CHAPTER SEVEN

Transport and community severance

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What is community severance?

Transport-related community severance is the "barrier effect" of transport infrastructure, or vehicles using that infrastructure, on the movement of pedestrians and cyclists, impeding access to the goods, services, and social networks necessary for a healthy and fulfilling life. Barriers from infrastructure include linear infrastructure such as motorways (or other roads with physical barriers preventing pedestrians from crossing), railways, rivers, and canals. These barriers cause what is sometimes referred to as "static severance," to distinguish it from the "dynamic severance" caused by the number, characteristics, and speed of motor vehicles. Roads with high volume of traffic tend to cause dynamic severance, especially when there is a high proportion of heavy goods vehicles in the traffic, or when traffic is moving at a fast speed (Anciaes et al., 2019). Fig. 7.1 shows

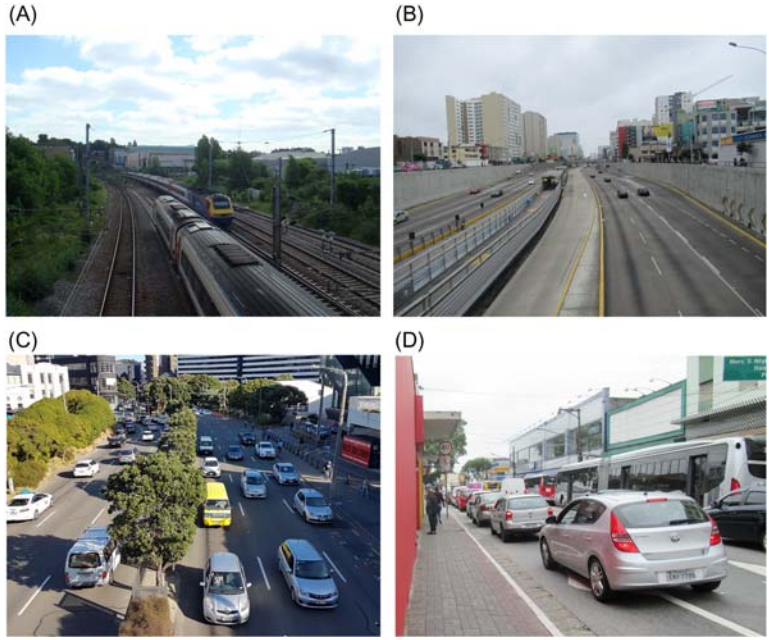

Figure 7.1 Different types of severance.
Static severance: (A) railway and (B) road with physical barriers.
Dynamic severance: (C) busy 6-lane road and (D) congested minor road. *(A) London, UK © P Anciaes, 2016; (B) Lima, Peru © P Anciaes, 2017; (C) Wellington, New Zealand © J Mindell, 2019; and (D) São Paulo, Brazil © P Anciaes, 2017.*

examples of different types of static and dynamic severances, which can occur in high-, middle-, or low-income countries and in urban or rural areas (Bradbury, 2014).

Many definitions of community severance exist (Anciaes, 2015; Mindell and Karlsen, 2012). Three stand out through focussing on the area surrounding roads and other transport infrastructure, rather than merely on the line of the transport infrastructure itself (Box 7.1).

BOX 7.1 Three of the many definitions of community severance

James et al. (2005): *The existence of real or perceived barrier to people's movement through an area that is created by the transport infrastructure (such as roads or railways) or traffic.*

Quigley and Thornley (2011): *Separation of people from facilities, services, and social networks they wish to use within their community; changes in comfort and attractiveness of areas; and/or people changing travel patterns due to the physical, traffic flow, and/or psychological barriers created by transport corridors and their use.*

Street Mobility team: *The variable and cumulative negative impact of the presence of transport infrastructure or motorized traffic on the perceptions, behavior, and well-being of people who use the surrounding areas or need to make trips along or across that infrastructure or traffic* (Anciaes, 2015; Mindell et al., 2017).

