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Forging a Path to Vision Zero in the US: A Critical Analysis of Road Safety in Australia

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16. Abstract

Despite similarities to the US in terms of transportation, land use, and culture, Australia kills 5.3 people per 100,000 population on the roads each year, as compared to the US rate of 12.4. Similar trends hold when accounting for distance driven and the number of registered cars. This research project seeks to understand what is behind the road safety disparities between these two countries.

The results suggest that a number of inter-related factors seem to play a role in the better road safety outcomes of Australia as compared to the US. This includes Australia's strategies related to seat belt usage and impaired driving as well as their efforts to help curb vehicle speeds and reduce exposure. Design-related differences include a much greater reliance on roundabouts and narrower street cross-sections as well as guidelines that encourage self-enforcing roads. Policy-related differences include stronger and more extensive enforcement programs, restrictive licensing programs, and higher driving costs.

Combined with a more urban population and multimodal infrastructure, Australia tends to discourage driving mileage and exposure while encouraging safer modes of transportation such as transit, at least more so than in most of the US. Australia also enacted their version of Vision Zero – called the Safe System Approach – more than a decade before similar policies began cropping up in US cities. While it is difficult to attribute recent road safety successes to any specific policy, Australia continues to expand their lead on the US in terms of safety outcomes and is a road safety example worthy of consideration.

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Forging a Path to Vision Zero in the US:
A Critical Analysis of Road Safety in Australia

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ABSTRACT

Despite similarities to the US in terms of transportation, land use, and culture, Australia kills 5.3 people per 100,000 population on the roads each year, as compared to the US rate of 12.4. Similar trends hold when accounting for distance driven and the number of registered cars. This paper seeks to understand what is behind the road safety disparities between these two countries.

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1. INTRODUCTION[1]

Road crashes take the lives of more than 1.2 million people worldwide each year and purge more productive years of life than any other disease, including cancer and heart disease combined. Road safety engineers often look to the safest motorized countries in the world – such as the Netherlands – but often make the argument that, culturally, their approaches would never work in countries such as the United States. While many of the Dutch approaches to transportation may work well in the United States, we rarely get the chance to find out. This research project focuses on critically analyzing the transportation system of a country that is much safer than the United States, but also more similar in terms of transportation, land use, and culture than most European countries. Australia – with 5.3 road fatalities per 100,000 people, as compared with the U.S. rate of 12.4, – stands out as an ideal candidate.

In 1970, Australia's road fatality rate greatly exceeded that of the United States, as shown in Figure 1.1. By 1980, the two countries were dead even. Since then, Australia has seen remarkable safety gains, far exceeding U.S. gains. Having adopted its version of Vision Zero in 2003 and cut its road fatality rate by more than one-third since then, there seems to be much the United States can learn from Australia. This project seeks to discover what those lessons might be. After a brief background section comparing the various historical road fatality rates back to 1925, I systematically analyze reasons why Australia might be safer and attempt to use data to substantiate or refute each supposition. These include engineering, enforcement, education, and exposure. More specifically, this comparison includes differences in the following: vehicles with respect to issues such as seat belt legislation; roadway designs in terms of built environments, intersections and street designs; and road users in terms of differences in travel behaviors, licensure, enforcement, and impaired driving. The discussion section then considers differences regarding the overarching road safety policies between Australia and the United States, as well as some of the structural differences in governance, in order to determine where Australia is finding their road safety gains.

