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Could smart research ensure healthy people in disrupted cities?

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ABSTRACT

Background: Since the late 19th century, city planners have struggled to cope with new types of urban transport and mobility that threatened the existing system, or even rendered it obsolete.

Purpose: As city planners confront the range of disruptive urban mobilities currently on the horizon, this paper explores how we can draw on a vast body of evidence to anticipate and avoid unintended consequences to people’s health and wellbeing.

Methods: This commentary involved a rapid review of the literature on transport disruption.

Results: We found that to avoid the unintended consequences of disruption, research, policy and practice must think beyond single issues (such as the risk of chronic disease, injury, or traffic management) and consider the broader consequences of interventions. For example, although autonomous vehicles will probably reduce road trauma, what will be the negative consequences for physical inactivity, sedentary behavior, chronic disease, land use, traffic congestion and commuting patterns? Research is needed that considers and informs how to mitigate the range of potential harms caused by disruptive mobilities.

Conclusion: In the face of new disruptive mobilities, we must: (a) draw on existing evidence to shape new regulations that address the ‘who, when and where’ rules of introducing new mobilities (such as electric assisted bicycles (e-bikes) and scooters (e-scooters)) of which the health repercussions can be easily anticipated; (b) monitor and evaluate the implementation of any interventions through natural experiment studies; and (c) use innovative research methods (such as agent-based simulation and health-impact-assessment modelling) to assess the likely effects of emerging disruptive mobilities (e.g., autonomous vehicles) on health and wellbeing and on the environment.

1. Introduction

Concerns about disruptions caused by urban mobility in cities are not new. At the turn of the 19th century, planners of rapidly industrialising cities were faced with disruptions caused by horse-drawn transportation (Kohlstedt, 2017; Morris, 2007). In London, in what became known as the ‘Great Horse Manure Crisis’, more than 50,000 horses were drawing 11,000 hansom cabs and several thousand buses (Morris, 2007). With each horse producing around 7–16 kg of manure each day, city planners were struggling to manage the disposal of around 18–41 million kilograms of manure annually.

Yet all this changed relatively quickly, with various urban mobility disruptions: first came the bicycle, then the motor vehicle. In the
late 1800s, major cities in the United Kingdom (Rubinstein, 1977) and the United States (Tobin, 1974) experienced a ‘bicycle craze’ with the rapid uptake of cycling. This followed significant technological advancements in bicycles: equal-sized wheels were introduced in 1886, and air-filled rubber tyres arrived two years later (Tobin, 1974). Buoyed by the freedom offered by ‘personal mobility’ (Rubinstein, 1977), city-dwellers began cycling. This had significant effects on the economy, with the rapid rise of a bicycle industry, which included bicycle factories, tyre makers and retailers, and complementary services such as repair shops and cycling clothing (Tobin, 1974). A disproportionate number of cyclists were from the upper and middle classes, and before long cyclists became a political force, advocating for road improvements. For example, in the United States the ‘Good Roads’ campaign aimed at reducing cycling injuries and preventing punctures by improving the quality of roads (Rubinstein, 1977; Tobin, 1974).

2. Disruptions and unintended consequences brought by private motorized transport

However, perhaps the greatest disruptor to urban mobility, and the longest lasting – still affecting cities and health and wellbeing in the 21st century – was the introduction of private motorized transportation (Giles-Corti et al., 2010). The introduction of non-horse powered public transport in the early 20th century was soon followed by privately owned motorized transportation. At first this was available only to the wealthy, but when Henry Ford began acting on his dream of making ‘motor vehicles affordable for the masses’ (Kjellstrom and Hinde, 2007), the full effect of this major disruptor became apparent. The uptake of privately owned motor vehicles radically changed where and how people lived, worked, shopped and socialized, and ultimately how cities and communities were planned and built (Giles-Corti et al., 2010). As illustrated by example in Fig. 1, cities were no longer being built around walking and the public transport system, but rather to facilitate and accommodate private motor vehicle transportation.

However, more immediate unintended consequences of the disruption caused by private motorized transportation soon became apparent: principally, road trauma. In 1924, an article in The American Journal of Public Health discussed public health hazards caused by the automobile (Chesley, 1924). While acknowledging the enormous benefits of motorized transportation, author A.J. Chesley, executive officer of the Minnesota State Board of Health, reported that ‘Mortality records everywhere show marked, rapid and mounting increase in the number of deaths due to automobile accidents’ (p. 917). And beyond road trauma, he reported a myriad of other causes of auto-related fatalities, including carbon monoxide poisoning, and industrial hazards from the production and maintenance of vehicles. He also predicted an increase in diabetes in people who ‘should’ be walking but were now riding in motor vehicles.