Community severance caused by linear infrastructure is particularly impactful in urban neighborhoods that are near other large single-use areas, such as non-linear transport infrastructure (e.g., airports, ports, and stations), industrial estates, and even hospitals and university campuses, which tend to have poor permeability for pedestrians (Héran, 2011). In some extreme cases, residential neighborhoods become "locked-in" because they are surrounded by transport and non-transport barriers on all sides.

While most existing research has focused on the role of transport infrastructures as physical barriers that are difficult to cross, these infrastructures may also be perceived as psychological barriers even when it is easy to cross them, due to their negative visual impact.

What are the effects of community severance?

Travel

Fig. 7.2 shows the hypothesized deterrent effects of *dynamic severance*, namely motorized traffic, on travel and the use of streets as social spaces. Traffic volume and speed increase the length of trips across the road, especially by walking and cycling, as people detour from the shortest paths in order to cross the road in safe places.

For people traveling along, across, or near a busy road, the noise and air pollution from motor vehicles also result in an unpleasant environment that reduces the likelihood of making trips on foot or by cycle, decreasing physical activity and leading either to journeys not made or to journeys made by motor vehicle (Duncan et al., 2005; Jacobsen et al., 2009; Saelens and Handy, 2008). The unpleasantness of busy streets also combines with a fear of road travel collisions to reduce permissions for children to travel independently and the use of social spaces for people of all ages, but particularly the old and the young.

As shown in the Fig. 7.2, the negative effects on physical activity, journeys not made, and use of streets as social spaces may be associated with indirect effects in terms of a reduced level of access to services, goods

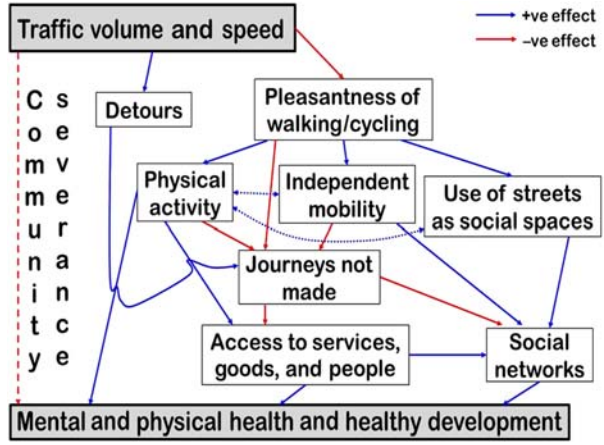

Figure 7.2 Theoretical paths from traffic-related severance to health impacts. Figure 1 in *Mindell, J.S., Karlsen, S., 2012. Community severance and health: what do we actually know?. J. Urban. Health 89, 232–246. Available from: https://doi.org/10.1007/s11524-011-9637-7.*

and people, and weaker social networks. These effects are then associated with mental and physical health and healthy development.

Static severance caused by transport infrastructure such as motorways and railways has similar effects except that the impact on the pleasantness of active travel is perhaps less relevant (because pedestrians and cyclists are usually not allowed to use that infrastructure). However, the detours are generally longer than in the case of dynamic severance, sometimes extending to many miles. In the case of railways, any crossing points that are available will generally be footbridges or underpasses. There are plans in several cities to remove a large proportion of unsignalized level crossings across railway lines to improve safety (see, e.g., https://levelcrossings.vic.gov.au/projects). However, in some cases, these plans may have the effect of exacerbating community severance (Mepham, 2016). In the United Kingdom, 1100 level crossings were removed in 2009–17 (https://www.networkrail.co.uk/communities/safety-in-the-community/level-crossing-safety/).

Independent mobility

Older people's independent mobility is a prerequisite for independent living in one's own home (Siren et al., 2015). Relating to the lack of mobility, Murray (2015) has differentiated between unmet demand, suppressed demand, systematic barriers to mobility, and aspirational mobility. Others refer to primary mobility—relating to the capacity to walk—and secondary mobility, reliance on motor vehicles, whether private or public transport (Silverstein et al., 2017). Those who are housebound are at high risk of both loneliness (a subjective feeling) and of isolation.