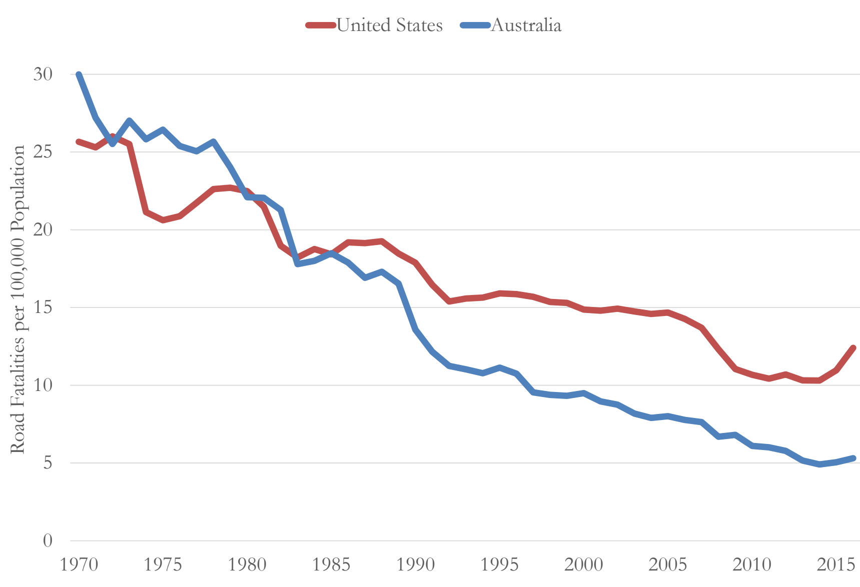

Figure 1.1 Road Fatalities per 100,000 Population: US vs. Australia (1970-2016)

[1]This portion of the report has been peer-reviewed and published: Marshall, W. Understanding International Road Safety Disparities: Why is Australia so much safer than the United States? *Accident Analysis & Prevention*, Vol. 111: 251-265, 2018 (doi.org/10.1016/j.aap.2017.11.031).

2. BACKGROUND

2.1 Viability of Australia as a Comparison to the US

Before trying to assess Australia's current road safety successes, it seems worthwhile to further gauge its viability as a comparison with the United States. The United States and Australia share a common heritage in terms of being relatively young countries that were both colonized by the British. Both are now democratic societies with a federal system of government and somewhat similar divisions of power divided at the state level (Williams & Haworth, 2007). English is the primary language in the two countries even though both grew via historically high levels of immigration.

Some of the more prominent work on international road safety comparisons originated in Europe and focused on the SUN countries (i.e., Sweden, the United Kingdom, and the Netherlands) (Koornstra et al., 2002; Luoma & Sivak, 2014). Such papers pointed out the appropriateness of the SUN countries as comparisons to the United States on the basis of similarities in economic situations and demographics (Luoma & Sivak, 2014). To assist with this overview, Table 2.1 compares Australia with the United States and the SUN countries (IndexMundi, 2017). GDP per capita for the SUN countries, for instance, ranges between 69% and 89% of that in the United States; Australia has a GDP per capita that is just over that of the United States. The Australian populations are also more similar to U.S. populations in terms of median age, the percent of the elderly population, and the percent of the population between the ages of 15 and 24. These latter percentages related to older and younger populations are particularly important when it comes to road safety outcomes. Both the United States and Australia also have the same percentages of couples with children and relatively similar rates of adult obesity. In terms of total area, Australia is also much closer to the United States than any of the SUN counterparts. While the U.S. population is larger, thus resulting in a much higher population density than Australia, the UK and the Netherlands have population densities that dwarf both the United States and Australia. Since it is important to also recognize that population density is potentially endogenous to road safety outcomes, section 3.2.1 on the built environment delves deeper into population density differences between the United States and Australia. The same can be said regarding levels of motorization even though the United States and Australia have been cited as being "sufficiently similar on these dimensions to allow reasonably valid comparisons" (Williams & Haworth, 2007). While section 3.3.1 considers the impact of motorization in terms of travel behavior and exposure on road safety outcomes, this next section compares safety outcomes while controlling for these potential differences.