By the 1930s, the scale of the difficulties confronting policymakers was evident. Reflecting on the expanding role of public health in the

Fig. 1. Perth, Western Australia: growth in urban sprawl following introduction of private motor vehicles in the mid-20th century (source: (Weiler, 2009)).
United States, in 1938 the editors of The American Journal of Public Health argued that motor vehicle trauma was ‘the next most urgent demand for consideration’ in public health, noting that in 1937 there had been 37,000 deaths from automobile collisions, and 1.25 million injuries of varying levels of severity. They argued that this ‘wholesale slaughter’ was ‘without parallel outside of America’ (Editorial, 1938 p. 194), and called for an urgent public health response.

Unquestionably, living in a city with high motor vehicle dependency brought many benefits: greater personal mobility, access to employment and services beyond one’s immediate neighborhood (Kjellstrom and Hinde, 2007), opportunities to live in a larger home in the suburbs, and real and perceived improvements to quality of life due to easier access to a wider region. Nevertheless, by the late 20th and early 21st centuries, the problems arising from cities designed for privately owned vehicles were clear. Combined with rapid urbanization and population growth, car-centric city design has led to unhealthy and unsustainable lifestyles, including increasing levels of sedentariness and physical inactivity, overweight and obesity, as well as traffic congestion, air pollution, and greenhouse gas emissions (Giles-Corti et al., 2016; Owen et al., 2014; Watts et al., 2015). This has been to the significant detriment of human health and to the built and natural environment (Bratman et al., 2019).

Ever since Henry Ford articulated a vision that motor vehicle ownership should be enjoyed by the masses, private motor vehicle transportation was prioritized at the expense of sustainable transport modes such as walking, cycling and public transport (Watts et al., 2015), with significant repercussions for the health of people and the environment (Giles-Corti et al., 2016). The number of privately owned vehicles has grown to around one billion globally and is predicted to double in the next decade (Crayton and Meier, 2017). An estimated 10 billion trips are made every day around the world, a figure expected to triple by 2050 (Thomopoulos and Givoni, 2015a). Cities now generate 75% of energy-related greenhouse gas emissions (Frumkin and Haines, 2019), with estimates that transport is responsible for around 23% of these, with road transportation generating around 72% of the total transport-sector emissions (United Nations Human Settlements Programme (UN Habitat, 2011). Although road and motor vehicle safety have improved over time, each year there are still 1.35 million road deaths and 20–50 million traffic-related injuries (World Health Organization, 2018b).

Perhaps even more importantly, private motorized transportation has led to low-density sprawling cities with high levels of motor vehicle dependency, vehicle kilometers travelled, traffic-related air pollution, traffic congestion, greenhouse gas emissions (Stone, 2008), physical inactivity, sedentary behavior and overweight and obesity (Giles-Corti et al., 2016). The economic cost of mortality and morbidity associated with motorized transport is high, and avoidable. For example, motorized transport is a major contributor of air pollution in cities (Rojas-Rueda, 2020). A recent study by the Organization for Economic Co-operation and Development (OECD) estimated that for 41 countries, including 35 OECD and BRIC countries (Brazil, Russia, Indonesia, China and South Africa), air pollution caused 3.2 million deaths at an economic cost of US$5.3 trillion in 2015. The cost of morbidity is less well established. Recent estimates for Europe indicate that it represents approximately 10% of the cost of mortality (WHO Regional Office for Europe and OECD, 2015). These individual, social and environmental risks directly and indirectly affect people’s health, including major chronic diseases, mental illness, and even infectious diseases, and ultimately the liveability and sustainability of cities (Giles-Corti et al., 2016). City planning that favors private motorized transportation also increases health and spatial inequities, because people living in low-density, low-walkable housing developments on the urban fringe often have poor access to services and public transportation (Lowe et al., 2020). This reduces the potential to use active modes of transport, forces car ownership upon low-income householders in order to reach employment and basic services, and increases household expenditure on transportation (Currie, 2018), which in turn increases mortgage stress (Dodson and Sipe, 2008).

