traffic can be a source of opposition to active travel infrastructure. The empirical evidence, however, suggests that any such effects tend to be small. A case study in Toronto estimated a 14-30% time

[1] For reference, the average car emits 2.75 tonnes of CO_2 per year.

increase for automobile traffic between two points after introducing a separate bike lane, which translated to an average increase in journey time of 1 minute in the most extreme case (Burke & Scott, 2018). Simulation analyses in Australia suggest that the introduction of bike lanes would lead to a 7% increase in travel times by car (Nanayakkara et al., 2022; see also Bertolini, 2020; Field et al., 2018). To illustrate, in Ireland average commuting time to work was 28.3 minutes in 2016 (CSO, 2016). A 7% increase would result in an average commute time of 30.3 minutes.[2]

However, these figures typically do not consider substitution from car to bike travel after the introduction of infrastructure and should thus be interpreted as higher-end estimates. Taking away road space for cars can lead to smaller effects on existing traffic than anticipated, and can even lessen traffic volume as some drivers switch to alternative travel modes (Cairns et al., 2002; Garcia-López et al., 2021). For example, in Scotland there was a decrease in the proportion of trips and number of days travelling by car as a driver following active travel schemes, whereas trips as a passenger increased, suggesting a potential shift towards multi-person car occupancy as well as walking and cycling (Halden & Anable, 2013). In Ireland, after the redesign of the main street in Blackrock to implement a bike lane and one-way traffic system, there were no reported negative effects on traffic on the main street or surrounding streets (O'Connor & D'Arcy, 2021.).

2.1.3 Economic Effects

Opposition to active travel initiatives also focuses on anticipated negative effects on local retailers. The main concern is that reallocating road space and parking slots to bikes and pedestrians will lead to fewer customers visiting local businesses. Empirical evidence does not support this view, however, but rather suggests the opposite is more likely. Increased pedestrianisation can boost local sales (Bertolini, 2020; Howarth & Polyviou, 2012), adding bicycle and pedestrian facilities to an area typically increases cyclist and pedestrian use of that area, with visitors spending more in local stores (Castillo-Manzano et al., 2014; Volker & Handy, 2021).

A recent systematic review compared consumer spending between active travellers and automobile users, quantifying the economic impact to local businesses following the installation of bicycle or pedestrian facilities (Volker & Handy, 2021). Results showed that improving active travel facilities generally has a positive or null effect on retail and food service businesses in the vicinity of newly-installed infrastructure. Where per-month spend by travel mode was assessed, most studies in the review found that non-motorists spent more than motorists, although one found that motorists

[2] This projection is merely for illustrative purposes and does not necessarily reflect real world changes that would occur.

spent more in supermarkets whereas non-motorists spent more in all other retail and hospitality outlets. The general exception is for businesses that cater specifically to car drivers (e.g. petrol stations, mechanics), where bicycle facilities may lead to negative effects. The pattern sustains when considering schemes that specifically remove vehicular parking or travel lanes, with multiple studies showing neutral effects of removing car parking spaces on local economies (Arancibia et al., 2019; Bertolini, 2020; Mingardo & van Meerkerk, 2012). One factor that may contribute to negative views of economic impact is that business owners tend to overestimate the proportion of their customers who travel by car (Wild et al., 2018). No peer-reviewed, PPQE-design study has demonstrated a negative relationship between active travel facilities and local retail sales (Volker & Handy, 2021).

Evidence from Ireland matches the international picture. Following the redesign of the main street in Blackrock in Dublin, the majority of local business owners reported that it had either been helpful for their business (citing increased footfall) or had not affected it (O'Connor & D'Arcy, 2021). However, 25% reported the redesign was unhelpful, citing delivery difficulties and lack of parking. In addition, businesses on side streets remarked on becoming disadvantaged compared to businesses on the redesigned main street, which speaks at least to a perception that the redevelopment helped the businesses whose shopfronts were directly affected. Similarly, a recent review of the pedestrianisation of Capel St showed that the majority of businesses (71%) reported that the change was an improvement (O' Brien & French, 2022). Concerns among businesses who judged the change to have worsened the street also included delivery difficulties, but were primarily driven by safety concerns for pedestrians, with many citing the lack of segregated lanes for bikes and e-scooters.

Beyond local effects, the economic benefit of active travel initiatives also derives from lowered health-related costs (Mueller et al., 2018). To illustrate, the cost to society of driving a car is estimated to be six times higher than cost of riding a bike (Gössling & Choi, 2015; Gössling et al., 2019). Cost-benefit analyses in multiple countries show that the health savings associated with increased active travel (e.g. reductions in costs related to cardiac disease, diabetes, cancer and respiratory disease) greatly outweigh economic costs of installing and maintaining bike lanes. Estimated returns on investment in active travel schemes in Scotland, based on changed transportation behaviour, were between a rate of 2.7 and 7, and the average annual saving per resident was £62 (Halden & Anable, 2013). Estimated cost-benefit ratios range from 2:1 in parts of Australia to 11:1 in New Zealand and as much as 50:1 in the UK (Aldred & Croft, 2019; Chapman et al., 2018; Whitehurst et al., 2021). Part of the variation in estimates is due to increasing returns to scale in the aggregate economic benefit of active travel, meaning benefits are greater for communities that invest in *networks* to overcome initial fixed costs rather than piecemeal implementation of disjointed tracks (Szell et al., 2022). However, these benefits are less observable for local communities.

2.2 Environmental Predictors of Use

Although active travel infrastructure in general is successful in promoting active forms of transportation, certain environmental factors (e.g., design features) are especially important for use. Among these environmental factors, better connectivity, typically measured by the density of intersections and scarcity of "discontinuities" (i.e. breaks in cycle lanes where stretches of road have no cycle lane), is one of the strongest predictors of the success of active travel infrastructure (Buehler & Dill, 2016; Giles-Corti et al., 2016; Stinson & Bhat, 2003). The evidence for this relationship derives from systematic reviews as well as meta-level reviews of systematic reviews, and should be considered very strong (Götschi et al., 2017; Kärmeniemi et al., 2018; Panter et al., 2019). The general idea is that being able to cycle or walk full journeys through multiple routes correlates positively with active travel frequency, controlling for other socio-demographic and environmental factors (Verduzco Torres et al., 2022; Winters et al., 2017). Example studies include a longitudinal survey from Australia (n = 909) showing that objective measures of street connectivity strongly correlated with self-reported use of cycling infrastructure for both recreation and utility purposes (e.g. commuting) (Badland et al., 2013). A cross-sectional survey of over 2,000 residents in small towns in Germany found street connectivity to the be the strongest environmental predictor of self-reported cycling frequency (Brüchert et al., 2022). Similarly, a survey of over 8,000 people across 8 countries in Latin America showed that better connectivity predicted higher frequencies of recreational walking and cycling (Ferrari et al., 2020). Hence, active travel routes that minimise discontinuities in pathways and cycle lanes should be prioritised when designing new infrastructure. The effect of connectivity may be strengthened by facilitating shortcuts between popular locations for active travellers that are not accessible to motorists (Piatkowski et al., 2019).

Relatedly, individual proximity to active travel infrastructure predicts usage, with evidence also from meta-level reviews (Brüchert et al., 2022; Fraser & Lock, 2011; Götschi et al., 2017). PPQE evaluation of the 'mini-Holland' programme in London (n = 1,712) suggested a potential "dose-response" to active travel infrastructure: individuals living in neighbourhoods with higher exposure to different schemes showed a greater propensity towards active travel, including walking (Aldred et al., 2019). Other PPQE research in the UK (n = 470) showed that boosting connectivity and proximity to public transport can increase the share of commutes that involve any form of active travel, with corresponding declines in the share of trips made entirely by private vehicle (Heinen et al., 2015).

Beyond connectivity and proximity, there are less controllable environmental factors that can affect active travel. There is some evidence that steep inclines have negative effects on infrastructure use (Fraser & Lock, 2011), although this effect may be weakened by the growing availability of e-bikes (Jenkins et al., 2022). Anecdotally, wind and rain are deterrents to cycling and, to a lesser extent, walking that are particularly relevant for Ireland. Indeed there is some evidence that fewer people engage in active commuting in Ireland during poor weather (Deenihan et al., 2013). Broadly speaking, however, weather effects tend to be small in temperate climates (Böcker et al. 2013; Clark et al., 2014; Saneinejad et al., 2012). We could find no research systematically investigating whether expectations of weather effects act as barrier to active travel infrastructure use among the public; expectations could play a greater role in deterring active travel than the weather itself.

The implication of these findings is that plans for new active travel infrastructure should seek to minimise the distance between start-points and high-density residential areas. Depending on whether the goal is to increase active travel for leisure or utility, endpoints should be located as close as possible to local amenities, high-density retail areas or areas with high concentrations of workers or students. Improving convenience, through highly connected and direct routes for active travellers, is likely to boost infrastructure uptake.

2.3 Psychological Predictors of Use

Turning to individual-level predictors of usage, the strongest psychological driver is perception of safety (Fishman, 2016; Koh & Wong, 2013; Krizek et al., 2009). A review of cycling infrastructure in six cities in the UK and the Netherlands concluded that safety perceptions are the deciding factor for whether potential cyclists choose to cycle (Hull & Holleran, 2014). Perceptions of safety and fear of traffic is especially important in communities with an 'emerging' population of new cyclists (Chataway et al., 2014). The relationship between connectivity and perceived safety is important to note. While higher density of intersections strongly predicts higher rates of cycling, cyclists often engage in detours to avoid intersections or crossings that have high volumes of traffic or that they perceive as unsafe (Gössling et al., 2019; Van Cauwenberg et al., 2018). Hence safety perceptions have the potential to undermine positive effects of connectivity, unless intersections are designed in ways that cyclists perceive as safe.

It is also important to note that the literature points to safety *perceptions* rather than objective safety indicators, such as accident statistics. Near-misses and conflict with motorists are deterrents to many cyclists, particularly those with lower levels of confidence, and are unlikely to be recorded in official statistics (e.g., Abadi & Hurwitz, 2018; Branion-Calles et al., 2017). However, this leads to difficulties in defining what constitutes “safe” infrastructure (Götschi et al., 2016). Broadly speaking there are infrastructural considerations that can help perceptions of safety that may not necessarily be linked to reductions in crash statistics, such as priority lights for cyclists at intersections, limited discontinuities and traffic-slowing policies (Ferrari et al., 2020; Hull & Holleran, 2014). We discuss empirical evidence for design features that influence perceptions of safety in Section 3.

A related psychological concept is an individual’s self-efficacy, defined as their belief in their own capabilities in specific domains (Bandura et al., 1999). A longitudinal survey of over 3,000 individuals in the UK assessed psychological predictors of change in active travel over a one- and two-year period. Results showed that higher baseline levels of active travel-related self-efficacy predicted greater amounts of walking and cycling for transport and recreation up to two years later (Bird et al., 2018). Similar results were observed in Australia (Badland et al., 2013). Importantly, it is possible to increase an individual’s self-efficacy. Interventions to boost active travel self-efficacy have been shown to increase objectively-measured active travel behaviours when tested via randomised controlled trials (Bélanger-Gravel & Janezic 2021; Darker et al., 2010). To the best of our knowledge, however, the interaction between self-efficacy interventions and measures to improve safety perceptions has not yet been tested. Effect sizes in the literature suggest that the latter are probably better to prioritise.

2.4 Socio-Demographic Predictors of Use

It is well-established that gender and age predict active travel, with men and younger adults far more likely to cycle in most countries (Moudon et al., 2005; Tilahun et al., 2007; Pucher et al., 2011). However, large-scale analyses of national travel surveys from multiple countries show that the relationship between gender and cycling exists only in low-cycling societies (Buehler & Goel, 2022). Communities where cycling has greater than a 7% share of travel modes tend to reach parity between men and women cyclists (and sometimes a gender bias in favour of women). Moreover, while older people are underrepresented in all jurisdictions, they have relatively better representation in high-cycling societies (Goel et al., 2022). Hence increasing rates of cycling among women and older adults is not an impossibility but may depend on design considerations.