Children's independent mobility has been curbed dramatically over the past five decades in many countries. In England, 55% of children under 10 were allowed to walk to local places other than school in 1971 but by 2010, hardly any children were given such permission (Shaw et al., 2015). The proportion traveling to school without an adult or being allowed to play outdoors varies (Carver et al., 2014). A comparison across 16 countries in three continents found wide variation. Children in Finland and Germany had the greatest freedom to cycle on a main road, cross main roads, travel home from school, or go out after dark alone. The strongest predictor affecting permissions for children was motor traffic, with only a weak effect of concerns about "stranger danger" (Shaw et al., 2015).

Economic effects

Barriers to walking and cycling can limit easy access to employment, with direct economic consequences. Reduced access to education has indirect economic effects, as educational attainment and subsequent income are so closely linked.

In general, pedestrianization and reductions in car traffic increase expenditure in local businesses (Mindell, 2015). Pedestrianization is associated with a 20%–40% increase in visits to local retailers and a 10%–25% increase in retail turnover (Tolley, 2011). The travel mode is associated with spend on a single visit in some (TfL, 2011, 2013) but not all studies (Wooller, 2010). However, studies consistently find more frequent visits by non-car users, so expenditure over time is lower for car users than for those using active travel or public transport (Mindell, 2015). Thus the deterrent effects of community severance that result in journeys not made at all or not made by walking or cycling are likely to have noticeable adverse effects on local businesses.

Trips not made by older people can also result in losses to the economy, not only from direct expenditure not made but also through volunteer work and childcare not provided due to the lack of travel options (Mackett, 2015).

Social cohesion

There is consistent evidence that barriers to pedestrian mobility caused by busy roads reduce social interaction between people living on opposite sides of the road (Appleyard et al., 1981; Hart and Parkhurst, 2011; Sauter and Huettenmoser, 2008; Wiki et al., 2018). There is also some evidence that large transport infrastructures contribute to the discontinuity of urban space and induce the relocation of people from different income and ethnic groups, reinforcing spatial segregation (King and Blackmore, 2013; Mitchell and Lee, 2014; Noonan, 2005). They may also induce social problems such as crime due to low footfall in the surrounding areas (Jacobs, 1961).

Long-term effects

In all these cases the effects of a change, such as construction of a new railway or road, may be different from the long-term effects of an existing barrier, due to adaptation by local residents or migration of people after the barrier existed. For example, Lee and Tagg (1976) compared

communities that were separated by roads built in different periods and found that over time the communities responded to the barrier by reorienting themselves away from the road, that is, by making more trips to places on their side of the road.

Some of the effects mentioned previously may also only appear in the long term. This is, for example, the case of economic effects. Jacobs (1961) noted that neighborhoods bordering barriers tend to decline economically because the poor accessibility and its indirect effects lead, over time, to a flight of residents and businesses.

Secondary effects

In addition to the *primary effects* of the original barrier, there are also *secondary effects* caused by inadequate, though well-intentioned, mitigation measures that either do not relieve the severance or have other unintended consequences (James et al., 2005; Jones and Lucas, 2012).

Footbridges and underpasses are generally disliked by pedestrians and cyclists (Rankavat and Tiwari, 2016; Räsänen et al., 2007; Tao et al., 2010; Villaveces et al., 2012) and avoided when another option exists, even when this implies extra walking time to use at-grade signalized crossings (Anciaes and Jones, 2018) or crossing in places without any crossing facilities (Obeng-Atuah et al., 2017; Sinclair and Zuidgeest, 2016).

This may be explained by the fact that even when they are sited along desire lines, footbridges and underpasses are often inaccessible for, or difficult to use by, some pedestrians. For users of wheelchairs and those with difficulties in climbing or descending steps, footbridges and underpasses can be even more of a barrier than the infrastructure it is bypassing. Even where a ramp is provided, this can take too much effort. As an example, the force required to push a wheelchair up a ramp to access a bus can require pressures equivalent to two to three times the body weight to be transferred through the shoulders (Velho et al., 2016).