3. What are the implications for current and future disruptions?

Today, a host of urban mobility disrupters are on the horizon, and researchers and decision-makers must learn from the history of private motorized transportation to anticipate, and where possible, avoid harm. Unquestionably, the most unexpected disruption to transportation across the world has been the global COVID-19 pandemic, which has seen unprecedented improvements in air quality as lockdowns have restricted mobility and private motor vehicle use (Yosufzai, 2020), public transport use plummet for fear of disease transmission, a bicycle boom reminiscent of the late 1800s (Mark, 2020) with demands for more road space and safe pop-up cycling infrastructure to be provided, and more space being allocated to pedestrians to enable physical distancing (Ottmann, 2020). With most countries currently experiencing second wave transmissions, the long-term impacts of this global disruption and rapid transition is yet unknown. However, Currie (2020) argues that fears that private motor vehicle travel will replace public transport in the long term is alarmist, based on experience of public transport use bounced-back in SARS-affected Asian cities.

Given the significant health gains from being physically active, active transport (walking and cycling) is an important way to encourage more people to be more active more often (World Health Organization, 2018a). Hence, the long-term impacts of this unprecedented massive natural experiment study of a rapid transition to sustainable activity mobility, is ripe for evaluation. It has enabled changes and investments in infrastructure that would typically have taken decades. However, will these be short- or long-term changes; and what will be the positive and negative effects of this transition? Similarly, what will be the effects of complementary disruptions from new motorized transportation that are on the horizon? To illustrate this point, here we consider the example of e-bikes and e-scooters.

Electric assisted bicycles (e-bikes) offering speeds of up to 25 km per hour (km/h) (or more if pedal assisted) are growing in popularity (MacArthur et al., 2014), with the global market expected to be US$23.8 billion by 2025 (Wagner, 2018). They overcome many of the barriers raised about other forms of active transportation (Leger et al., 2019; Van Cauwenberg et al., 2019) by making cycling easier and more palatable for a wider range of people, particularly in hillier areas (Van Cauwenberg et al., 2019) and in hotter climates.

Nevertheless, the health benefits of this new mobility disruptor were unknown until recently, when Bourne and colleagues...
examined the evidence (Bourne et al., 2018). They reviewed e-bike experiments and longitudinal observational studies of interventions involving adults, to assess the physical activity, cardio-respiratory, metabolic and psychological benefits of e-cycling. They concluded that ‘E-cycling can contribute to meeting physical activity recommendations and increasing physical fitness. As such, e-bikes offer a potential alternative to conventional cycling’ (p. 15). However, their paper did not discuss the consequences of e-cycling for road injuries, despite growing evidence of this type of harm.

While to date many e-bikes travel up to 25 km/h, peddle assisted e-bikes known as ‘pedelecs’ can travel considerably faster (Schleinitz, 2017). A growing Wikipedia entry on Electric Bicycle Laws (https://en.wikipedia.org/wiki/Electric_bicycle_laws), suggests there are inconsistent regulations across jurisdictions about permitted speeds of e-bikes, who can use them and where. This is raising concerns given growing cycling injuries and fatalities (Schleinitz, 2017). For example, a case-control study of emergency department admissions of patients aged 16 years and older for cycling-related road trauma concluded that e-bike cyclists were more likely than mechanical-bike cyclists to be admitted to hospital for injuries, although they found no difference in the severity of injuries (Schepers et al., 2014). But paediatric injuries tell a different story. For children, there is evidence suggesting that the severity of injuries is higher for e-bikes compared with mechanical-bikes, particularly among children aged 12 years and older (Zmora et al., 2019). As the popularity of e-bikes grows and sales mount, there is an urgent need for policies that ‘minimize the risk and maximize the health benefits for users of electric bicycles’ (Schepers et al., 2014) p.174.

Similar concerns equally apply to electric scooters or ‘e-scooters’. Powered by a rechargeable battery with a top speed of around 24 km/h, e-scooters can be either individually owned and shared (Sipe and Pojani, 2018). Commercial fleets of dockless e-scooters are now appearing in cities across the globe (Aizpuru et al., 2019; Sikka et al., 2019). Yet they have already been banned or restricted in some cities, due to conflicts between pedestrians and other road users, and growing concern about injuries (CNN, 2019).

It is hardly surprising that without policies and rules to control the ‘who, what and where’ of use, there will be a rise in e-bike and e-scooter injuries. Rules and regulations are needed about who (adults, children) should ride-bikes and e-scooters, where (footpaths, roads, cycle paths) and under what conditions (such as wearing helmets). Without suitable regulation, there will be a rise in e-bike and e-scooter-related road (and footpath) trauma, and an even heavier burden on already overloaded emergency services (Mayhew and Bergin, 2019).

Any benefits that might come from the implementation of new forms of urban mobility – whether e-scooters, e-bikes or the next innovation – will be undermined unless we anticipate the unintended consequences. We must capitalise on a century of (often government-funded) research and knowledge on how to maximize the benefits and minimize the harms of various forms of transportation. Unlike decision-makers who were confronted by disruptive new forms of urban mobility at the turn of the 19th century, as innovations emerge in the 21st-century, decision-makers could and should draw on the vast body of research available. This would ensure we have evidence-informed policy designed to reduce risk and maximize benefit.