Analyses of large-scale travel survey data across Asia and Europe have shown that older adults are especially sensitive to features of the built environment, such as connectivity (Brüchert et al., 2022; Cheng et al., 2019; Portegijs et al., 2020; Yang et al., 2022a, 2022b). Importantly, these analyses consider within-city differences in active travel (both cycling and walking) and show that better facilities are associated with higher rates of older people cycling. Since cultural differences within cities are smaller than between countries, the results suggest that providing accessible and safe active travel infrastructure to older individuals is likely to boost active travel. Recent evidence further suggests that older adults in particular may benefit from e-bikes (Jenkins et al., 2022).

The literature on the cycling gender gap is less conclusive, although there is good evidence that safety considerations are especially salient for women. One analysis of 10 million journeys on a bike-share scheme in London showed that women preferentially select routes with slower traffic and those that are offset from major roads (Beecham & Wood, 2013; Mitra & Nash, 2017). The primary issue with the available evidence is that, while gender gaps have been identified, there has been little consideration of gendered processes underlying the differences, such as social norms (Gorrini et al., 2021) or the greater complexity of travel patterns required by women due to their typically larger share of household responsibilities (Ravensbergen et al., 2019). One analysis of travel patterns in New Zealand showed that women indeed tend to use more diverse routes (Shaw et al., 2020), potentially reflecting women's greater propensity to engage in multi-purpose trips (Craig & van Tienoven, 2019). A cross-sectional survey of 2,283 residents and 1,111 intercepted cyclists in the US showed that women cyclists were far less likely to have children than non-cyclists, whereas there was no difference among men (Dill et al., 2014). Census analysis of cycle frequency in Dublin suggests that women are more sensitive to proximity effects of cycle lanes compared to men, as well as income effects (Carroll et al., 2020). Hence, improving connectivity and the provision of appropriate facilities (e.g. cargo e-bikes) may be especially important for women, although more research is needed on potential cultural influences (e.g. Egan & Hackett, 2022).

Despite the potential for larger marginal benefits for women and older people of behaviourally-informed designs, the evidence for who benefits from changes to active travel infrastructure is mixed. One reason is that many infrastructural changes aim to facilitate active commuting, which may favour men and younger people. UK analyses suggest that cities with growing rates of cycling do not necessarily see greater diversity among cyclists (Aldred et al., 2016). Research in New Zealand showed that infrastructural change leads to little overall change in physical activity, as active travel merely replaced other forms of exercise among those already active (Keall et al., 2015) and that those who already walked and cycled simply did so more, rather than changing the behaviour of those who didn't already engage in active travel (Keall et al., 2018). One systematic review claimed that infrastructure changes benefit socio-economically advantaged groups, although the authors acknowledge most of the individual studies to be of low quality (Smith et al., 2017). By contrast, better quality PPQE evidence from New Zealand suggests the opposite, that groups least likely to travel by active modes benefit more (Keall et al., 2022; see also Hansmann et al., 2022). This variability in the literature with respect to who benefits from active travel infrastructure may be attributable to differences in design focus; it is unclear from the available evidence whether connectivity and safety were priorities within studies that have sought to analyse uptake among disadvantaged groups.

2.5 Summary

The empirical literature reviewed in this chapter highlights the importance of infrastructure design on uptake, particularly among groups less inclined to cycle. Based on the above evidence, the best way to increase uptake is to design routes that are easily accessible from places of residence and allow for full journeys to be made safely by foot or bike, with limited breaks in infrastructure. Built environment components (e.g. such as perceived safety at intersections) can also influence how safe active travellers feel on their journey. Improving perceived safety is likely to increase uptake by all socio-demographic groups, but especially women and older adults. We examine the literature on design features in more detail in the next section.

3. Lessons for Development and Design

This section analyses the available evidence on ways to design active travel infrastructure to improve safety, perceptions and uptake.

3.1 Safety

Active travel infrastructure reduces the incidence of acute injury among cyclists (Schepers et al., 2015). For example, an expansion of the bike network in the US – which is more dangerous for cyclists compared to most European countries – was associated with a fall of between 25 and 75 per 100 000 trips in crashes, severe injuries, and fatalities (Pucher & Buehler, 2016). Similarly, retrospective studies have shown an association between increased bike lane milage and decreased cycling-related trauma admissions (Goerke et al., 2020). Separated bike lanes are safer than mixed traffic, particularly as they remove the possibility of car-door crashes (Nanayakkara et al., 2022), as well as reducing vehicle-cycle collisions (Ling et al., 2020).

A systematic review of the effects of cycle tracks on objective safety measures concluded that cycle tracks boost safety, but one-way cycle lanes tend to be safer than two-way ones (Thomas & DeRobertis, 2013). Where it is not feasible to implement one-way tracks, intersections can be designed to improve cyclist safety. Some of the most effective ways to improve intersection safety include using advance stop lines, providing dedicated priority lights for cyclists, raising cyclist crossings to the pavement level and traffic calming measures such as speed limits of 30km/hr (Pucher & Buehler, 2016; Thomas & DeRobertis, 2013). In general, policies that incentivise cycling and disincentivise driving, for example by providing deliberately circuitous routing for cars and direct routing for cyclists, improve cycling safety.

Assessing ways to design infrastructure to reduce crashes is relatively straightforward given the availability of statistics for most countries. However, these design features may not be sufficient to increase uptake, as Section 2 outlined how perceptions of safety determine whether most people choose to engage with active travel infrastructure, particularly when cycling. The following sections outline the available evidence on safety perceptions.

3.1.1 Segregation

For confident cyclists, the primary decision factor when choosing to cycle and which route to take is estimated travel time (Caulfield et al., 2012; Gutiérrez et al. 2020). For others, however, the nature of the infrastructure on their journey makes the largest difference. Cyclists in multiple countries show a strong preference for cycle lanes that are segregated from other forms of traffic. A common design choice is to segregate bike lanes from car traffic by combining cycle and bus lanes, which may even decrease rates of cycling (Echiburú et al., 2021). The relevant body of evidence is substantial, including qualitative and quantitative methods, reviews and meta-reviews (Berghoefer & Vollrath, 2022; Buehler & Dill, 2016; Götschi et al., 2017; Rossetti et al., 2019). Safety perception-boosting segregation can be achieved by building active travel infrastructure away from roads or by installing buffers or planters between cycle lanes and traffic (Knight & Charlton, 2022; Márquez et al. 2021). Planters may be especially beneficial for cyclists due to incidental green exposure, although visibility issues need to be considered (Beery et al., 2017).

Safety perceptions are typically elicited using experimental surveys, where participants are asked to make judgements about images or videos of cycle lanes that have been digitally altered to test different designs. Findings from these types of studies are supported by other studies that have focused instead on biological indicators of perceived safety, by recording biological responses to stress while people cycle on roads or in simulators. These studies also show that stress responses are significantly lower on segregated cycle lanes and higher on busy roads, at intersections, on cobbled surfaces and in noisier places (Cobb et al., 2021; Teixeira et al., 2020).

3.1.2 Lane Colour

A relatively easy infrastructural change with implications for perceived safety is to paint cycle lanes (Márquez et al., 2021). There is strong evidence in favour of painted lanes from a PPQE, multimethod analysis of the effect of painting an existing cycle lane red in Norway (Fyhri et al., 2021). The study included video analysis of cyclist and motorist behaviour as well as GPS analysis of almost 2,500 journeys and a survey of over 1,500 residents. After painting, cyclists were more likely to cycle in the lane than on the pavement which, coupled with survey results, implied greater perceived safety. GPS data showed that the first streets with painted cycle lanes saw significant increases in cycling. The painted cycle lanes also affected motorists' behaviour. Following painting, they were less likely to park in the cycle lane and routinely kept a greater distance from the lane when driving (Fyhri et al., 2021).

Evidence on whether the colour itself matters is inconclusive (Vera-Villarroel et al., 2016). A web survey of 560 cyclists and motorists in Norway identified preferences for coloured over uncoloured bicycle lanes, but whether red or green lanes were favoured depended on familiarity: participants living in areas with existing red lanes preferred those lanes, whereas participants living in areas without coloured lanes preferred green ones (Karlsen & Fyrhri, 2020).

Some studies have also sought to evaluate the effect of transverse lines on cycle lanes as a way to reduce cyclist speed at specified points. One PPQE study in Sweden showed limited results, with a small effect observed only on recreational cyclists (Kovaceva et al., 2022).

3.1.3 Combining Safety Features

Most studies on safety perceptions tend to focus on effects of removing or adding one specific feature, but the combination effect of multiple safety features is also important: what is the marginal benefit of painting a cycle lane if it is already segregated? To answer questions like this, one study in Germany asked over 21,000 participants to judge multiple digitally enhanced road and street configurations (Gössling & McRae, 2022). Each participant made at least 10 judgements but the large sample size allowed for almost 2,000 possible configurations to be evaluated, which varied along multiple factors: path width, segregation, boundaries, the presence of parked cars, lane colour, busyness, type of road. The study also varied the participant's perspective, by showing images from the perspective of motorists, cyclists or pedestrians (assigned based on the participant's typical mode of travel). Supporting the findings above, separation from other forms of traffic was judged to be the most important safety feature, particularly when achieved using clearly demarcated boundaries. Path width emerged as the second most important feature. Lane colouring had larger effects on safety perceptions where other features were missing rather than present. In other words, where physical separation is not possible, colouring the lane becomes more important for maintaining perceived safety. Wide, painted lanes with physical boundaries away from parked cars and commercial activity received almost universal safety ratings (98%), regardless of whether they were on a major road, alongside pavement or on a side street. The setup of the experimental survey allowed for the marginal effects of individual factors to be estimated. For example, even with physical boundaries, safety ratings dropped to 78% if the lane narrowed or if the lane ran alongside parked cars. Removing the boundary led to a further drop to 50%. Importantly, cyclists, motorists and pedestrians were in agreement about what constituted safe travel infrastructure, including the presence of parked cars.

3.2 End-of-Journey Facilities

A systematic review of 39 interventions to increase cycling suggested that adding facilities, such as secure parking facilities, can have relatively large effects on use of cycle lanes (Doğru et al., 2021; see also Hamre & Buehler, 2014; Hunt & Abraham, 2007). Other reviews have suggested that secure facilities can help to address the gender and age gap in cycling (Goel et al., 2022; Tilahun et al., 2007). For commuters, shower availability at work can encourage active travel (Hamre & Buehler, 2014; Tilahun et al., 2007).

3.3 Summary

Marginal gains in active travel are likely to be enhanced through behaviourally-informed design. The evidence above provides reasonably strong support for the importance of segregating wide, painted cycle lanes from traffic using physical boundaries. Importantly, the literature on reducing crashes focuses on intersection features, whereas the literature on safety perceptions tends to focus on stretches of road. Hence these safety features should be combined to maximise real and perceived safety.

One limitation of the research reviewed in this section is that it generally considers the impact of infrastructural change independently of how visible the changes are to the target users. It is essentially unclear how cognizant potential cyclists are of features installed to improve safety. This is important, because the wider behavioural science literature suggests that drawing attention to safety features and improvements is likely to further encourage uptake. However, this idea would benefit from robust evaluation, ideally through a PPQE design.

4. Lessons for Implementation

In this section, we outline relevant behavioural science research on public responses to potential infrastructural change, informed by the psychology of opinion formation and research on climate policy support.

4.1 Public Response

Although the general public in many countries report high levels of support for climate change mitigation and active travel infrastructure more specifically (Andre et al., 2021; Timmons & Lunn, 2022), initiatives often face unexpectedly high levels of opposition, or “bikelash”, during planning and consultation stages (Aldred et al., 2019; Wild et al., 2018). There is a relatively small body of literature that has investigated this phenomenon. The majority are case studies conducted in areas where active travel schemes either have been implemented or are at the proposal stage. Some studies have sought to understand public opposition through interviews and surveys with small samples of opponents, planners, and stakeholders (Field et al., 2018; Lambe et al., 2017; Parajuli, 2018; Vreugdenhil & Williams, 2013). The majority do so after the implementation of a scheme through interviews (Field et al., 2018; Melia & Shergold, 2018) or field surveys (Aldred & Croft, 2019; Castillo-Manzano et al., 2014; Larson et al., 2016; Noland et al., 2022; O’Connor & D’Arcy, 2021). Other studies have recorded public expectations before implementation and attitudes after implementation, again through interviews (Crane et al., 2016; Halden, 2013; Lambe et al., 2017) or field surveys (Halden, 2013; Melia & Shergold, 2018).