Table 2.1 Comparison of United States to Australia and SUN Countries

Country	GDP (per capita)	Age (median)	Percent Elderly	Percent Age 15-24	Percent of Couples with Children	Percent Obesity	Total Area	Pop. Density (people per mi^2)
United States	$57,771	37.9	12.4%	13.5%	28.0%	33.0%	3,677,647 mi^2 (9,525,067 km^2)	87.4
Australia	$58,961	38.6	12.9%	13.0%	28.0%	26.8%	2,969,906 mi^2 (7,692,024 km^2)	7.2
Sweden	$51,549	41.2	17.3%	11.6%	31.0%	12.0%	173,732 mi^2 (449,964 km^2)	57.1
UK	$40,055	40.5	16.0%	12.2%	52.0%	26.9%	94,058 mi^2 (243,610 km^2)	697.9
Netherlands	$45,275	42.5	14.0%	12.1%	56.0%	18.8%	16,033 mi^2 (41,526 km^2)	1,062.3

2.2 Historical Comparison of US/Australia Road Safety Outcomes via Exposure Metrics that Control for the Level of Motorization

Figure 2.1 depicts Australia's road fatality rate per 100,000 population against U.S. outcomes back to 1925. In this figure, we see that the United States was generally more dangerous between 1925 and 1950, followed by Australia becoming more dangerous until 1980, when both countries experienced remarkable safety improvements – to what might be considered historic levels of road safety during the automobile era – over the last few decades. The difference is that the road safety improvements in Australia were an order of magnitude better. If the United States had the same population-based fatality rate as Australia, 23,000 lives would have been saved in 2016 alone and over 294,000 lives altogether since 2000.