4. What can we learn from these mini 21st-century disruptors, that could be applied to the major disruptions on the horizon?

New forms of e-transportation have been mildly disruptive to date. However, these modest effects will be overshadowed by what has been called the trifecta of approaching disruptions: shared mobility, electrification, and autonomous vehicles (Fox-Penner et al., 2018). The potential health and environmental effects of the electrification of vehicles are not considered here, however emerging evidence is already signalling potential difficulties with the widespread uptake of shared mobility and autonomous vehicles.

4.1. Shared mobility

Shared mobility is a growing area of interest, with considerable public discourse and debates in the literature about whether the introduction of autonomous vehicles will result in more vehicles being shared. This debate is considered briefly below. However, the focus of this section is on one specific type of shared mobility, which has caused major disruptions in cities in recent years: ridesharing (or hailing) services. Ride-sharing service companies such as Uber and Lyft match drivers of private vehicles to people seeking transportation. In 2017, Clewlow and Mishra estimated that in their first five years of operation, these ride-sharing services attracted around 250 million trips globally (Clewlow and Mishra, 2017). Although one could argue that ridesharing serves the same purpose as traditional taxis, these new services seem to attract a different clientele. Clewlow and Mishra found that between 49% and 61% of ride-sharing services either replaced a pedestrian, cycling or transit trip, or would not have occurred at all. Indeed, they concluded that ride-sharing services are likely to increase vehicle kilometers travelled, by encouraging more motorized trips and competing with public transport (Clewlow and Mishra, 2017). This forecast is confirmed by Erhardt and colleagues’ study in San Francisco (Erhardt et al., 2019). They found that Uber and Lyft trips were the major contributor to the city’s 62% increase in weekday traffic congestion.

Hence, a major question for the transport and health research field is: what will be the health and environmental consequences of increasing use of ride-sharing services, particularly if they replace short, incidental, active-transport trips with motorized transport? Similarly, urban air mobility or urban aviation—also known as passenger drones or ‘flying taxis’—is already being tested in cities across the globe (Editorial, 2019). However, are the physical, mental and ecosystem health effects of urban aviation being considered? Moreover, if their introduction is inevitable, how – if at all – can we avoid any harm to health, wellbeing and the environment (including the effects on birds and biodiversity)?
4.2. Autonomous vehicles

These concerns apply equally to autonomous vehicles. It is estimated that, by 2040, around 40% of motor vehicle travel could be autonomous (self-driving) (Litman, 2020), with many driverless vehicles ‘shared’ (Editorial, 2019), and private vehicle ownership falling by 50%. Arguing in favour of the health and other benefits of autonomous vehicles, some estimate that fuel consumption will drop by between 25% and 80% with automation, due to less braking and acceleration, and that greenhouse gas emissions will reduce by between 5% and 60%, depending upon fuel source and vehicle miles travelled (Kopelias et al., 2020; Pettigrew, 2017). With predictions that private motor vehicle ownership will decline, it is envisaged that the amount of road space required to accommodate vehicles will be reduced, and this space could be re-purposed for trees, public open space and cycling infrastructure. At the same time, if vehicles are shared, car parking requirements could also decline, and parking spaces could also be re-purposed (Kane and Whitehead, 2017).

Considerable health benefits from the introduction of autonomous vehicles are also anticipated. For transport-disadvantaged subgroups such as older adults, people with disabilities, children and those living in areas poorly served by public transport, autonomous vehicles offer the potential to enhance their mobility, connect them to their community and services, and to reduce social isolation (Pettigrew, 2017). Moreover, as human error is removed from driving (Infrastructure Victoria, 2018; Pettigrew, 2017), a massive reduction in road trauma and associated health costs is predicted. In addition, as autonomous vehicles are likely to be electric, air quality will improve and there will be less traffic-related noise.

However, other authors are more cautious (Anderson et al., 2014) or sceptical (Maughan, 2019), because the ‘devil is in the detail’ (Duarte and Ratti, 2018; Kane and Whitehead, 2017). They caution that the benefits of autonomous vehicles will depend on the regulatory frameworks and rules adopted to manage their introduction (Brodsky, 2016; Kane and Whitehead, 2017; Tan et al., 2019). For example, some researchers doubt that there will be widespread acceptance of shared vehicles and ‘mobility as a service’ (Thompson and Givoni, 2015b), given the many intrinsic and extrinsic motivations for private motor vehicle ownership, and the motor vehicle industry’s significant investment in automation technology (Mertz, 2018). Others argue that private autonomous vehicle ownership will prevail, unless there are concerted efforts to manage demand (such as road-charging) (Bagloee et al., 2016). These cautions cast doubt on the touted benefits of freeing up road and car-parking spaces.