Hence, the above research predominately takes the form of interviews with a relatively small number of participants and the strength of the relationship between expectations and support has been inferred qualitatively. While such approaches can provide rich, scheme-specific data, they do not permit general inferences that are likely to be widely applicable. However, we have located a few quantitative studies that have investigated public opinion of active travel schemes generally and individual predictors of support (Cradock et al., 2018; Gase et al., 2015; Gustat et al., 2014; Rissel et al., 2018; Semple & Fountanas, 2022). A recent international survey on more than 40,000 residents in high-emission countries provides a useful framework for considering the factors that drive public support for climate mitigation policies: individuals’ perceptions of effectiveness, fairness and self-interest (Dechezleprêtre et al., 2022). This section is structured around these factors.

4.1.1 Perceptions of Effectiveness

Both qualitative and quantitative studies on public opinion of active travel initiatives highlight expected outcomes as drivers of support. While we have found no evidence that people doubt whether active travel is effective in reducing emissions, other research suggests that the public in multiple countries find it difficult to estimate the relative effects on emissions of different pro-environmental behaviours, often underestimating the impact of more effective actions (Cologna et al., 2022; Timmons & Lunn, 2022; Wynes & Nicholas, 2017). Hence, while the public may not doubt that active travel has environmental and health benefits, they may underestimate the scale of these benefits. Improving people's understanding of the causal relationship between individual actions and climate mitigation can boost support (Ranney & Clark, 2016).

Underestimation of the environmental and health benefits of active travel initiatives may be compounded by the frequently-cited expectation of negative economic effects. Qualitative interviews from multiple countries before and after the implementation of active travel initiatives show that retail traders strongly associate the presence of car parking spaces with turnover (Crane et al., 2016; Ferster et al., 2021; Field et al., 2018; Lambe et al., 2017; Wild et al., 2018). As outlined in Section 2, such concerns regarding retail turnover do not align with the empirical evidence. For example, while car drivers may spend more per trip, cyclists tend to spend more frequently, which can lead to higher accumulated spend over time (Lambe et al., 2017; Volker & Handy, 2021). Consultations in Ireland suggest that the majority of businesses in the immediate vicinity of active travel schemes report positive effects (O' Connor & D'Arcy, 2021.; O' Brien & French, 2022).

Reported opposition from residents typically cites concerns about the local economy too, but also often highlights concerns around traffic safety (Crane et al., 2016; Field et al., 2018; Vreugdenhil & Williams, 2013; Wild et al., 2018) and expected increases in traffic congestion. Again, as described in Section 2, these concerns do not match available evidence.

The potential for inaccurate expectations is unsurprising, as there is strong evidence that people are often poor at predicting the consequences of both large and small events including how they will feel (Wilson and Gilbert, 2005). People also dislike uncertainty. If there is uncertainty over the effects of a change, for example if they think there is a large chance the change will be very good but a small chance it will be somewhat bad, they often rationalise maintaining a status quo of 'good enough'. This type of reasoning can be grounds for sticking with the 'okay' status quo that doesn't necessarily reflect a true preference for the way things currently are. We consider this bias towards the status quo in more detail below. Inaccurate projections of this kind can explain why people do not make behaviour changes that would improve their well-being. For example, people underestimate the boost in happiness from spending more time in nature (Nisbet & Zelenski, 2011).

People can also be poor at predicting the future trajectory of numerical data. There is a 'conversative bias' in many predictions, where people become anchored to the starting point and make linear projections for non-linear phenomena, such as compound interest (Stango and Zinman, 2009; McGowan, Robertson and Lunn, 2018). This phenomenon can help explain why people often underestimate the effect of traffic disincentives at reducing car numbers (Schuitema et al., 2010). After such schemes are introduced and people witness the actual change, attitudes tend to become more positive (Hansla et al., 2017). While part of the change in attitude could be due to dissipation of the status quo bias, survey evidence supports the underestimation of policy effectiveness as having some explanatory power (Nilsson et al., 2016; Schuitema et al., 2010).

Another reason an individual may discount the evidence in favour of active travel schemes is lack of trust in the implementing body to carry out the work with sufficient competence. Trust in the implementing institution is positively related to policy acceptance across a range of climate policies (Bergquist et al., 2022) and there is some evidence that low trust in government can translate to low perceived effectiveness of transport policy (Huber & Wicki, 2021). However, most of the research on trust and climate policy is in the context of carbon taxes. It generally finds that much of the opposition to carbon taxes is due to distrust of politicians (Fairbrother et al, 2019). People suspect government of using carbon taxation as a way of raising public revenue generally, rather than as a way to lower emissions. Research has implicated low levels of trust as the reason why the public prefer ring-fencing carbon tax revenues for green investment projects, even though from an optimal taxation viewpoint this approach is not ideal (Carattini et al, 2018).

4.1.2 Perceptions of Fairness

Opponents of bike lanes often report feeling that they had no voice or control over the changes being made (Crane et al., 2016) and complain of a lack of meaningful consultation (Field et al., 2018). These views are reiterated from retailer evaluations of active travel schemes in Ireland: feeling that one's concerns are being ignored is cited as a source of opposition and distrust (Lambe et al., 2017). For instance, the main complaint for the 2021 court action against the Sandymount bike lane was the lack of proper process in its implementation (Kelly, 2021). Similarly, media coverage of Capel St pedestrianisation cited a lack of consultation in the implementation of the street (Farrell, 2022) while the official report highlighted cited multiple rounds of consultation with businesses (O' Brien & French, 2022).

An important point to note is that, when judgements of fairness are made post-hoc, they may be influenced by the outcome rather than an objective evaluation of the process, known as the "outcome bias" or "hindsight bias". The results of courses of action colour peoples' judgements, including ethical or moral evaluations (Byrne & Timmons, 2018; Fleischhut et al., 2017; Roese & Vohs, 2012). Outcome biases are difficult to overcome, but one avenue potentially worth exploring is to crowd-source ideal consultation processes using similar methods to those used for public consultations on active travel implementation itself. Communicating that the consultation process was agreed prior to any decisions on infrastructure may help.

Another important aspect of fairness is whether the distribution of costs of the policy is perceived as fair (Dechezleprêtre et al., 2022, Muhammad et al, 2021). In a meta-analysis on public opinion about climate change laws and policies, perceived distributional fairness was one of the strongest predictors of support (Bergquist et al., 2022). Most of the controversy around active travel initiatives concern incentives that relocate and transform spaces reserved for vehicles to bikes and pedestrians (Wilson & Mitra, 2020). It is not evident whether these initiatives are viewed as resulting in an unfair cost for drivers in favour of pedestrians and cyclists. Moreover, many salient objections to changes to car access relate to accessibility for those less able-bodied (e.g. O' Brien & French, 2022), which warrant consideration at design and implementation stages. It is thus important to assess perceived and expected costs and benefits for different population subgroups, especially those with low mobility. Moreover, the potential for e-bikes to overcome mobility barriers may warrant subsidies (Jenkins et al., 2022).

4.1.3 Self-Interest

Implementing active travel infrastructure typically requires retrofitting existing car infrastructure, either through the removal of lanes or car parking spaces. Hence existing motorists inevitably experience some losses, while current and prospective cyclists stand to experience gains. Some studies have indeed shown a relationship between regular active travel and stronger support for active travel and pedestrianisation investments (Gase et al., 2015; Semple & Fountas, 2022). However, this relationship is not guaranteed. Other studies have found support for the introduction of bike lanes to be similarly as high or higher among motorists as cyclists (Cradock et al., 2018; Rissel et al., 2018). This finding may be linked to preference among some motorists for greater safety precautions for cyclists (Gössling & McCrae, 2022), or it could indicate a subset of motorists who would prefer to cycle if provided with appropriate infrastructure.

However, regular travel by car is typically associated with reduced support for removing car parking spaces or restrictions on car travel to facilitate active travel (Rissel et al., 2018). This points to perhaps the largest psychological barrier to public support for active travel infrastructure: status quo bias. Status quo bias is the tendency for individuals to prefer things to stay as they are, even if change may be beneficial (Samuelson & Zeckhauser, 1988). Status quo effects can be large. For instance, Lang et al (2021) investigated the role of status quo bias in preferences to join a state-level climate mitigation scheme. When the status quo was to be outside the scheme, the average 'willingness to pay' to join was $170, but when the status quo was to already be part of the scheme, maintaining membership was valued at $420.

'Not-in-my-backyard' syndrome (NIMBY; Dear, 1992) is often cited as a barrier to implementing climate policies at a local level and can be attributed to the status quo bias. Others argue that the concept of NIMBYism is too simplistic and opposition should instead consider the strong emotional attachment between residents and their locality (Anton & Lawrence, 2016; Clarke et al., 2018; Devine-Wright, 2009; Sebastien et al., 2019). However, status quo bias may also drive this association between place attachment and dislike of change.

Dissipation of status quo bias has been implicated as a reason for the increased support for congestion charges post-implementation (Börjesson et al. 2016). Similar effects are observed following the implementation of bike lanes (Ferster et al., 2021). After active travel schemes in Scotland were in place, quantitative evidence through household surveys found a change towards more positive attitudes of walking, cycling, and the infrastructure, as well as access to shops and services (Halden, 2013). Specifically, retailers mentioned concerns about revenue decreasing due to limited parking prior to implementation of bike lanes, but not after (Crane et al., 2016).

One of many potential reasons for status quo bias is loss aversion. Loss aversion describes how most people give more psychological weight to losing something they already have than they would give to gaining that same something if they didn't have it (Kahneman & Tversky, 1984). Loss aversion may be linked to the endowment effect, which refers to people's tendency to demand much more to give up something they already own than they are willing to pay to acquire it (Thaler, 1980). Note that the endowment effect can come into play even when an individual hasn't paid for the good, as with access to a public parking space.

Status quo bias, loss aversion and the endowment effect can be difficult to overcome. One reassuring piece of evidence comes from the evaluation of active travel initiatives after implementation, which tend to be generally positive, including in Ireland (Castillo-Manzano et al., 2014; Melia & Shergold, 2018; Noland et al., 2022). Similarly, congestion charges, which impose losses to disincentivise driving but lead to gains in terms of better air quality, less congestion and lower emissions, typically face strong opposition prior to implementation. Yet after implementation most people report that the benefits were larger and costs were smaller than they had anticipated, leading to support for increased charges (Schuitema et al., 2010). Other studies suggest that opposition to such policies is driven primarily by status quo bias (Börjesson et al. 2016; Nilsson et al., 2016). In other words, change is initially opposed because it is a change, and then supported because it has been made, regardless of the respective costs and benefits.

4.1.4 Preventing Biased Reasoning

Retailers and residents often hold legitimate concerns that should be considered and addressed during consultation phases. However, evidence from behavioural science highlights how misperceptions can form and lead to biases in reasoning. Once initial opinions have formed, they are difficult to shift. People tend to interpret new information in ways that match their existing beliefs, to downplay information that contradicts these beliefs, and to seek out information that supports them. These effects are referred to as motivated reasoning and confirmation bias (Kunda, 1990; Nickerson, 1998). How opinions initially form is therefore important. The psychology of opinion formation suggests two important factors to overcome to reduce bias: primacy effects and messenger effects.

Initial information tends to be overweighted in attitude formation, particularly about personally relevant topics (Petty et al., 2001). This primacy effect is difficult to counteract. When trying to correct initial misperceptions, simply providing factual information tends to be ineffective and can even backfire (Walter & Tukachinsky, 2020; Lewandowsky et al., 2012). Evidence on opinion formation about changes to local areas for environmental reasons shows that presenting counterarguments to initial information does little to alter beliefs and can in fact reinforce those beliefs (Poluektova et al., forthcoming). Hence, public consultations about active travel schemes should prioritise communicating accurate information on anticipated effects as early as possible, to "pre-bunk" against potential misperceptions (Maertens et al., 2020).