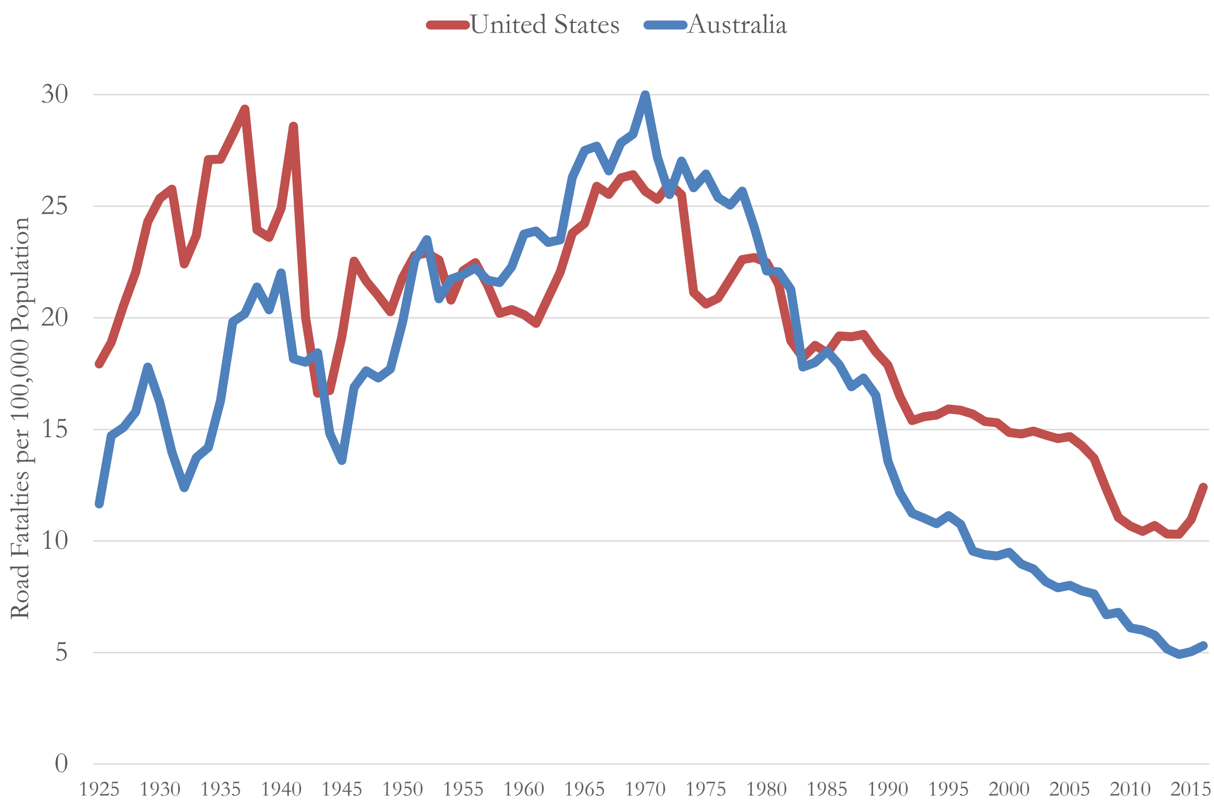

Figure 2.1 Road Fatalities per 100,000 Population: US vs. Australia (1925-2016)

While population-based road safety metrics are often considered a good means of measuring the public health impact of road safety, they do not account for differences in the level of motorization between these two countries (Marshall & Ferenchak, 2017). For instance, in Figure 2.1, the differences found in the first half of the 20th century might be explained by the United States having widely adopted cars earlier. Thus, Figure 2.2 looks at the same time period using the number of vehicles in each country as the exposure metric instead of population. This graph suggests that Australia was actually the more dangerous country from 1925 through 1990. Figure 2.3 more closely details the same graph since 1990, and akin to what we see with the population-based exposure metric, the US now seems to be more than twice as dangerous as Australia on a per-vehicle basis. Given the most recent data, the United States kills 1.33 people for every 10,000 vehicles while Australia kills approximately 0.47 people for every 10,000 vehicles. Australia's vehicle-based road fatality rate would have saved over 22,728 lives in 2015 alone and over 246,000 since 2000.