Indeed, others raise concerns that driverless vehicles may increase motor vehicle kilometres travelled (Bagloee et al., 2016; Duarte and Ratti, 2018; Fagnant and Kockelman, 2014, 2015), possibly resulting in: (1) further urban sprawl, as city dwellers will be able to live even further away from employment and use their travel time for activities such as sleeping and working; (2) vehicles circling the city or returning home rather than paying for parking; (3) those traditionally immobile such as the elderly and/or children, taking more trips; and (4) privately owned vehicles being shared by several family members – including children and older relatives – resulting in more trips due to multiple drop-offs and pick-ups throughout the day.

The land-use, social and environmental consequences of autonomous vehicles are yet to be estimated. As autonomous vehicles are adopted, if land-use and transport planning fail to favour active transportation, active modes will decline, and vehicle kilometres travelled will increase. The uptake and use of autonomous vehicles will be determined by the regulatory frameworks and demand-management strategies that will govern their operation, and ultimately by how individuals use them. For example, if autonomous vehicle trips replace active modes such as walking and cycling, chronic diseases are likely to increase, due to reductions in physical activity and increases in sedentary behavior and increases in overweight and obesity. This will be compounded if land use decisions encourage people to live further away from employment to take advantage of more affordable housing on the urban fringe.

5. Could smart research ensure that we have healthy people in disrupted cities?

One theme of International Transport and Health Conference was ‘Smart Cities’. To date, the concept of ‘Smart’ cities has focused on technology. But smart cities are not just technologically enabled cities; technology alone cannot solve 21st-century problems. Truly smart cities will be those that protect the health and wellbeing of both people and the ecosystem. They will harness interdisciplinary technical, policy and social evidence to create solutions that maximize the benefits and minimize any harms arising from emerging technologies.

In this context, Smart Cities will be those that make use of ‘smart’ policy- and practice-relevant research that can inform decision-making. It is inevitable that cities will be disrupted by the new forms of urban mobility currently being introduced (such as e-bikes and e-scooters) or just on the horizon (such as urban aviation and autonomous vehicles). However, some of the foreseeable harms of their introduction could potentially be avoided, if evidence-informed policy was implemented and interventions were carefully monitored to assess unintended consequences.

Hence, the questions for transport and health researchers include: are they willing to modify their approach to research and undertake policy- and practice-research co-designed with policymakers and practitioners? And if so, what ‘smart’ policy- or practice-relevant research might help society and decision-makers anticipate and avert foreseeable harms caused by disruptive urban mobility, and enable them to put in place early-warning systems to alert them of unforeseen consequences? Conversely, for policymakers and practitioners, are they willing to form long-term trusted research partnerships with transport and health researchers, and to require that evidence is used to inform policy (Thackway et al., 2017; Giles-Corti et al., 2015)? This section provides examples of potentially fruitful lines of enquiry for researchers and policymakers and practitioners to pursue.
5.1. Evidence reviews and policy briefs

In the same way that Bourne and colleagues allayed concerns that e-bikes may be harmful to physical health (Bourne et al., 2018), prompt policy briefs or evidence reviews (Giles-Corti et al., 2015) developed in in partnership with policy-makers, could alert them to potential problems and solutions associated with new forms of urban mobility. Nevertheless, researchers must exercise care when conceptualising the problem and drawing conclusions.

For example, as highlighted above, although e-bikes appear to be an acceptable form of active transportation to reduce the risk of chronic disease, evidence is emerging that e-bikes may lead to more frequent and severe injuries, particularly in older children, than do mechanical bicycles. Transport and health researchers need to think comprehensively about the problem (Giles-Corti and King, 2009) in order to anticipate and attempt to avoid unintended consequences. Care needs to be given when writing papers, including abstracts, to alert busy decision-makers to other factors that need to be considered in developing policy. For example, an intervention might solve one problem (traffic congestion) yet exacerbate another (road trauma or chronic disease).