The format of information also makes a difference. Where people have difficulty evaluating the veracity of information, they often rely on mental shortcuts or heuristics rather than expending additional effort. One such heuristic is the messenger effect, whereby the source of information colours how people evaluate it. Familiar and trusted sources are, unsurprisingly, favoured. In Ireland, the public report higher levels of trust about climate information from scientists, educators and family and friends, whereas trust of journalists, politicians and businesses is far lower (e.g., Leiserowitz et al., 2021). This issue may be particularly relevant for active travel initiatives, as they are often viewed as the pet projects of faceless and unaccountable technocrats (Selmoune et al., 2020). One systematic review of factors that affect the successful implementation of infrastructural change highlighted the importance of influential individuals and their communication strategies with the public (Lawlor et al., 2022). Planners of such projects could thus benefit from collaboration and involvement of individuals or community groups to build public trust.

Another psychological tendency worth noting is that people often underestimate the level of support for progressive change in their communities, which can lead to self-silencing among advocates for change (Bursztyn et al., 2020). As an illustrative example, one study in the US showed that people who underestimated other people's concern about climate change were less willing to discuss climate change with others. Correcting this misperception boosted willingness (Geiger & Swim, 2016). Similar instances of "pluralistic ignorance" have been observed in relation to other environmental beliefs and behaviour (Drews et al., 2022; Ejelöv et al, 2022). Hence collecting data on privately-held support for active travel infrastructure early in a consultation process may be important.

5. Discussion

5.1 Effective Design

Multiple individual studies and systematic reviews show strong evidence that implementing active travel infrastructure is likely to increase rates of active travel. Planning and design decisions determine the scale of effectiveness. There is strong evidence that connectivity, proximity and safety should be prioritised over other design elements. These considerations benefit all cyclists regardless of confidence, but are likely to have a greater marginal benefit among older adults and women. Schemes that make e-bikes and cargo bikes more readily available also hold potential to boost cycling rates within these groups.

Table 5.1. Example Checklist for Behaviourally-Informed Active Travel Infrastructure

Cycle lane…	is physically segregated from traffic	
	is 2 metres wide	
	is one-way	
	is painted *(minimum requirement)*	
Intersection…	contains pavement-level cyclist crossings	
	contains priority cyclist signals	
	uses advance stop lines	
Route…	contains no discontinuities	
	has start points at high-density residential areas/park-and-cycle facilities	
	has end points at local retail hubs/schools/areas with high concentrations of workers	
	has end points with secure bicycle parking facilities	
	uses traffic calming measures (e.g. 30km/hr speed limits)	
	contains direct cyclist routes	
	has regular, secure bicycle parking facilities	

Note. Recommendations are ordered by priority within each factor, with a view to maximising uptake and safety.

Whereas connectivity and proximity depend on route choices, safety and perceptions of safety are influenced by design choices. Segregating cycle lanes from traffic is beneficial for both real and perceived safety and is favoured by all road users. Real safety can be maximised by using one-way lanes, dedicated priority lights at intersections, advance stop lines, traffic calming measures and direct routes accessible only by walkers and cyclists. Perceived safety – which drives uptake – can be maximised using elements of the above, alongside physical barriers from traffic on wide, painted lanes. Taking this behaviourally-informed design approach can help increase the environmental and health benefits from active travel infrastructure, as these combinations can not only increase active travel frequency but also decrease car dependency, particularly when implemented with policies that disincentivise driving. Table 5.1 presents an example checklist for behaviourally-informed active travel infrastructure.

5.2 Public Support

Design decisions can have large effects on the success of active travel infrastructure, but public support for implementation is a necessary precondition; “bikelash” represents a significant barrier to the shift towards more sustainable communities. The perceived effectiveness of active travel schemes remains a primary factor. People are more willing to support something that they think will work. This finding arises in a context where the overwhelming conclusion from international research into active travel initiatives is that they are, in fact, effective. The implications of this research suggest a need for continued efforts to communicate the supportive evidence and specific measured benefits of active travel schemes. Where initiatives are successful these can be used as demonstration projects.

Trust in public institutions and procedural and distributional fairness are strong predictors of support. The implication is that the conduct of public authorities that propose and undertake schemes is important. Presenting balanced views of evidence and taking multiple perspectives into account may be a more fruitful approach than expressing certainty in the righteousness of a proposed initiative. Similarly, investment in early, open and extensive consultation is likely to generate returns in the form of stronger support.

The relationship between self-interest and support for active travel initiations present a challenge for drawing broad implications. Instead, research undertaken within a locality is likely required, to assess perceptions in determining how people adopting a self-interested perspective are likely to view any proposals. However, even where public perceptions are measured and understood, expectations about likely impact are often inaccurate and attitudes are prone to change once active travel infrastructure is actually in place. The evidence suggests that these changes can be substantial, as has proved to be the case in relation to congestion charging. This is tricky territory for policymakers, as asserting to the public that they are mistaken and will grow to like a scheme that they presently do not may come across as paternalistic, or even deluded. A commitment to a trial period, where this is feasible, may be a useful solution.

More generally, however, there is a need to understand and account for biases in the way information is processed. Various psychological mechanisms behind support for active travel schemes were explored in more depth in Section 4. Status quo bias is strong and is linked to loss aversion and dislike of uncertainty. People may also assume that a majority opposes change, especially where that majority is quieter on the issue than a more vocal minority. People may also view active travel schemes as a rebalancing of resources between transport users and not “join the dots” to efforts to tackle climate change, which in general enjoy broad support. All of these forces potentially undermine support for change.

Finally all of this takes place in a context where people are most strongly influenced by the information and arguments that they hear first and who they hear the arguments from. Once opinions have formed, even when based on poor information or superficial arguments, they can be resistant to new information that challenges them. Early, clear communication from trusted sources is likely to be the best way to inoculate against misperceptions.

5.3 Conclusion

Planning of new active travel schemes needs to begin with early communication undertaken within an open and fair consultation (see Lawlor et al., 2022). Ideally, messages would be designed to challenge status quo bias and would aim to help local citizens to make up their minds about the benefits, or otherwise, of change based on accurate perceptions and expectations. The international (and some domestic) research that informs this conclusion is helpful in providing some principles to support this aim. However, more targeted research is needed if the planning and communication of active travel schemes is to achieve it.

References

Abadi, M. G., & Hurwitz, D. S. (2018). Bicyclist's perceived level of comfort in dense urban environments: How do ambient traffic, engineering treatments, and bicyclist characteristics relate?. *Sustainable cities and society*, *40*, 101-109. https://doi.org/10.1016/j.scs.2018.04.003

Aldred, R., & Croft, J. (2019). Evaluating active travel and health economic impacts of small streetscape schemes: an exploratory study in London. *Journal of transport & health*, *12*, 86-96. https://doi.org/10.1016/j.jth.2018.11.009

Aldred, R., Croft, J., & Goodman, A. (2019). Impacts of an active travel intervention with a cycling focus in a suburban context: One-year findings from an evaluation of London's in-progress mini-Hollands programme. *Transportation research part A: policy and practice*, *123*, 147-169. https://doi.org/10.1016/j.tra.2018.05.018

Aldred, R., Woodcock, J., & Goodman, A. (2016). Does more cycling mean more diversity in cycling?. *Transport reviews*, *36*(1), 28-44. https://doi.org/10.1080/01441647.2015.1014451

Andre, P., Boneva, T., Chopra, F., & Falk, A. (2021). Fighting climate change: The role of norms, preferences, and moral values. *CEPR Discussion Paper No. DP16343*, Available at SSRN: https://ssrn.com/abstract=3886831

Anton, C. E., & Lawrence, C. (2016). The relationship between place attachment, the theory of planned behaviour and residents' response to place change. *Journal of Environmental Psychology*, *47*, 145–154. https://doi.org/10.1016/j.jenvp.2016.05.010

Arancibia, D., Farber, S., Savan, B., Verlinden, Y., Smith Lea, N., Allen, J., & Vernich, L. (2019). Measuring the local economic impacts of replacing on-street parking with bike lanes: A toronto (canada) case study. *Journal of the American Planning Association*, *85*(4), 463-481. https://doi.org/10.1080/01944363.2019.1638816

Arnott, B., Rehackova, L., Errington, L., Sniehotta, F. F., Roberts, J., & Araujo-Soares, V. (2014). Efficacy of behavioural interventions for transport behaviour change: systematic review, meta-analysis and intervention coding. *International journal of behavioral nutrition and physical activity*, *11*(1), 1-23. https://doi.org/10.1186/s12966-014-0133-9

Badland, H., Knuiman, M., Hooper, P., & Giles-Corti, B. (2013). Socio-ecological predictors of the uptake of cycling for recreation and transport in adults: Results from the RESIDE study. *Preventive medicine*, *57*(4), 396-399. https://doi.org/10.1016/j.ypmed.2013.06.015

Bandura, A., Freeman, W. H., & Lightsey, R. (1999). Self-efficacy: The exercise of control. *Journal of Cognitive Psychotherapy, 13*(2). https://doi.org/10.1891/0889-8391.13.2.158

Bauman, A., Rissel, C., Garrard, J., Ker, I., Speidel, R., & Fishman, E. (2008). *Cycling: Getting Australia Moving: Barriers, facilitators and interventions to get more Australians physically active through cycling* (pp. 593-601). Melbourne: Cycling Promotion Fund.

Beecham, R., Wood, J., & Bowerman, A. (2014). Studying commuting behaviours using collaborative visual analytics. *Computers, Environment and Urban Systems*, *47*, 5-15. https://doi.org/10.1016/j.compenvurbsys.2013.10.007

Beery, T. H., Raymond, C. M., Kyttä, M., Olafsson, A. S., Plieninger, T., Sandberg, M., ... & Jönsson, K. I. (2017). Fostering incidental experiences of nature through green infrastructure planning. *Ambio*, *46*(7), 717-730. https://doi.org/10.1007/s13280-017-0920-z

Bélanger-Gravel, A., & Janezic, I. (2021). Does communication support the promotion of cycling for transportation? Results from an experiment to test messaging strategies. *Journal of Transport & Health*, *21*, 101081. https://doi.org/10.1016/j.jth.2021.101081

Berghoefer, F. L., & Vollrath, M. (2022). Cyclists' perception of cycling infrastructure–A Repertory Grid approach. *Transportation research part F: traffic psychology and behaviour*, *87*, 249-263. https://doi.org/10.1016/j.trf.2022.04.012

Bergquist, M., Nilsson, A., Harring, N., & Jagers, S. C. (2022). Meta-analyses of fifteen determinants of public opinion about climate change taxes and laws. *Nature Climate Change*, *12*(3), 235-240. https://doi.org/10.1038/s41558-022-01297-6

Bertolini, L. (2020). From “streets for traffic” to “streets for people”: can street experiments transform urban mobility?. *Transport reviews*, *40*(6), 734-753. https://doi.org/10.1080/01441647.2020.1761907

Bird, E. L., Panter, J., Baker, G., Jones, T., & Ogilvie, D. (2018). Predicting walking and cycling behaviour change using an extended Theory of Planned Behaviour. *Journal of Transport & Health*, *10*, 11–27. https://doi.org/10.1016/j.jth.2018.05.014

Böcker, L., Dijst, M., & Prillwitz, J. (2013). Impact of everyday weather on individual daily travel behaviours in perspective: a literature review. *Transport reviews*, *33*(1), 71-91. https://doi.org/10.1080/01441647.2012.747114

Börjesson, M., Eliasson, J., & Hamilton, C. (2016). Why experience changes attitudes to congestion pricing: The case of Gothenburg. *Transportation Research Part A: Policy and Practice*, *85*, 1-16. https://doi.org/10.1016/j.tra.2015.12.002

Boyce, P. R., Eklund, N. H., Hamilton, B. J., & Bruno, L. D. (2000). Perceptions of safety at night in different lighting conditions. *International Journal of Lighting Research and Technology*, *32*(2), 79-91. https://doi.org/10.1177/096032710003200205

Brand, C., Götschi, T., Dons, E., Gerike, R., Anaya-Boig, E., Avila-Palencia, I., ... & Nieuwenhuijsen, M. J. (2021). The climate change mitigation impacts of active travel: Evidence from a longitudinal panel study in seven European cities. *Global environmental change*, *67*, 102224. https://doi.org/10.1016/j.gloenvcha.2021.102224

Branion-Calles, M., Nelson, T., & Winters, M. (2017). Comparing crowdsourced near-miss and collision cycling data and official bike safety reporting. *Transportation research record*, *2662*(1), 1-11. https://doi.org/10.3141/2662-01

Brüchert, T., Quentin, P., & Bolte, G. (2022). The relationship between perceived built environment and cycling or e-biking for transport among older adults–a cross-sectional study. *PLoS one*, *17*(5), e0267314. https://doi.org/10.1371/journal.pone.0267314

Buehler, R., & Dill, J. (2016). Bikeway networks: A review of effects on cycling. *Transport Reviews*, *36*(1), 9-27. https://doi.org/10.1080/01441647.2015.1069908

Buehler, R., & Goel, R. (2022). A global overview of cycling trends. *Cycling*, 137.