Due to poor design or maintenance, crossing facilities can also be inaccessible or unpleasant in flooding or icy conditions. Underpasses (and, to some extent, also footbridges), especially if poorly lit, are also avoided primarily through fear of crime as well as on esthetic grounds, as they are often used as public toilets. Fig. 7.3 shows examples of footbridges and underpasses with obvious problems of poor accessibility and attractiveness. Women and older people are particularly likely to be deterred from using footbridges and underpasses, contributing to the inequalities engendered

Figure 7.3 Example of footbridge and underpasses with poor conditions: (A) footbridge and (B) underpass. *(A) London, UK © P Anciaes, 2016 and (B) Chisinau, Moldova © P Anciaes, 2018.*

by community severance (Bradbury, 2014), although a study in Tanzania found that women were more likely than men to say that they preferred to cross roads above or below ground level (Mfinanga, 2014).

In addition, neglect encourages—or does not remove—graffiti or litter. Pitner et al. (2011) describe graffiti, vandalism, and litter as *physical incivilities*, and noisy neighbors and criminal activities as *social incivilities*; occurring together in public spaces where the community feels no ownership of the area, they are associated with increased perceptions of crime, referred to as the *broken window* theory. These incivilities combine to deter walking wherever they occur, not just on severance mitigation measures. However, the lack of people walking along the street or using streets as social spaces increases the likelihood of these neighborhood incivilities.

What are the health impacts of these effects?

Travel

Physical activity and sedentary behavior

Walking and cycling for travel are among the easiest and cheapest ways to incorporate physical activity into everyday life. Walking and cycling can provide the same health benefits as sports or other exercise, reducing the risks of obesity, diabetes, heart disease, stroke, many cancers, depression, osteoporosis (thinning of the bones), and improving mental well-being. Walking or cycling to work can be as effective as a training program, can

increase cardiorespiratory fitness, and can fulfill the recommendations for physical activity.

People who commute by car gain more weight than those who do not, even in those who meet the physical activity recommendations with leisure time activity (Sugiyama et al., 2013). Because most public transport journeys start and/or end with walking or cycling, public transport can be considered as active travel. The study of Martin et al (2015) in the United Kingdom found that people who changed from car commuting to public transport lost weight, with those changing to walking or cycling losing more weight. Weight increased in those who switched from active travel to car commuting. A study in Canada found that people who perceived both walkability and social connectedness of their neighborhood as high walked more, both for travel and leisure. One estimate from a small study of closing a road to motor vehicles estimated health economic benefits from increased physical activity of around £500,000 over 20 years (Aldred and Croft, 2019).

Independent mobility

Apart from issues of access to health-promoting destinations, independent mobility is inherently important. In older people, it is associated with well-being and maintenance of social networks (Murray, 2015). It also promotes healthy aging and helps to maintain function through providing opportunities for physical activity and movement, with benefits for circulatory and respiratory capacity, muscle strength, and balance (Rantanen, 2013). Independence for mobility is also important for self-esteem and mental well-being, to avoid dependence on others and feelings of control (Siren et al., 2015). Even where journeys could be made by public transport, community severance may prevent access to the bus stop or station if access involves crossing a busy road.

Freedom to travel and to play independently of adult supervision is also associated with levels of educational attainment of children (Shaw et al., 2015). Children who are not allowed to travel independently or to play outside have delays in their mental and physical development and lower self-esteem (Hüttenmoser, 1995). Other effects on social isolation and curtailment of children's independent mobility and activities have been reviewed elsewhere (Mindell and Karlsen, 2012).

Social isolation

Social contacts are very important for health. In their classic Almeida Study, Berkman and Syme (1979) found that age-adjusted mortality was

two to three times higher for the most isolated adults compared with those with the most social contacts, even after adjusting for socioeconomic position, use of preventive healthcare, obesity, and health risk behavior such as smoking, alcohol, and physical activity. A meta-analysis of 148 studies found that the greater the social network, the lower the mortality, with an overall 50% lower mortality for those with stronger social connections. Importantly, in the context of community severance, the effect was much larger for those with a greater extent of social integration (Holt-Lunstad et al., 2010). The effects of objective measures or subjective feelings of loneliness are very similar: mortality increased by 26%–32% for those reporting loneliness, with social isolation, or living alone (Holt-Lunstad et al., 2015).