To this end, in the absence of evidence of the effects of new forms of mobility, to what extent can we extrapolate lessons from older modes of transport? For example, is there now a century of road safety evidence that clearly illustrates that a lack of regulation to govern who, where and under what circumstances people can use the road (and footpaths) will bring a rapid increase in road trauma (World Health Organization, 2018b). While we are waiting for new evidence to emerge, could we summarize relevant existing evidence in briefs to inform policies to support the introduction of (say) e-bikes or e-scooters, rather than wait for the inevitable road trauma that will follow? While there is no guarantee this evidence will be used, summarising existing evidence to support transport and health advocates, and in preparation for a policy-window to open is vital (Kingdon, 2010).

5.2. Using big data to identify solutions and inform policy

In smart cities, big data are collected and used to improve city management. Much of the drive behind smart city initiatives is to ease traffic congestion, and better utilise existing urban infrastructure, employing a large array of sensors to enable real-time analytics of transport data, including congestion and traffic incidents as well as responsive infrastructure that can adjust itself to meet the needs of its users, for example by adjusting the pricing of parking spaces (Lee et al., 2014). However, big data could be used proactively to rapidly test a variety of potential policies on the-ground, including using virtual laboratories.

Importantly, how could big data be used to improve health and wellbeing and the environment? For example, how could big data on cycling be used to identify cycling black spots and direct resources to interventions in a timely manner (Thompson et al., 2020)? Similarly, how could big data be used to monitor the introduction of new transport policies that affect a city to provide a timely evaluation of the consequences?

Another application of big data involves computer simulations. Urban planning and transport infrastructure are the foundations of cities, and significantly influence the health and wellbeing of urban dwellers. For this reason, virtual laboratories are now being used to assess the behavioral and environmental effects of proposed urban and transport infrastructure or policy reforms (Batty, 2013). The rise in use of big data facilitated by high computational power, and increasingly sophisticated simulation tools, have created many new possibilities and applications for simulation models, so that they can serve as a virtual laboratory for studying complex social systems, such as transport and urban systems.

5.3. Innovative, policy-relevant research methods

Previously we have argued that to translate active living research into policy – among other things – we need to understand the policy environment we are trying to change (Giles-Corti et al., 2015). We must formulate research projects in close collaboration with policy-makers and practitioners, design studies (including natural experiment studies of interventions) that are directly relevant to policy, and pursue research that understands the needs and preferences of the community (Giles-Corti et al., 2015). In the case of new urban mobilities, what policy-relevant innovative research methods could we use to simulate and predict the behavioral shifts, and health and environmental effects, of implementing transport and planning scenarios before their implementation?

In transport modelling, for example, traditional four-step demand models are focused on aggregate behaviors and zone-based traffic flow (McNally, 2007). As a result, they are often criticized for not considering the behavior and decision-making of individuals. New methods involving agent-based modelling, have made it possible to simulate detailed individual behavior, and through the micro-scale interactions of these individuals (i.e. agents), to generate the macro-scale behaviors within the system (Bhat and Koppelman, 1999). Because these novel techniques simulate behavior at the individual level, they are being used increasingly by planners to study urban and transportation systems in finer detail than is possible with the traditional four-step demand models (Bazzan, 2014), and to open up new possibilities for transport models, from modelling micro-mobility such as cycling at a macro scale to searching for a parking spot. The Multi-Agent Transport Simulation toolkit or MATSim (Andreas et al., 2016), is among the most widely used agent-based simulation platforms for modelling travel associated with daily activities (Bazzan and Klugl, 2014).

For example, simulation models can be created to study the effect of autonomous vehicles on road network efficiency, to simulate changes in transport behaviors (mode shift, route choice, trip frequency and length), to test the response of transport or urban scenarios, including the introduction of automated vehicles, and behavioral changes in certain sub-groups, such as older adults, children, or people with a disability. For example, in Melbourne, Australia, an agent-based model developed by Infrastructure Victoria has demonstrated that the introduction of automated vehicles is likely to bring significant reductions in road trauma (Infrastructure Victoria, 2018), but it does not consider the potential chronic disease effects of increasing vehicle kilometres travelled, and reduced
physical activity by active modes.

5.4. Predicting the health effects of changing behavior

Interest is growing in simulating the health, environmental and economic effects of changes in active travel (Brown et al., 2016; Chapman et al., 2018; Mueller et al., 2015). Research ranges from assessing hypothetical scenarios of shifts from motorized to active modes (such as a government’s active-travel aspirational targets) (Zapata-Diomedi et al., 2017), active transport interventions (bike-sharing scheme, urban developments) (Mueller et al., 2020; Woodcock et al., 2014; Zapata-Diomedi et al., 2019) and active transport policies (Macmillan et al., 2014). The World Health Organization developed a tool to measure the potential consequences of active-transport interventions on walking and cycling-related mortality and the environment (https://www.heatwalkingcycling.org/#homepage). Many high-income countries have published guidelines for assessing the health and environmental implications of transport (ATAP Steering Committee, 2019; Department of Transport, 2019; NZ Transport Agency, 2018).