Burke, C. M., & Scott, D. M. (2018). Identifying "sensible locations" for separated bike lanes on a congested urban road network: A Toronto case study. *The Professional Geographer*, *70*(4), 541-551. https://doi.org/10.1080/00330124.2018.1455518

Bursztyn, L., González, A. L., & Yanagizawa-Drott, D. (2020). Misperceived social norms: Women working outside the home in saudi arabia. *American economic review*, *110*(10), 2997-3029. https://doi.org/10.1257/aer.20180975

Byrne, R. M., & Timmons, S. (2018). Moral hindsight for good actions and the effects of imagined alternatives to reality. *Cognition*, *178*, 82-91. https://doi.org/10.1016/j.cognition.2018.05.010

Cairns, S., Harmer, C., Hopkin, J., & Skippon, S. (2014). Sociological perspectives on travel and mobilities: A review. *Transportation research part A: policy and practice*, *63*, 107-117. https://doi.org/10.1016/j.tra.2014.01.010

Carattini, S., Carvalho, M., & Fankhauser, S. (2018). Overcoming public resistance to carbon taxes. *Wiley Interdisciplinary Reviews: Climate Change*, 9(5), e531

Carroll, J., Brazil, W., Morando, B., & Denny, E. (2020). What drives the gender-cycling-gap? Census analysis from Ireland. *Transport Policy*, *97*, 95-102. https://doi.org/10.1016/j.tranpol.2020.07.007

Castillo-Manzano, J. I., Lopez-Valpuesta, L., & Asencio-Flores, J. P. (2014). Extending pedestrianization processes outside the old city center; conflict and benefits in the case of the city of Seville. *Habitat International*, *44*, 194-201. https://doi.org/10.1016/j.habitatint.2014.06.005

Caulfield, B., Brick, E., & McCarthy, O. T. (2012). Determining bicycle infrastructure preferences–A case study of Dublin. *Transportation research part D: transport and environment*, *17*(5), 413-417. https://doi.org/10.1016/j.trd.2012.04.001

Chapman, R., Keall, M., Howden-Chapman, P., Grams, M., Witten, K., Randal, E., & Woodward, A. (2018). A cost benefit analysis of an active travel intervention with health and carbon emission reduction benefits. *International journal of environmental research and public health*, *15*(5), 962. https://doi.org/10.3390/ijerph15050962

Chataway, E. S., Kaplan, S., Nielsen, T. A. S., & Prato, C. G. (2014). Safety perceptions and reported behavior related to cycling in mixed traffic: A comparison between Brisbane and Copenhagen. *Transportation research part F: traffic psychology and behaviour*, *23*, 32-43. https://doi.org/10.1016/j.trf.2013.12.021

Cheng, L., Chen, X., Yang, S., Cao, Z., De Vos, J., & Witlox, F. (2019). Active travel for active ageing in China: The role of built environment. *Journal of transport geography*, *76*, 142-152. https://doi.org/10.1016/j.jtrangeo.2019.03.010

Ciccone, A., Fyhri, A., & Sundfør, H. B. (2021). Using behavioral insights to incentivize cycling: Results from a field experiment. *Journal of Economic Behavior & Organization*, *188*, 1035-1058. https://doi.org/10.1016/j.jebo.2021.06.011

Clark, A. F., Scott, D. M., & Yiannakoulias, N. (2014). Examining the relationship between active travel, weather, and the built environment: a multilevel approach using a GPS-enhanced dataset. *Transportation*, *41*(2), 325-338. https://doi.org/10.1007/s11116-013-9476-3

Clarke, D., Murphy, C., & Lorenzoni, I. (2018). Place attachment, disruption and transformative adaptation. *Journal of Environmental Psychology*, *55*, 81–89. https://doi.org/10.1016/j.jenvp.2017.12.006

Cobb, D. P., Jashami, H., & Hurwitz, D. S. (2021). Bicyclists' behavioral and physiological responses to varying roadway conditions and bicycle infrastructure. *Transportation research part F: traffic psychology and behaviour*, *80*, 172-188. https://doi.org/10.1016/j.trf.2021.04.004

Cook, S., Stevenson, L., Aldred, R., Kendall, M., & Cohen, T. (2022). More than walking and cycling: What is 'active travel'?. *Transport Policy*, *126*, 151-161. https://doi.org/10.1016/j.tranpol.2022.07.015

Cologna, V., Berthold, A., & Siegrist, M. (2022). Knowledge, perceived potential and trust as determinants of low-and high-impact pro-environmental behaviours. *Journal of Environmental Psychology*, *79*, 101741. https://doi.org/10.1016/j.jenvp.2021.101741

Cradock, A. L., Barrett, J. L., Chriqui, J. F., Evenson, K. R., Goins, K. V., Gustat, J., ... & Valko, C. (2018). Driven to support: individual-and county-level factors associated with public support for active transportation policies. *American journal of health promotion*, *32*(3), 657-666. https://doi.org/10.1177/08901171177387

Craig, L., & Van Tienoven, T. P. (2019). Gender, mobility and parental shares of daily travel with and for children: a cross-national time use comparison. *Journal of transport geography*, *76*, 93-102. https://doi.org/10.1016/j.jtrangeo.2019.03.006

Crane, M., Rissel, C., Greaves, S., Standen, C., & Wen, L. M. (2016). Neighbourhood expectations and engagement with new cycling infrastructure in Sydney, Australia: Findings from a mixed method before-and-after study. *Journal of Transport & Health*, *3*(1), 48-60. https://doi.org/10.1016/j.jth.2015.10.003

CSO (2016). *Census of Population 2016 – Profile 6 Commuting in Ireland.* https://www.cso.ie/en/releasesandpublications/ep/p-cp6ci/p6cii/p6td/

Dai, H., Milkman, K. L., & Riis, J. (2014). The fresh start effect: Temporal landmarks motivate aspirational behavior. *Management Science*, *60*(10), 2563-2582. https://doi.org/10.1287/mnsc.2014.1901

Darker, C. D., French, D. P., Eves, F. F., & Sniehotta, F. F. (2010). An intervention to promote walking amongst the general population based on an 'extended'theory of planned behaviour: a waiting list randomised controlled trial. *Psychology and Health*, *25*(1), 71-88. https://doi.org/10.1080/08870440902893716

Dear, M. (1992). Understanding and overcoming the NIMBY syndrome. *Journal of the American Planning Association*, *58*(3), 288. https://doi.org/10.1080/01944369208975808

De Nazelle, A., Nieuwenhuijsen, M. J., Antó, J. M., Brauer, M., Briggs, D., Braun-Fahrlander, C., ... & Lebret, E. (2011). Improving health through policies that promote active travel: a review of evidence to support integrated health impact assessment. *Environment international*, *37*(4), 766-777. https://doi.org/10.1016/j.envint.2011.02.003

Dechezleprêtre, A., Fabre, A., Kruse, T., Planterose, B., Chico, A. S., & Stantcheva, S. (2022). *Fighting climate change: International attitudes toward climate policies* (No. w30265). National Bureau of Economic Research.

Deenihan, G., Caulfield, B., & O'Dwyer, D. (2013). Measuring the success of the Great Western Greenway in Ireland. *Tourism Management Perspectives*, *7*, 73-82. https://doi.org/10.1016/j.tmp.2013.03.004

Devine-Wright, P. (2009). Rethinking NIMBYism: The role of place attachment and place identity in explaining place-protective action. *Journal of Community & Applied Social Psychology*, *19*(6), 426–441. https://doi.org/10.1002/casp.1004

Dill, J., Goddard, T., Monsere, C., & McNeil, N. (2014). Can protected bike lanes help close the gender gap in cycling? Lessons from five cities. *Urban Studies and Planning Faculty Publications and Presentations*. 123. http://archives.pdx.edu/ds/psu/16603

Doğru, O. C., Webb, T. L., & Norman, P. (2021). What is the best way to promote cycling? A systematic review and meta-analysis. *Transportation research part F: traffic psychology and behaviour*, *81*, 144-157. https://doi.org/10.1016/j.trf.2021.06.002

Drews, S., Savin, I., & Van Den Bergh, J. C. (2022). Biased perceptions of other people's attitudes to carbon taxation. *Energy Policy*, *167*, 113051. https://doi.org/10.1016/j.enpol.2022.113051

Echiburú, T., Muñoz, J. C., & Hurtubia, R. (2021). The role of perceived satisfaction and the built environment on the frequency of cycle-commuting. *Journal of transport and land use*, *14*(1), 171-196. https://www.jstor.org/stable/48646182

Egan, R., & Hackett, J. (2022). The Social Practice and Regulation of Cycling as" A Boy's Thing" in Irish Secondary Schools. *Active Travel Studies*, *2*(1). https://doi.org/10.16997/ats.1121

Egan, R., Dowling, C. M., & Caulfield, B. (2022). Planning for diverse cycling practices: a cycle-parking type preference typology. *Case studies on transport policy*, *10*(3), 1930-1944. https://doi.org/10.1016/j.cstp.2022.08.007

Ejelöv, E., Hansla, A., & Nilsson, A. (2022). Can Unexpected Support Promote Environmental Policy Acceptability? An Experimental Investigation of Norm Source and Strength. *Journal of Social and Political Psychology*, *10*(1), 123-140. https://doi.org/10.5964/jspp.9287

Elvik, R., & Bjørnskau, T. (2017). Safety-in-numbers: a systematic review and meta-analysis of evidence. *Safety science*, *92*, 274-282. https://doi.org/10.1016/j.ssci.2015.07.017

European Commission. (2020). *Sustainable and Smart Mobility Strategy –putting European transport on track for the future.* https://eur-lex.europa.eu/resource.html?uri=cellar:5e601657-3b06-11eb-b27b-01aa75ed71a1.0001.02/DOC_1&format=PDF

Fairbrother, M. (2019). When will people pay to pollute? Environmental taxes, political trust and experimental evidence from Britain. *British Journal of Political Science*, 49(2), 661-682.

Farrell, D. (2022). Capel Street's traders remain at odds over its pedestrianisation. *The Irish Times.*

Fell, D., & Kivinen, E. (2016). *Investing in Cycling & Walking: Rapid Evidence Assessment*.