Subjective well-being

Living near motorways and busy roads is also associated with lower subjective well-being. A study in Glasgow found that people living near a motorway had lower well-being than people living further away (Foley et al., 2017). This impact may be explained by higher levels of exposure to noise and air pollution. In a study in London, Anciaes et al. (2019) also found an association between living near a busy road and lower subjective well-being, but in this case the association was explained by people's perceptions of the negative impact of the road on walking.

Air pollution

The health impacts of air pollution are relevant to community severance because motor vehicle emissions contribute to the unpleasant environment that deters people from walking or cycling near busy roads.

In many countries, motor vehicles are the leading and/or only increasing source of air pollution. The main vehicle-related pollutants are products of combustion, particularly oxides of nitrogen, particulates, and oxides of carbon. Oxides of nitrogen drift and combine with volatile organic compounds also emitted from fuel to form ozone in a reaction catalyzed by sunlight. Carbon dioxide is the most widely found greenhouse gas that contributes to climate change. The health impacts of air pollution have been summarized recently (RCP and RCPCH, 2016) and include increasing the incidence and severity of mortality from heart disease, stroke, asthma, and other respiratory diseases, as well as contributing to obesity and to dementia. The health impacts of global climate change have also been summarized (Watts et al., 2017). Other pollutants include

heavy metals from catalytic converters and particulates from tires and brakes. It is important to note that these nonexhaust particulates are emitted just as much by electric as conventional vehicles.

Noise

Motor vehicles are the main cause of noise in most countries. In Europe, noise is second only to air pollution in the impacts of environmental factors on disability-adjusted life years (Stansfeld, 2015). As well as being unpleasant and thus contributing to the deterrent effect of community severance on local nonmotorized travel, noise has a range of impacts on health. One of the most important is increasing blood pressure, thus increasing the risks of stroke and heart disease. While the effects of noise on reducing concentration and cognition (and thus educational achievement) and impairing sleep are important health impacts of motor vehicles in general, they are experienced more by those working, studying, or living near busy roads rather than by travelers. However, measures to reduce community severance, particularly those operating through reducing traffic speed and/or volume, can mitigate these health impacts.

Injury

Globally, there were 1.35 million road travel fatalities in 2018 (WHO, 2018). Road travel injury and fatality rates vary widely by country. Static severance is seldom related to travel injuries except for level crossings of railways, for example. However, dynamic severance can have a complicated relationship with injury risk. Where severance is very high, the deterrent effect of high collision and injury risk may predominate, with few pedestrians crossing the road if they have other options. Where severance is less extreme, or where the need to cross overrides safety concerns, pedestrians are likely to take a chance and collisions are likely. The highest fatality rates are in low-income countries with rising motorization, a predominance of non-motorized traffic, and poor infrastructure. Casualty rates are particularly high in rural areas (Bradbury, 2014).

Cumulative impacts and inequalities

Many of the effects of community severance are cumulative and tend to create or reinforce inequalities. For example, severance generally

affects poorer people the most. This is because more affluent people can choose not to live in areas with less severance and usually have better access to a car, which can protect the individual against most of the harmful impacts of severance. In addition to greater exposure, poorer people are often more susceptible to air pollution, which particularly affects people with preexisting cardiorespiratory disease.

In the case of dynamic severance, age inequalities may also occur because walking speed restricts people's ability to cross busy roads. Even where there are signalized crossings, the time allowed is often too short for many people. For example, where *pelican*[1] crossings are used, the *invitation to cross* (see footnote 1) is a set number of seconds, depending on the width of the road. The *clearance time* (see footnote 1) before the lights turn green for motorists uses 1.2 meters/second as the assumed minimum speed of pedestrians in Brazil, the United Kingdom, and the United States (Asher et al., 2012; Duim et al., 2017; Webb et al., 2017). However, the mean walking speed of a nationally representative sample of men and women in England aged 65 + was 0.9 m/s and 0.8 m/s, respectively (Asher et al., 2012). In a similar study in São Paulo in Brazil, 96% of adults aged 60 + walked more slowly than 1.2 m/s; 70% walked more slowly than 0.9 m/s (Duim et al., 2017). These results suggest that the dynamic severance caused by roads, and the use of signalized crossings to reduce that severance generate inequalities between older and younger pedestrians. In addition, all three studies cited previously found that the decline of walking speed with age is greater in poorer people and in less healthy people. For example, 15% of the richest and 3% of the poorest men aged 60 years old in an English study were predicted to be able to cross the road in time (Webb et al., 2017).