Just as transport and public health academics are studying the effects of active transportation, there is enormous potential to forecast the health and environmental repercussions of the introduction of autonomous vehicles, by combining simulation research on behavior change caused by the introduction of autonomous vehicles previously described, with health and environmental effects research. Research designed collaboratively by academics and government officials is crucial if we are to understand the full implications of the autonomous vehicle disruption and have our findings used to create policies that will maximize societal wellbeing.

6. Conclusion

The theme of the 2019 International Conference on Transport and Health was Smart Cities. Disruptive Mobility. Healthy People. The central argument of this keynote address was that disruptions to urban mobility are not new. However, history tells us that without good regulatory frameworks governing the rules about the ‘who, where and under what conditions’ disruptive mobilities are to be introduced, avoidable harm is inevitable. Hence, to maintain the health and wellbeing of people (and the planet), smart cities will be those that use smart research. This means learning from the past to inform future urban mobility policies; establishing early-warning systems using evidence from natural experiment studies that benchmark and monitor the implementation of interventions over time to detect any unintended consequences; and using innovative computer science and health impact assessment methodologies to simulate and assess the health, environment and social consequences of new interventions before they are implemented. Given that the responsibility of government is to protect the health, safety and welfare of citizens, it is imperative that governments use the vast amount of publicly funded research that has been conducted across the globe over many decades, to maximize the benefits of innovation and minimize any harms. At the same time, if evidence is to inform policy in a rapidly changing, disruptive environment, transport and health research must be agile, drawing on the past to inform the future, being policy-relevant, and being co-designed with policymakers and practitioners to facilitate its translation into action. While there are no guarantees evidence will be used in the policymaking process, co-designing policy-relevant with policymakers and practitioners, gives it the best chance of being adopted when a policy window opens.