Ferrari, G., Werneck, A. O., Da Silva, D. R., Kovalskys, I., Gómez, G., Rigotti, A., ... & Fisberg, M. (2020). Is the perceived neighborhood built environment associated with domain-specific physical activity in Latin American adults? An eight-country observational study. *International journal of behavioral nutrition and physical activity*, *17*(1), 1-14. https://doi.org/10.1186/s12966-020-01030-6

Ferster, C., Laberee, K., Nelson, T., Thigpen, C., Simeone, M., & Winters, M. (2021). From advocacy to acceptance: Social media discussions of protected bike lane installations. *Urban Studies*, *58*(5), 941-958. https://doi.org/10.1177/004209802093825

Field, A., Wild, K., Woodward, A., Macmillan, A., & Mackie, H. (2018). Encountering bikelash: Experiences and lessons from New Zealand communities. *Journal of Transport & Health*, *11*, 130-140. https://doi.org/10.1016/j.jth.2018.10.003

Fishman, E. (2016). Bikeshare: A review of recent literature. *Transport Reviews*, *36*(1), 92-113. https://doi.org/10.1080/01441647.2015.1033036

Fleischhut, N., Meder, B., & Gigerenzer, G. (2017). Moral hindsight. *Experimental Psychology*, *64*(2), 110. https://doi.org/10.1027/1618-3169/a000353

Foster, C., Kelly, P., Reid, H. A., Roberts, N., Murtagh, E. M., Humphreys, D. K., ... & Milton, K. (2018). What works to promote walking at the population level? A systematic review. *British journal of sports medicine*, *52*(12), 807-812. http://dx.doi.org/10.1136/bjsports-2017-098953

Fraser, S. D., & Lock, K. (2011). Cycling for transport and public health: a systematic review of the effect of the environment on cycling. *European journal of public health*, *21*(6), 738-743. https://doi.org/10.1093/eurpub/ckq145

Friman, M., Gärling, T., & Ettema, D. (2019). Improvement of public transport services for non-cycling travelers. *Travel Behaviour and Society*, *16*, 235-240. https://doi.org/10.1016/j.tbs.2018.03.004

Fyhri, A., Karlsen, K., & Sundfør, H. B. (2021). Paint it red-a multimethod study of the nudging effect of coloured cycle lanes. *Frontiers in psychology*, 1995. https://doi.org/10.3389/fpsyg.2021.662679

Garcia-López, M.-À., Pasidis, I., & Viladecans-Marsal, E. (2021). Congestion in highways when tolls and railroads matter: Evidence from European cities. *Journal of Economic Geography*, lbab025. https://doi.org/10.1093/jeg/lbab025

Gase, L. N., Barragan, N. C., Simon, P. A., Jackson, R. J., & Kuo, T. (2015). Public awareness of and support for infrastructure changes designed to increase walking and biking in Los Angeles County. *Preventive medicine*, *72*, 70-75. https://doi.org/10.1016/j.ypmed.2014.12.033

Geiger, N., & Swim, J. K. (2016). Climate of silence: Pluralistic ignorance as a barrier to climate change discussion. *Journal of Environmental Psychology*, *47*, 79-90. https://doi.org/10.1016/j.jenvp.2016.05.002

Giles-Corti, B., Vernez-Moudon, A., Reis, R., Turrell, G., Dannenberg, A. L., Badland, H., ... & Owen, N. (2016). City planning and population health: a global challenge. *The lancet*, *388*(10062), 2912-2924. https://doi.org/10.1016/S0140-6736(16)30066-6

Goel, R., Goodman, A., Aldred, R., Nakamura, R., Tatah, L., Garcia, L. M. T., ... & Woodcock, J. (2022). Cycling behaviour in 17 countries across 6 continents: levels of cycling, who cycles, for what purpose, and how far?. *Transport reviews*, *42*(1), 58-81. https://doi.org/10.1080/01441647.2021.1915898

Goerke, D., Zolfaghari, E., Marek, A. P., Endorf, F. W., & Nygaard, R. M. (2020). Incidence and profile of severe cycling injuries after bikeway infrastructure changes. *Journal of community health*, *45*(3), 542-549. https://doi.org/10.1007/s10900-019-00773-z

Gormley, L., Belton, C. A., Lunn, P. D., & Robertson, D. A. (2022). Interventions to increase physical activity: An analysis of candidate behavioural mechanisms. *Preventive Medicine Reports*, 101880. https://doi.org/10.1016/j.pmedr.2022.101880

Gorrini, A., Choubassi, R., Messa, F., Saleh, W., Ababio-Donkor, A., Leva, M. C., ... & Aragón, P. (2021). Unveiling Women's Needs and Expectations as Users of Bike Sharing Services: The H2020 DIAMOND Project. *Sustainability*, *13*(9), 5241. https://doi.org/10.3390/su13095241

Gössling, S., & Choi, A. S. (2015). Transport transitions in Copenhagen: Comparing the cost of cars and bicycles. *Ecological Economics*, *113*, 106-113. https://doi.org/10.1016/j.ecolecon.2015.03.006

Gössling, S., & McRae, S. (2022). Subjectively safe cycling infrastructure: New insights for urban designs. *Journal of Transport Geography*, *101*, 103340. https://doi.org/10.1016/j.jtrangeo.2022.103340

Gössling, S., Choi, A., Dekker, K., & Metzler, D. (2019). The social cost of automobility, cycling and walking in the European Union. *Ecological Economics*, *158*, 65-74. https://doi.org/10.1016/j.ecolecon.2018.12.016

Götschi, T., de Nazelle, A., Brand, C., & Gerike, R. (2017). Towards a comprehensive conceptual framework of active travel behavior: a review and synthesis of published frameworks. *Current environmental health reports*, *4*(3), 286-295. https://doi.org/10.1007/s40572-017-0149-9

Götschi, T., Garrard, J., & Giles-Corti, B. (2016). Cycling as a part of daily life: a review of health perspectives. *Transport Reviews*, *36*(1), 45-71. https://doi.org/10.1080/01441647.2015.1057877

Gustat, J., O'Malley, K., Hu, T., Tabak, R. G., Goins, K. V., Valko, C., Litt, J., & Eyler, A. (2014). Support for Physical Activity Policies and Perceptions of Work and Neighborhood Environments: Variance by BMI and Activity Status at the County and Individual Levels. *American Journal of Health Promotion*, *28*(3), 13.

Gutiérrez, M., Hurtubia, R., & de Dios Ortúzar, J. (2020). The role of habit and the built environment in the willingness to commute by bicycle. *Travel behaviour and society*, *20*, 62-73. https://doi.org/10.1016/j.tbs.2020.02.007

Hajna, S., Ross, N. A., Brazeau, A. S., Bélisle, P., Joseph, L., & Dasgupta, K. (2015). Associations between neighbourhood walkability and daily steps in adults: a systematic review and meta-analysis. *BMC public health*, *15*(1), 1-8. https://doi.org/10.1186/s12889-015-2082-x

Halden, D., & Anable, J. (2013). *Going Smarter: Monitoring and Evaluation of the Smarter Choices, Smarter Places Programme.*

Hamre, A., & Buehler, R. (2014). Commuter mode choice and free car parking, public transportation benefits, showers/lockers, and bike parking at work: evidence from the Washington, DC region. *Journal of Public Transportation*, *17*(2), 4. http://doi.org/10.5038/2375-0901.17.2.4

Hansmann, K. J., Grabow, M., & McAndrews, C. (2022). Health equity and active transportation: A scoping review of active transportation interventions and their impacts on health equity. *Journal of Transport & Health*, *25*, 101346. https://doi.org/10.1016/j.jth.2022.101346

Hansla, A., Hysing, E., Nilsson, A., & Martinsson, J. (2017). Explaining voting behavior in the Gothenburg congestion tax referendum. *Transport Policy*, *53*, 98–106. https://doi.org/10.1016/j.tranpol.2016.10.003

Heinen, E., Panter, J., Mackett, R., & Ogilvie, D. (2015). Changes in mode of travel to work: a natural experimental study of new transport infrastructure. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 1-10. https://doi.org/10.1186/s12966-015-0239-8

Howarth, C. C., & Polyviou, P. (2012). Sustainable travel behaviour and the widespread impacts on the local economy. *Local Economy*, *27*(7), 764-781. https://doi.org/10.1177/0269094212455149

Huber, R. A., & Wicki, M. (2021). What explains citizen support for transport policy? the roles of policy design, trust in government and proximity among Swiss citizens. Energy Research & Social Science, 75, 101973. https://doi.org/10.1016/j.erss.2021.101973

Hull, A., & O'Holleran, C. (2014). Bicycle infrastructure: can good design encourage cycling?. *Urban, Planning and Transport Research*, *2*(1), 369-406. https://doi.org/10.1080/21650020.2014.955210

Hunt, J. D., & Abraham, J. E. (2007). Influences on bicycle use. *Transportation*, *34*(4), 453-470. https://doi.org/10.1007/s11116-006-9109-1

Jacobsen, P. L. (2015). Safety in numbers: more walkers and bicyclists, safer walking and bicycling. *Injury prevention*, *21*(4), 271-275. http://dx.doi.org/10.1136/ip.9.3.205rep

Jenkins, M., Lustosa, L., Chia, V., Wildish, S., Tan, M., Hoornweg, D., ... & Dogra, S. (2022). What do we know about pedal assist E-bikes? A scoping review to inform future directions. *Transport Policy*. https://doi.org/10.1016/j.tranpol.2022.09.005

Kaczynski, A. T., & Glover, T. D. (2012). Talking the talk, walking the walk: examining the effect of neighbourhood walkability and social connectedness on physical activity. *Journal of public health*, *34*(3), 382-389. https://doi.org/10.1093/pubmed/fds011

Kahneman, D., & Tversky, A. (1984). Choices, values, and frames. *American psychologist*, *39*(4), 341. https://doi.org/10.1037/0003-066X.39.4.341

Karlsen, K., & Fyhri, A. (2020). Is red the new black? A quasi-experimental study comparing perceptions of differently coloured cycle lanes. *Frontiers in psychology*, *11*, 554488. https://doi.org/10.3389/fpsyg.2020.554488

Kärmeniemi, M., Lankila, T., Ikäheimo, T., Koivumaa-Honkanen, H., & Korpelainen, R. (2018). The built environment as a determinant of physical activity: a systematic review of longitudinal studies and natural experiments. *Annals of behavioral medicine*, *52*(3), 239-251. https://doi.org/10.1093/abm/kax043

Keall, M., Chapman, R., Howden-Chapman, P., Witten, K., Abrahamse, W., & Woodward, A. (2015). Increasing active travel: results of a quasi-experimental study of an intervention to encourage walking and cycling. *J Epidemiol Community Health*, *69*(12), 1184-1190. http://dx.doi.org/10.1136/jech-2015-205466

Keall, M., Chapman, R., Shaw, C., Abrahamse, W., & Howden-Chapman, P. (2018). Are people who already cycle and walk more responsive to an active travel intervention?. *Journal of Transport & Health*, *10*, 84-91. https://doi.org/10.1016/j.jth.2018.08.006

Keall, M., Randal, E., Abrahamse, W., Chapman, R., Shaw, C., Witten, K., ... & Howden-Chapman, P. (2022). Equity and other effects of a program facilitating and promoting active travel. *Transportation Research Part D: Transport and Environment*, *108*, 103338. https://doi.org/10.1016/j.trd.2022.103338

Kelly, O. (2021, Aug 21). Give me a crash course in ... cycle path opposition. *The Irish Times.*

Kelly, P., Williamson, C., Baker, G., Davis, A., Broadfield, S., Coles, A., ... & Gill, J. M. (2020). Beyond cycle lanes and large-scale infrastructure: a scoping review of initiatives that groups and organisations can implement to promote cycling for the Cycle Nation Project. *British journal of sports medicine*, *54*(23), 1405-1415. http://dx.doi.org/10.1136/bjsports-2019-101447

Knight, A., & Charlton, S. G. (2022). Protected and unprotected cycle lanes' effects on cyclists' behaviour. *Accident Analysis & Prevention*, *171*, 106668. https://doi.org/10.1016/j.aap.2022.106668

Koh, P. P., & Wong, Y. D. (2013). Influence of infrastructural compatibility factors on walking and cycling route choices. *Journal of Environmental Psychology*, *36*, 202-213. https://doi.org/10.1016/j.jenvp.2013.08.001

Kovaceva, J., Wallgren, P., & Dozza, M. (2022). On the evaluation of visual nudges to promote safe cycling: Can we encourage lower speeds at intersections?. *Traffic injury prevention*, *23*(7), 428-433. https://doi.org/10.1080/15389588.2022.2103120

Krizek, K. J., Handy, S. L., & Forsyth, A. (2009). Explaining changes in walking and bicycling behavior: challenges for transportation research. *Environment and Planning B: Planning and Design*, *36*(4), 725-740. https://doi.org/10.1068/b34023

Kunda, Z. (1990). The case for motivated reasoning. *Psychological bulletin*, *108*(3), 480. https://doi.org/10.1037/0033-2909.108.3.480

Lambe, B., Murphy, N., & Bauman, A. (2017). Smarter Travel, car restriction and reticence: Understanding the process in Ireland's active travel towns. *Case studies on transport policy*, *5*(2), 208-214. https://doi.org/10.1016/j.cstp.2017.02.003

Lang, C., Weir, M., & Pearson-Merkowitz, S. (2021). Status quo bias and public policy: evidence in the context of carbon mitigation. *Environmental Research Letters*, 16(5), 054076.