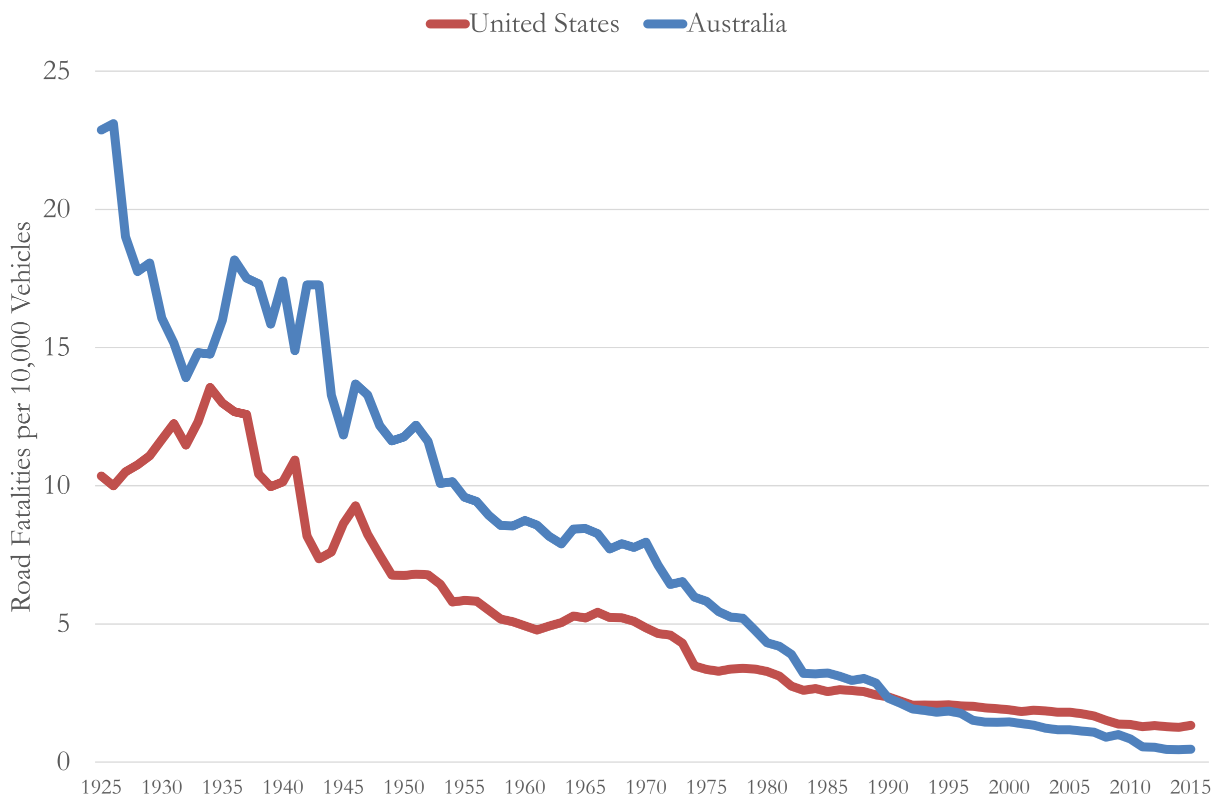

Figure 2.2 Road Fatalities per 10,000 Vehicles (1925–2015)

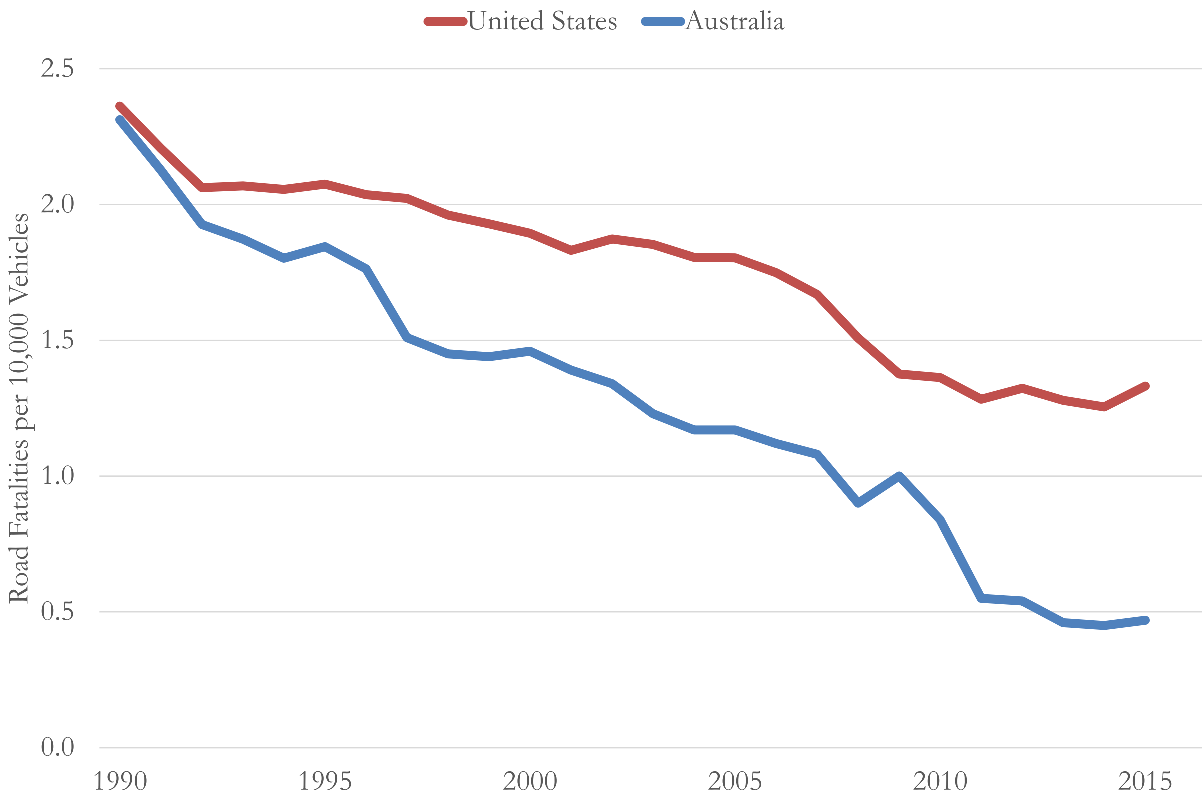

Figure 2.3 Road Fatalities per 10,000 Vehicles (1990–2015)