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References

Aizpuru, M., Farley, K.X., Rojas, J.C., Crawford, R.S., Moore, T.J., Wagner, E.R., 2019. Motorized scooter injuries in the era of scooter-shares: a review of the national electronic surveillance system. Am. J. Emerg. Med. 37, 1133–1138.
Anderson, J.M., Nidhi, K., Stanley, K.D., Sorenson, P., Samaras, C., Oluwatola, O.A., 2014. Autonomous Vehicle Technology: A Guide for Policymakers. Rand Corporation.
Andreas, H., Nagel, K., Axhausen, K.W., 2016. The Multi-Agent Transport Simulation MATSim. Ubiquity Press, London.
ATAP Steering Committee, 2019. Australian Transport Assessment and Planning (ATAP) Guidelines. Commonwealth Department of Infrastructure and Regional Development, Canberra.
Bagloee, S.A., Tavassoli, M., Asadi, M., Oliver, T., 2016. Autonomous vehicles: challenges, opportunities, and future implications for transportation policies. J. Mod. Transport. 24, 284–303.
Batty, M., 2013. The New Science of Cities. MIT Press, Cambridge, Mass.
Bazzan, A., 2014. Multiagent reinforcement learning in traffic and transportation. In: 2014 Ieee Symposium on Computational Intelligence in Vehicles and Transportation Systems (Civts) vols. ii-Vil.
Bazzan, A.L.C., Klugl, F., 2014. A review on agent-based technology for traffic and transportation. Knowl. Eng. Rev. 29, 375–403.
Bhat, C.R., Koppelman, F.S., 1999. Activity-based modeling of travel demand. In: RW, H. (Ed.), Handbook of Transportation Science. International Series in Operations Research & Management Science. Springer, Boston.
Bourne, J.E., Sauchelli, S., Perry, R., Page, A., Leary, S., England, C., Cooper, A.R., 2018. Health benefits of electrically-assisted cycling: a systematic review. Int. J. Behav. Nutr. Phys. Activ. 15, 116.
Sikka, N., Vila, C., Stratton, M., Ghassemi, M., Pourmand, A., 2019. Sharing the sidewalk: a case of E-scooter related pedestrian injury. Am. J. Emerg. Med. 37.
Sipe, N., Pojani, D., 2018. Can e-scooters solve the ‘last mile’ problem? They’ll need to avoid the fate of dockless bikes. The Conversation (18 Sept). https://theconversation.com/can-e-scooters-solve-the-last-mile-problem-theyll-need-to-avoid-the-fate-of-dockless-bikes-102633. (Accessed 31 July 2020).
Tan, Y., Mark, W., Md, K., 2019. Disruptive impacts of automated driving systems on the built environment and land use: an urban planner’s perspective. J. Open Innov.: Tech, Market Compl. 24.
Thackway, S., et al., 2017. A long-term, strategic approach to evidence generation and knowledge translation in NSW, Australia. Publ. Health Res. Pract. 27 (1).
Thomopoulos, N., Givoni, M., 2015a. The autonomous car—a blessing or a curse for the future of low carbon mobility? An exploration of likely vs. desirable outcomes. Eur. J. Futures Res. 3, 14.
Thomopoulos, N., Givoni, M.J., 2015b. The autonomous car—a blessing or a curse for the future of low carbon mobility? An exploration of likely vs. desirable outcomes. Eur. J. Futures Res. 3, 14.
Thompson, J., Stevenson, M., Wijnamds, J.S., Nice, K.A., Aschwanden, G.D., Silver, J., Nieuwenhuijsen, M., Rayner, P., Schofield, R., Hariharan, R., Morrison, C.N., 2020. A global analysis of urban design types and road transport injury: an image processing study. Lancet Planet Health 4, e32–e42.
Tobin, G.A., 1974. The bicycle boom of the 1890’s: the development of private transportation and the birth of the modern tourist. J. Pop Cult. VII 838–849.
United Nations Human Settlements Programme UN Habitat, 2011. Global Report on Human Settlements 2011. Cities and Climate Change. Earthscan, London.
Van Cauwenberg, J., De Bourdeaudhuij, I., Clarys, P., de Geus, B., Deforche, B., 2019. E-bikes among older adults: benefits, disadvantages, usage and crash characteristics. Transportation 46, 2151–2172.
Wagner, I., 2018. Size of the Global Market for Electric Bicycles in 2017 and 2025 Statista. Hamburg.
Watts, N., Adger, W.N., Agnolucci, P., Blackstock, J., Byass, P., Cai, W., Chaytor, S., Colbourn, T., Collins, M., Cooper, A., Cox, P.M., Depledge, J., Drummond, P., Ekins, P., Galaz, V., Grace, D., Graham, H., Grubb, M., Haines, A., Hamilton, I., Hunter, A., Jiang, X., Li, M., Kelman, I., Liang, L., Lott, M., Lowe, R., Luo, Y., Mace, G., Maslin, M., Nilsson, M., Oreszczyn, T., Pye, S., Quinn, T., Svedsotender, M., Venevsky, S., Warner, K., Xu, B., Yang, J., Yin, Y., Yu, C., Zhang, Q., Gong, P., Montgomery, H., Costello, A., 2015. Health and climate change: policy responses to protect public health. Lancet 386, 1861–1914.
Woodcock, J., Tainio, M., Cheshire, J., O’Brien, O., Goodman, A., 2014. Health effects of the London bicycle sharing system: health impact modelling study. BMJ 348, g425.
Weller, R., 2009. Boomtown 2050: Scenarios for a Rapidly Growing City. UWA Publishing, Perth.
WHO Regional Office for Europe, OECD, 2015. Economic Cost of the Health Impact of Air Pollution in Europe: Clean Air, Health and Wealth. WHO Regional Office for Europe, Copenhagen.
World Health Organization, 2018a. Global Action Plan on Physical Activity 2018-2030. WHO, Geneva, Switz.
World Health Organization, 2018b. Global Status Report on Road Safety 2018. WHO, Geneva, Switz.
Yosufzai, R., 2020. How the Coronavirus Crisis Is Helping Improve the Environment across the World. SBS News accessed 2 August, 2020. https://www.sbs.com.au/news/how-the-coronavirus-crisis-is-helping-improve-the-environment-across-the-world.
Zapata-Diomedi, B., Boulang, C., Giles-Corti, B., Phelan, K., Washington, S., Veereman, J.L., Gunn, I.D., 2019. Physical activity-related health and economic benefits of building walkable neighbourhoods: a modelled comparison between brownfield and greenfield developments. Int. J. Behav. Nutr. Phys. Activ. 16, 11.
Zapata-Diomedi, B., Knibbs, L.D., Ware, R.S., Heesch, K.C., Tainio, M., Woodcock, J., Veerman, J.L., 2017. A shift from motorised travel to active transport: what are the potential health gains for an Australian city? PloS One 12, e0184799.
Zmora, O., Peleg, K., Klein, Y., 2019. Pediatric electric bicycle injuries and comparison to other pediatric traffic injuries. Traffic Inj. Prev. 20, 540–543.