Larcom, S., Rauch, F., & Willems, T. (2017). The benefits of forced experimentation: striking evidence from the London underground network. *The Quarterly Journal of Economics*, *132*(4), 2019-2055. https://doi.org/10.1093/qje/qjx020

Larson, L. R., Keith, S. J., Fernandez, M., Hallo, J. C., Shafer, C. S., & Jennings, V. (2016). Ecosystem services and urban greenways: What's the public's perspective? *Ecosystem Services*, *22*, 111–116. https://doi.org/10.1016/j.ecoser.2016.10.004

Laverty, A. A., Palladino, R., Lee, J. T., & Millett, C. (2015). Associations between active travel and weight, blood pressure and diabetes in six middle income countries: a cross-sectional study in older adults. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 1-11. https://doi.org/10.1186/s12966-015-0223-3

Lawlor, E. R., Ellis, K., Adams, J., Jago, R., Foley, L., Morris, S., ... & Panter, J. (2022). Stakeholders' experiences of what works in planning and implementing environmental interventions to promote active travel: a systematic review and qualitative synthesis. *Transport Reviews*, 1-24. https://doi.org/10.1080/01441647.2022.2119298

Lawson, A. R., Pakrashi, V., Ghosh, B., & Szeto, W. Y. (2013). Perception of safety of cyclists in Dublin City. *Accident Analysis & Prevention*, *50*, 499-511. https://doi.org/10.1016/j.aap.2012.05.029

Leiserowitz, A., J. Carman, S. Rosenthal, L. Neyens, J. Marlon, M. Desmond, S. Smith, M.F.Rochford, J. O'Mahony and L. Reaper (2021). *Climate Change in the Irish Mind*. New Haven, CT: Yale Program on Climate Change Communication

Lewandowsky, S., Ecker, U. K. H., Seifert, C. M., Schwarz, N., & Cook, J. (2012). Misinformation and Its Correction: Continued Influence and Successful Debiasing. *Psychological Science in the Public Interest*, 13(3), 106–131. https://doi.org/10.1177/1529100612451018

Ling, R., Rothman, L., Cloutier, M. S., Macarthur, C., & Howard, A. (2020). Cyclist-motor vehicle collisions before and after implementation of cycle tracks in Toronto, Canada. *Accident Analysis & Prevention*, *135*, 105360. https://doi.org/10.1016/j.aap.2019.105360

Maertens, R., Anseel, F., & van der Linden, S. (2020). Combatting climate change misinformation: Evidence for longevity of inoculation and consensus messaging effects. *Journal of Environmental Psychology*, *70*, 101455. https://doi.org/10.1016/j.jenvp.2020.101455

Malacarne, D., Handakas, E., Robinson, O., Pineda, E., Saez, M., Chatzi, L., & Fecht, D. (2022). The built environment as determinant of childhood obesity: A systematic literature review. *Obesity Reviews*, *23*, e13385. https://doi.org/10.1111/obr.13385

Márquez, L., Cantillo, V., & Arellana, J. (2021). How do the characteristics of bike lanes influence safety perception and the intention to use cycling as a feeder mode to BRT?. *Travel Behaviour and Society*, *24*, 205-217. https://doi.org/10.1016/j.tbs.2021.04.005

Martin, A., Suhrcke, M., & Ogilvie, D. (2012). Financial incentives to promote active travel: an evidence review and economic framework. *American journal of preventive medicine*, *43*(6), e45-e57. https://doi.org/10.1016/j.amepre.2012.09.001

May, A. D., Khreis, H., & Mullen, C. (2018). Option generation for policy measures and packages: An assessment of the KonSULT knowledgebase. *Case studies on transport policy*, *6*(3), 311-318. https://doi.org/10.1016/j.cstp.2018.03.002

McGowan, F. P., Lunn, P., & Robertson, D. A. (2019). Underestimation of money growth and pensions: Experimental investigations (No. 611). ESRI Working Paper

Melia, S., & Shergold, I. (2018). Pedestrianisation and politics: a case study. In *Proceedings of the Institution of Civil Engineers-Transport* (Vol. 171, No. 1, pp. 30-41). Thomas Telford Ltd. https://doi.org/10.1680/jtran.16.00104

Mingardo, G., & Van Meerkerk, J. (2012). Is parking supply related to turnover of shopping areas? The case of the Netherlands. *Journal of Retailing and Consumer Services*, *19*(2), 195-201. https://doi.org/10.1016/j.jretconser.2011.12.001

Mitra, R., & Nash, S. (2017). Does the built environment explain gender gap in cycling? A study of post-secondary students in Toronto, Canada. *Journal of Transport & Health*, *5*, S24-S25. https://doi.org/10.1016/j.jth.2017.05.307

Moudon, A. V., Lee, C., Cheadle, A. D., Collier, C. W., Johnson, D., Schmid, T. L., & Weather, R. D. (2005). Cycling and the built environment, a US perspective. *Transportation Research Part D: Transport and Environment*, *10*(3), 245-261. https://doi.org/10.1016/j.trd.2005.04.001

Mueller, N., Rojas-Rueda, D., Basagaña, X., Cirach, M., Cole-Hunter, T., Dadvand, P., ... & Nieuwenhuijsen, M. (2017). Urban and transport planning related exposures and mortality: a health impact assessment for cities. *Environmental health perspectives*, *125*(1), 89-96. https://doi.org/10.1289/EHP220

Mueller, N., Rojas-Rueda, D., Salmon, M., Martinez, D., Ambros, A., Brand, C., de Nazelle, A., Dons, E., Gaupp-Berghausen, M., Gerike, R., Götschi, T., Iacorossi, F., Int Panis, L., Kahlmeier, S., Raser, E., & Nieuwenhuijsen, M. (2018). Health impact assessment of cycling network expansions in European cities. *Preventive Medicine, 109*, 62–70. https://doi.org/10.1016/j.ypmed.2017.12.011

Muhammad, I., Mohd Hasnu, N. N., & Ekins, P. (2021). Empirical Research of Public Acceptance on Environmental Tax: A Systematic Literature Review. *Environments*, *8*(10), 109. https://doi.org/10.3390/environments8100109

Nanayakkara, P. K., Langenheim, N., Moser, I., & White, M. (2022). Do safe bike lanes really slow down cars? A simulation-based approach to investigate the effect of retrofitting safe cycling lanes on vehicular traffic. *International journal of environmental research and public health*, *19*(7), 3818. https://doi.org/10.3390/ijerph19073818

National Transport Authority (2021). *The Universal Design Walkability Audit Tool.*

Nickerson, R. S. (1998). Confirmation bias: A ubiquitous phenomenon in many guises. *Review of general psychology*, *2*(2), 175-220. https://doi.org/10.1037/1089-2680.2.2.175

Nielsen, T. A., & Haustein, S. (2019). Behavioural effects of a health-related cycling campaign in Denmark: evidence from the National travel survey and an online survey accompanying the campaign. *Journal of Transport & Health*, *12*, 152-163. https://doi.org/10.1016/j.jth.2018.12.003

Nieuwenhuijsen, M. J., & Khreis, H. (2016). Car free cities: Pathway to healthy urban living. *Environment international*, *94*, 251-262. https://doi.org/10.1016/j.envint.2016.05.032

Nilsson, A., Schuitema, G., Bergstad, C. J., Martinsson, J., & Thorson, M. (2016). The road to acceptance: Attitude change before and after the implementation of a congestion tax. *Journal of environmental psychology*, *46*, 1-9. https://doi.org/10.1016/j.jenvp.2016.01.011

Nisbet, E. K., & Zelenski, J. M. (2011). Underestimating nearby nature: Affective forecasting errors obscure the happy path to sustainability. *Psychological science*, 22(9), 1101-1106

Noland, R. B., Iacobucci, E., & Zhang, W. (2022). Public Views on the Reallocation of Street Space Due to COVID-19. *Journal of the American Planning Association*, 1-14. https://doi.org/10.1080/01944363.2022.2058595

O' Brien, B. & French, C. (2022). *Initial Feedback on Traffic Free Capel Street Consultation.*

O'Connor, D., & D'Arcy, D. L. (2021). *Dún Laoghaire-Rathdown County Council Project Team: 160.*

Ogilvie, D., Egan, M., Hamilton, V., & Petticrew, M. (2004). Promoting walking and cycling as an alternative to using cars: systematic review. *Bmj*, *329*(7469), 763. https://doi.org/10.1136/bmj.38216.714560.55

Oldmeadow, J. A., Povey, S., Povey, A., & Critchley, C. (2019). Driver anger towards cyclists in Australia: Investigating the role of the perceived legitimacy of cyclists as road users. *Transportation research part F: traffic psychology and behaviour*, *63*, 240-251. https://doi.org/10.1016/j.trf.2019.04.021

Panter, J., Guell, C., Humphreys, D., & Ogilvie, D. (2019). Can changing the physical environment promote walking and cycling? A systematic review of what works and how. *Health & place*, *58*, 102161. https://doi.org/10.1016/j.healthplace.2019.102161

Parajuli, A. (2018). *Barriers to the pedestrianization of city centres: Perspectives from the Global North and the Global South*. 20.

Petty, R. E., Tormala, Z. L., Hawkins, C., & Wegener, D. T. (2001). Motivation to think and order effects in persuasion: The moderating role of chunking. *Personality and Social Psychology Bulletin*, *27*(3), 332-344. https://doi.org/10.1177/0146167201273007

Piatkowski, D. P., Marshall, W. E., & Krizek, K. J. (2019). Carrots versus sticks: assessing intervention effectiveness and implementation challenges for active transport. *Journal of Planning Education and Research*, *39*(1), 50-64. https://doi.org/10.1177/0739456X17715306

Poluektova, O., Julienne, H., Robertson, D. A., Braiden, A., & Lunn, P. D. (forthcoming). Psychological Mechanisms Underlying Formation of Public Opinion on an Unfamiliar Environmental Topic: Example of Mineral Exploration and Mining.