Where the barrier effect means that journeys cannot be made or are difficult to make except by car, those who are too young, old, ill, or poor to own or drive a car become dependent on others to drive them. Where nuclear families live in different areas from their extended family, where there is less social cohesiveness, and in poorer neighborhoods, there are probably fewer people able to give lifts to others. There are also gender inequalities, as women are less likely than men to have access to a car even in car-owning households.

[1] A pelican crossing has a light on the other side of the road showing a person. When it is red, the signals are green for motor vehicles. A green person is an invitation to cross; a green flashing person indicates that those on the crossing should continue (clearance) but no one should start to cross.

Community severance may also reinforce spatial inequalities, as residents in some areas may be more vulnerable to the loss of accessibility caused by the barrier effect of transport infrastructure. This is, for example, the case of isolated suburban areas and rural areas with poor public transport access and few options of pedestrian destinations (e.g., villages with just one shop, located on the other side of the barrier). An extreme example is some rural areas of sub-Saharan Africa where children need to cross streams to access school but the streams can become hazardous rivers (Bradbury, 2014).

These inequalities are often greatest in low-income countries. Rapid motorization may lead to a focus on increasing the infrastructure for cars at the expense of other travelers (Bradbury, 2014). However, there have been calls to prioritize provision for pedestrians (de Langen, 2005; Mitullah et al., 2019).

What tools are available to assess community severance?

Anciaes et al. (2016) have summarized the measures that have been used or proposed in a number of different countries. These include pedestrian time spent waiting to cross, multiplied by the number of crossings, and then ascribed monetary values. National-level guidance in Switzerland and the United Kingdom have suggested a simple qualitative classification, for example, slight, moderate, or severe. The article then describes more complicated measures that have been proposed by researchers, most of them being adaptations of walkability and accessibility indicators that are usually used to analyze other issues. There is also a growing number of studies estimating the economic value of community severance using stated preference surveys, that is, surveys that ask people to choose among different scenarios for road designs, traffic conditions, and an hypothesized personal benefit or cost (e.g., Anciaes et al., 2018; Grisolía et al., 2015).

The authors are part of the Street Mobility team that developed a toolkit to assess community severance using a range of approaches. These include participatory mapping and a pen-and-paper survey of local residents, enquiring about ease of walking around the local area; use of video surveys to assess motor and pedestrian traffic and pedestrians' crossing

behaviors; a walkability model; a severance index; and a tool for economic appraisal of current severance and proposed changes. Existing tools that are also a part of the toolkit include spatial analysis (using space syntax), and street audits, to assess the quality of provision for pedestrians and wheelchair users both at junctions and along links between junctions. The tools were designed to be used independently or in combination, by local communities, local government, or researchers; they can be downloaded freely (www.ucl.ac.uk/street-mobility/toolkit). The toolkit website also includes information on how to run a survey and analyze the resultant data.

Policies to remove or reduce community severance

Remove the infrastructure

Radical solutions to completely remove the transport infrastructure have become more politically acceptable in recent years, due to an increasing priority given by city authorities to street liveability. A 2012 report (ITDP and EMBARQ, 2012) describes a series of cases around the world where urban highways were removed. One of the most well-known cases is the demolition of the Cheonggyecheon Expressway in Seoul and its replacement with a park alongside a stream that was previously underground.