After controlling for the number of vehicles, it makes sense to ask how much these vehicles are being driven. In other words, Australians may be driving much less than their American counterparts, which may in turn be reducing their overall risk and the number of road fatalities. The Australian data for driving distances were a bit more limited, only going back to 1975, so Figure 2.4 illustrates the number of road fatalities per 100 million miles (161M km) driven from 1975 through 2016. Here, we see Australia as the more dangerous country until around the year 2000. Figure 2.5 highlights this more recent time period when we see Australia gradually becoming increasingly safer than the United States. The most recent U.S. data show 1.27 road fatalities for every 100 million miles (161M km) driven, as compared with 0.83 road fatalities every 100 million miles (161M km) driven in Australia. This difference is not quite on the order of the population-based and vehicle-based rates but is still striking. For instance, if the United States had the same mileage-based road fatality rate as Australia, we would expect 13,805 fewer fatalities in 2016 and over 97,000 since 2000.

Whatever the underlying exposure metric used, the consistent trend is that the surface transportation system in Australia is safer than in the United States. The question is why? The next section attempts to answer this question by aggregating data from a variety of sources to see if the plausible reasons for these differences in road safety outcomes hold true.

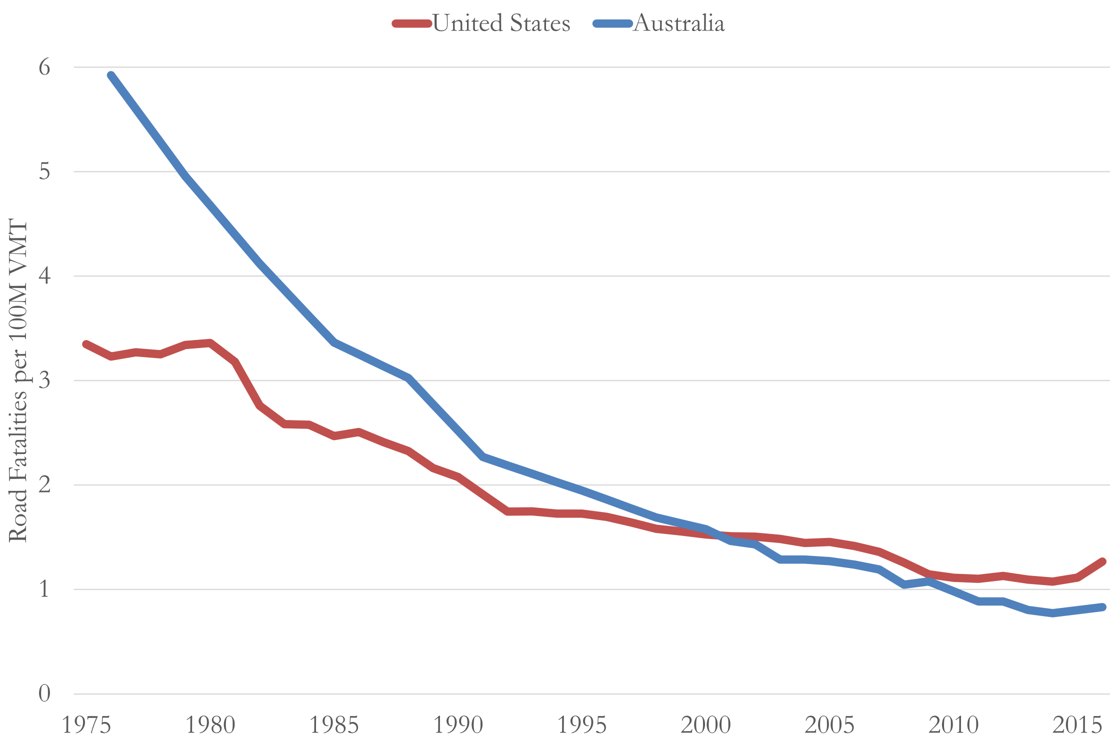

Figure 2.4 Road Fatalities per 100 Million Vehicle Miles (161M km) Traveled (1975–2016)