Portegijs, E., Timmermans, E. J., Castell, M. V., Dennison, E. M., Herbolsheimer, F., Limongi, F., ... & Deeg, D. J. (2020). Neighborhood resources associated with active travel in older adults—A cohort study in six European countries. *Journal of Aging and Physical Activity*, *28*(6), 920-933. https://doi.org/10.1123/japa.2019-0267

Prince, S. A., Lancione, S., Lang, J. J., Amankwah, N., de Groh, M., Garcia, A. J., ... & Geneau, R. (2022). Are people who use active modes of transportation more physically active? An overview of reviews across the life course. *Transport reviews*, *42*(5), 645-671. https://doi.org/10.1080/01441647.2021.2004262

Pucher, J., & Buehler, R. (2016). Safer cycling through improved infrastructure. *American Journal of Public Health*, *106*(12), 2089-2091. https://doi.org/10.2105/AJPH.2016.3

Pucher, J., Buehler, R., Merom, D., & Bauman, A. (2011). Walking and cycling in the United States, 2001–2009: evidence from the National Household Travel Surveys. *American journal of public health*, *101*(S1), S310-S317. https://doi.org/10.2105/AJPH.2010.300067

Pucher, J., Dill, J., & Handy, S. (2010). Infrastructure, programs, and policies to increase bicycling: an international review. *Preventive medicine*, *50*, S106-S125. https://doi.org/10.1016/j.ypmed.2009.07.028

Ranney, M. A., & Clark, D. (2016). Climate change conceptual change: Scientific information can transform attitudes. *Topics in cognitive science*, *8*(1), 49-75. https://doi.org/10.1111/tops.12187

Ravensbergen, L., Buliung, R., & Laliberté, N. (2019). Toward feminist geographies of cycling. *Geography compass*, *13*(7), e12461. https://doi.org/10.1111/gec3.12461

Rissel, C., Crane, M., Standen, C., Wen, L. M., Ellison, R., & Greaves, S. (2018). Public support for bicycling and transport policies in inner Sydney, Australia: a cross-sectional survey. *Australian and New Zealand journal of public health*, *42*(3), 309-314. https://doi.org/10.1111/1753-6405.12791

Roese, N. J., & Vohs, K. D. (2012). Hindsight bias. *Perspectives on psychological science*, *7*(5), 411-426. https://doi.org/10.1177/1745691612454303

Rossetti, T., Saud, V., & Hurtubia, R. (2019). I want to ride it where I like: Measuring design preferences in cycling infrastructure. *Transportation*, *46*(3), 697-718. https://doi.org/10.1007/s11116-017-9830-y

RPS (2022). *Street Survey September 22nd – Results.*

Saberi, M., Ghamami, M., Gu, Y., Shojaei, M. H. S., & Fishman, E. (2018). Understanding the impacts of a public transit disruption on bicycle sharing mobility patterns: A case of Tube strike in London. *Journal of Transport Geography*, *66*, 154-166. https://doi.org/10.1016/j.jtrangeo.2017.11.018

Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of risk and uncertainty*, *1*(1), 7-59. https://doi.org/10.1007/BF00055564

Saneinejad, S., Roorda, M. J., & Kennedy, C. (2012). Modelling the impact of weather conditions on active transportation travel behaviour. *Transportation research part D: transport and environment*, *17*(2), 129-137. https://doi.org/10.1016/j.trd.2011.09.005

Schepers, P., Fishman, E., Beelen, R., Heinen, E., Wijnen, W., & Parkin, J. (2015). The mortality impact of bicycle paths and lanes related to physical activity, air pollution exposure and road safety. *Journal of Transport & Health*, *2*(4), 460-473. https://doi.org/10.1016/j.jth.2015.09.004

Schmitz, S., Caseiro, A., Kerschbaumer, A., & von Schneidemesser, E. (2021). Do new bike lanes impact air pollution exposure for cyclists?—a case study from Berlin. *Environmental Research Letters*, *16*(8), 084031. https://doi.org/10.1088/1748-9326/ac1379

Schuitema, G., Steg, L., & Forward, S. (2010). Explaining differences in acceptability before and acceptance after the implementation of a congestion charge in Stockholm. *Transportation Research Part A: Policy and Practice*, *44*(2), 99-109. https://doi.org/10.1016/j.tra.2009.11.005

Sebastien, L., Pelenc, J., & Milanesi, J. (2019). Resistance as an enlightening process: A new framework for analysis of the socio-political impacts of place-based environmental struggles. *Local Environment*, *24*(5), 487–504. https://doi.org/10.1080/13549839.2019.1592133

Selmoune, A., Cheng, Q., Wang, L., & Liu, Z. (2020). Influencing factors in congestion pricing acceptability: a literature review. *Journal of Advanced Transportation*, *2020*. https://doi.org/10.1155/2020/4242964

Semple, T., & Fountas, G. (2022). Demographic and behavioural factors affecting public support for pedestrianisation in city centres: The case of Edinburgh, UK. *International Journal of Transportation Science and Technology*. https://doi.org/10.1016/j.ijtst.2021.12.001

Shaw, C., Russell, M., Keall, M., MacBride-Stewart, S., Wild, K., Reeves, D., ... & Woodward, A. (2020). Beyond the bicycle: Seeing the context of the gender gap in cycling. *Journal of Transport & Health*, *18*, 100871. https://doi.org/10.1016/j.jth.2020.100871

Sloman, L., Hopkinson, L., & Taylor, I. (2017). *The impact of road projects in England*. TfQL Community Interest Company: Machynlleth, Wales.

Smith, M., Hosking, J., Woodward, A., Witten, K., MacMillan, A., Field, A., ... & Mackie, H. (2017). Systematic literature review of built environment effects on physical activity and active transport–an update and new findings on health equity. *International journal of behavioral nutrition and physical activity*, *14*(1), 1-27. https://doi.org/10.1186/s12966-017-0613-9

Song, Y., Preston, J., Ogilvie, D., & iConnect Consortium. (2017). New walking and cycling infrastructure and modal shift in the UK: a quasi-experimental panel study. *Transportation research part A: policy and practice*, *95*, 320-333. https://doi.org/10.1016/j.tra.2016.11.017

Stango, V., & Zinman, J. (2009). Exponential growth bias and household finance. *The Journal of Finance*, 64(6), 2807-2849.

Stappers, N. E. H., Van Kann, D. H. H., Ettema, D., De Vries, N. K., & Kremers, S. P. J. (2018). The effect of infrastructural changes in the built environment on physical activity, active transportation and sedentary behavior–a systematic review. *Health & place*, *53*, 135-149. https://doi.org/10.1016/j.healthplace.2018.08.002

Stewart, G., Anokye, N. K., & Pokhrel, S. (2015). What interventions increase commuter cycling? A systematic review. *BMJ open*, *5*(8), e007945. http://dx.doi.org/10.1136/bmjopen-2015-007945

Stinson, M. A., & Bhat, C. R. (2003). Commuter bicyclist route choice: Analysis using a stated preference survey. *Transportation research record*, *1828*(1), 107-115. https://doi.org/10.3141/1828-13

Sulikova, S., & Brand, C. (2022). Do information-based measures affect active travel, and if so, for whom, when and under what circumstances? Evidence from a longitudinal case-control study. *Transportation research part A: policy and practice*, *160*, 219-234. https://doi.org/10.1016/j.tra.2022.03.021

Szell, M., Mimar, S., Perlman, T., Ghoshal, G., & Sinatra, R. (2022). Growing urban bicycle networks. *Scientific reports*, *12*(1), 1-14. https://doi.org/10.1038/s41598-022-10783-y

Teixeira, I. P., da Silva, A. N. R., Schwanen, T., Manzato, G. G., Dörrzapf, L., Zeile, P., ... & Botteldooren, D. (2020). Does cycling infrastructure reduce stress biomarkers in commuting cyclists? A comparison of five European cities. *Journal of Transport Geography*, *88*, 102830. https://doi.org/10.1016/j.jtrangeo.2020.102830

Thaler, R. (1980). Toward a positive theory of consumer choice. *Journal of economic behavior & organization*, *1*(1), 39-60. https://doi.org/10.1016/0167-2681(80)90051-7

Thomas, B., & DeRobertis, M. (2013). The safety of urban cycle tracks: A review of the literature. *Accident Analysis & Prevention*, *52*, 219-227. https://doi.org/10.1016/j.aap.2012.12.017

Thompson, J., Wijnands, J. S., Savino, G., Lawrence, B., & Stevenson, M. (2017). Estimating the safety benefit of separated cycling infrastructure adjusted for behavioral adaptation among drivers; an application of agent-based modelling. *Transportation research part F: traffic psychology and behaviour*, *49*, 18-28. https://doi.org/10.1016/j.trf.2017.05.006

Tilahun, N. Y., Levinson, D. M., & Krizek, K. J. (2007). Trails, lanes, or traffic: Valuing bicycle facilities with an adaptive stated preference survey. *Transportation Research Part A: Policy and Practice*, *41*(4), 287-301. https://doi.org/10.1016/j.tra.2006.09.007

Timmons, S., & Lunn, P. (2022). Public understanding of climate change and support for mitigation. *Economic and Social Research Institute (ESRI) Research Series Report No. 135.* https://doi.org/10.26504/rs135

Van Cauwenberg, J., Clarys, P., De Bourdeaudhuij, I., Ghekiere, A., De Geus, B., Owen, N., & Deforche, B. (2018). Environmental influences on older adults' transportation cycling experiences: A study using bike-along interviews. *Landscape and urban planning*, *169*, 37-46. https://doi.org/10.1016/j.landurbplan.2017.08.003

Vera-Villarroel, P., Contreras, D., Lillo, S., Beyle, C., Segovia, A., Rojo, N., ... & Oyarzo, F. (2016). Perception of safety and liking associated to the colour intervention of bike lanes: contribution from the behavioural sciences to urban design and wellbeing. *Plos one*, *11*(8), e0160399. https://doi.org/10.1371/journal.pone.0160399

Verduzco Torres, J. R., Hong, J., & McArthur, D. P. (2022). How do psychological, habitual and built environment factors influence cycling in a city with a well-connected cycling infrastructure?. *International Journal of Urban Sciences*, *26*(3), 478-498. https://doi.org/10.1080/12265934.2021.1930111

Volker, J. M., & Handy, S. (2021). Economic impacts on local businesses of investments in bicycle and pedestrian infrastructure: a review of the evidence. *Transport reviews*, *41*(4), 401-431. https://doi.org/10.1080/01441647.2021.1912849

Vreugdenhil, R., & Williams, S. (2013). White line fever: a sociotechnical perspective on the contested implementation of an urban bike lane network. *Area*, *45*(3), 283-291. https://doi.org/10.1111/area.12029

Walter, N., & Tukachinsky, R. (2020). A meta-analytic examination of the continued influence of misinformation in the face of correction: How powerful is it, why does it happen, and how to stop it?. *Communication research*, *47*(2), 155-177. https://doi.org/10.1177/0093650219854600

Whitehurst, D. G., DeVries, D. N., Fuller, D., & Winters, M. (2021). An economic analysis of the health-related benefits associated with bicycle infrastructure investment in three Canadian cities. *PLoS one*, *16*(2), e0246419. https://doi.org/10.1371/journal.pone.0251031

Wild, K., Woodward, A., Field, A., & Macmillan, A. (2018). Beyond 'bikelash': Engaging with community opposition to cycle lanes. *Mobilities*, *13*(4), 505-519. https://doi.org/10.1080/17450101.2017.1408950

Wilson, T. D., & Gilbert, D. T. (2005). Affective forecasting: Knowing what to want. *Current directions in psychological science*, 14(3), 131-134.

Wilson, A., & Mitra, R. (2020). Implementing cycling infrastructure in a politicized space: Lessons from Toronto, Canada. *Journal of Transport Geography*, *86*, 102760. https://doi.org/10.1016/j.jtrangeo.2020.102760

Winters, M., Buehler, R., & Götschi, T. (2017). Policies to promote active travel: evidence from reviews of the literature. *Current environmental health reports*, *4*(3), 278-285. https://doi.org/10.1007/s40572-017-0148-x

Woodcock, J., Givoni, M., & Morgan, A. S. (2013). Health impact modelling of active travel visions for England and Wales using an Integrated Transport and Health Impact Modelling Tool (ITHIM). *PloS one*, *8*(1), e51462. https://doi.org/10.1371/journal.pone.0051462

Wynes, S., & Nicholas, K. A. (2017). The climate mitigation gap: education and government recommendations miss the most effective individual actions. *Environmental Research Letters*, *12*(7), 074024. https://doi.org/10.1088/1748-9326/aa7541

Yang, L., Sahlqvist, S., McMinn, A., Griffin, S. J., & Ogilvie, D. (2010). Interventions to promote cycling: systematic review. *BMJ, 341*. https://doi.org/10.1136/bmj.c5293

Yang, Y., Sasaki, K., Cheng, L., & Liu, X. (2022b). Gender differences in active travel among older adults: non-linear built environment insights. *Transportation research part D: transport and environment*, *110*, 103405. https://doi.org/10.1016/j.trd.2022.103405

Yang, Y., Sasaki, K., Cheng, L., & Tao, S. (2022a). Does the built environment matter for active travel among older adults: Insights from Chiba City, Japan. *Journal of Transport Geography*, *101*, 103338. https://doi.org/10.1016/j.jtrangeo.2022.103338