Compared with completely removing the infrastructure from the transport network, solutions that simply separate the infrastructure from the pedestrian network are less desirable:

- Burying the infrastructure (i.e., building a tunnel) is not always technically or economically feasible.
- Flyovers can restore street connectivity but are visually intrusive and do not reduce exposure to noise and air pollution (Future of London, 2018).
- Sinking (without burying) the infrastructure reduces exposure to noise and air pollution and allows for the replacement of grade-separated pedestrian crossings with surface crossings, but pedestrian movement is still limited by the number of these crossings.
- Bypasses tend to shift the problem to other areas. In addition, projects to build bypasses are often met with protest for economic or environmental reasons (see https://www.theguardian.com/environment/2013/jan/12/combe-haven-green-protesters-trees).

Add or modify crossing facilities

When completely removing the infrastructure is not politically or financially viable, community severance can still be reduced by adding more crossing facilities for pedestrians. This reduces the detours to walking trips and allows pedestrians to cross the road safely, reducing the perceived danger and unpleasantness of crossing the road.

Another possibility is to change the type of existing crossings. In comparison with pelican crossings, puffin[2] crossings and nonsignalized (zebra) crossings have the advantage that pedestrians are not limited in how long they take to cross the road; the disadvantages are a lack of understanding of the camera-controlled lights at puffin crossings, leading to fear that motor vehicles will resume, and dependence on drivers stopping at zebra crossings. The latter is a problem in many areas, that is, dealt with in differing ways. A survey in Japan found that 90% of drivers do not stop; education is being proposed as the solution (https://japantoday.com/category/national/more-than-90-of-vehicles-dont-stop-at-crosswalks-without-lights-despite-presence-of-pedestrians). In France a new law has increased the penalty for drivers who fail to stop at an unsignalized crossing to 6 points on their license for (https://www.connexionfrance.com/French-news/France-decrees-new-laws-on-pedestrian-and-road-safety). In New Zealand, there have been calls by transport planners to remove zebra crossings. A more sensible approach would be to deal with driver behavior and to add more visible flashing beacons.

Another possibility is to change the characteristics of the existing crossing facilities. For example, in signalized crossings, reducing the assumed walking speed used for clearance times would allow pedestrians with lower walking speeds to cross the road safely. Until camera-controlled signals based on detection of a person crossing the road are universal, the current default 1.2 m/s is too far quick for almost all older people, as well as many others with mobility impairments, young children, or luggage. Reducing the waiting time for pedestrians in signalized crossing facilities can also reduce delays to pedestrian trips, reducing the perceived barrier effect of the road.

Improvements to grade-separated facilities can also increase their attractiveness to pedestrians, reducing the perceived barrier effect. For example, there are ways where good and innovative design can make

[2] A puffin crossing is a signalized crossing controlled by sensors that detect if pedestrians are crossing. The green phase for vehicles starts only when all pedestrians have finished crossing. Unlike pelican crossings the lights for pedestrians are on the nearside of the road.

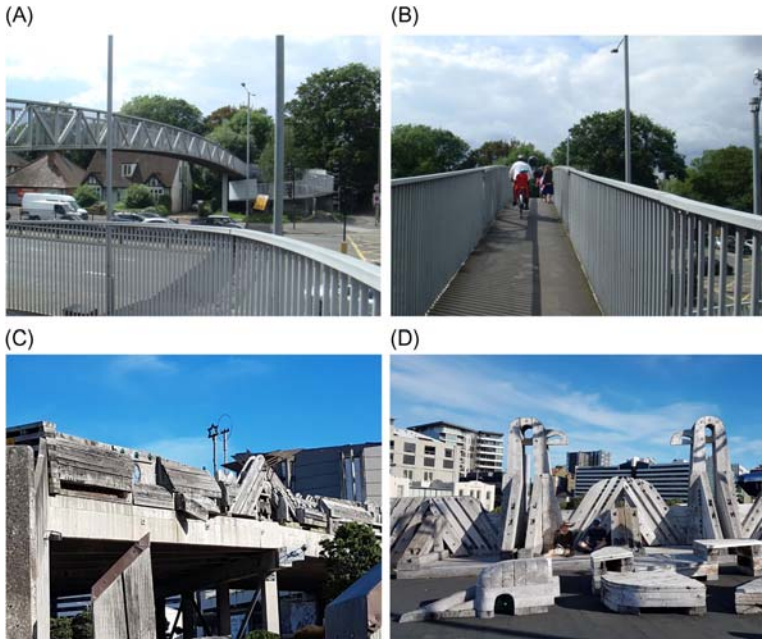

Figure 7.4 Traditional and innovative approaches to pedestrian bridges across busy roads:
(A and B) traditional footbridge and (C and D) innovative carved bridge. *(A and B) London, UK © P Anciaes, 2016 and (C and D) Wellington, New Zealand © J Mindell, 2019.*

footbridges desirable places to spend time and use as social spaces (Fig. 7.4). Improving the design and maintenance of underpasses can also mitigate their general unpleasantness.

Road redesign and traffic policies

In the case of the dynamic severance caused by busy roads, possible solutions include modifying the road design or implementing policies to change the characteristics of road traffic.

Changes to road design that could reduce severance include the following:

- Reducing the number of lanes for motorized traffic—this reduces the total width of road that pedestrians need to cross.
- Adding a central reservation (i.e. a median strip) or widening existing central reservations—this allows pedestrians to cross in two stages, stopping in the central reservation.

- Removing physical barriers (such as walls or guard railings)—this increases the number of places where pedestrians can cross.

Changes to the characteristics of road traffic include the following:

- Reducing traffic levels, using economic policies (e.g., road pricing) or regulations (e.g., restrictions based on license plate numbers).
- Changing the composition of the traffic, by restricting the circulation of some types of vehicles at all or some times of the day or days of the week.
- Reducing traffic speeds, by imposing lower speed limits.

Improve conditions for pedestrians walking along the road

The barrier effect of the road on pedestrian mobility can also be reduced by improving conditions for pedestrians walking along (and not necessarily across) the road. This could be achieved by

- providing pavements (sidewalks) where they do not exist;
- widening existing pavements, including removing obstructions;
- improving the pavements' surface quality;
- adapting the design of pavements to increase their accessibility to people with disabilities (e.g., by adding dropped kerbs, tactile information, and color contrast);
- other measures, such as providing places to sit and rest and improving lighting conditions, soft landscaping, and cleanliness.

Governments around the world have been attaching more priority to the interventions mentioned previously, aimed at creating more equitable road and street design. For example, in the United States, the Complete Streets Act (2009) aimed to change car-centric street design by creating "complete streets" that address the needs to all users, including pedestrians, cyclists, and people using streets as places (e.g., for socializing, relaxing, and window-shopping). Inclusion of pedestrian falls in the street within the definitions of road travel injuries (Methorst et al., 2017a,b; Schepers et al., 2017) might also help decision-makers to prioritize better facilities for pedestrians.

Summary

This chapter reviewed the state of the art of the relationship between transport and community severance, defined as the "barrier

effect" of transport infrastructure and motorized traffic on the movement of pedestrians and cyclists. Community severance affects travel behavior because people may avoid walking due to the risk and inconvenience of crossing busy roads and other transport infrastructures and/or due to the exposure to noise and air pollution when crossing or walking along those infrastructures. This reduces the independent mobility of some groups (such as older people and children) and has potential negative economic and social effects. Facilities to cross the road do not always relieve severance, especially in the case of bridges and underpasses, which are generally disliked by pedestrians and cyclists.

Community severance is related to health as it tends to reduce physical activity, independent mobility, social contacts, and subjective wellbeing, and is also associated with other negative health impacts of transport, such as exposure to noise and air pollution and increased probability of injuries. Many of the effects of community severance are cumulative and often generate or reinforce inequalities, as they are particularly impactful for certain age and socioeconomic groups.

A range of different tools have been proposed by researchers to assess community severance. These tools can also be used to assess the effectiveness of possible policies to remove or reduce the problem. This includes removing the transport infrastructure, adding or modifying crossing facilities, road redesign, traffic policies, and general improvements of the conditions for pedestrians walking along roads.

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