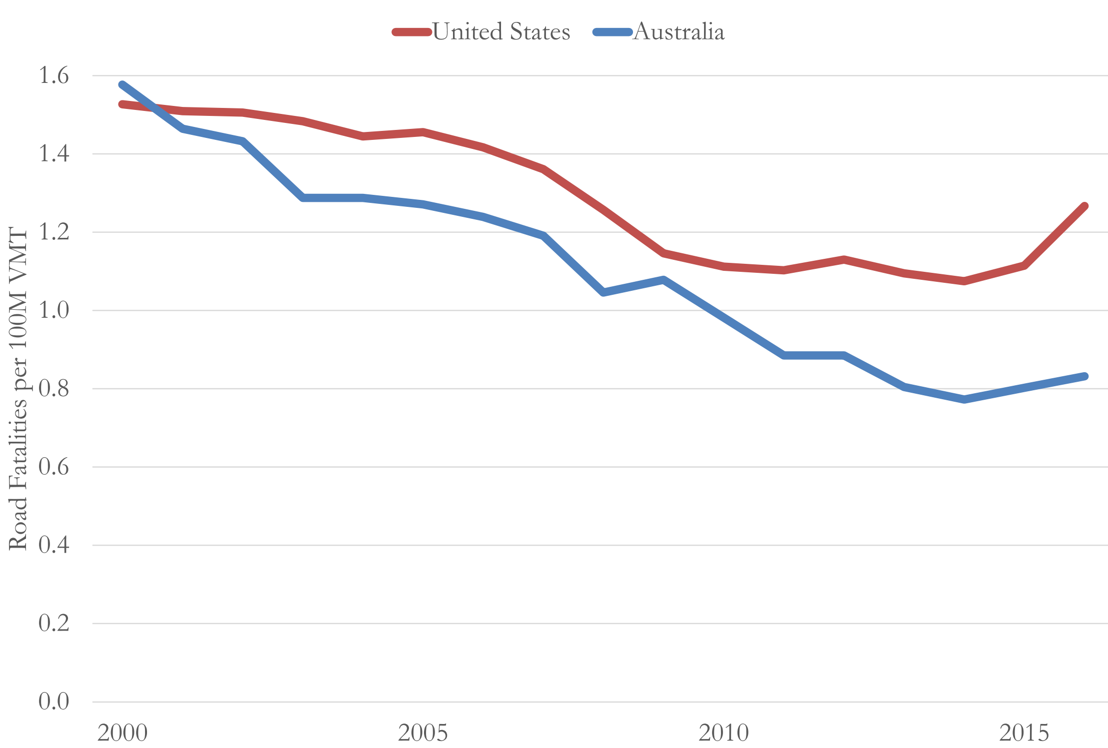

Figure 2.5 Road Fatalities per 100 Million Vehicle Miles (161M km) Traveled (2000–2016)

3. WHY IS AUSTRALIA SAFER THAN THE UNITED STATES?

When trying to answer such a broad road safety question, it is sometimes difficult to know where to start; thus, it seemed appropriate to seek out a relevant conceptual framework to help guide this effort. Figure 3.1 depicts the Safe Road Transport System model, originally developed by the Swedish Transport Agency and now used more broadly, including by the Organisation for Economic Co-operation and Development (ITF, 2016). The main premise behind this conceptual model is that the human body has physiological limits, and when crashes push the body beyond those limits, severe injuries and fatalities result. While safe speeds represent the primary pathway toward a safer system, the models break that down into three key elements: i) safe vehicles; ii) safe roads; and iii) safe road users. The next part of the report covers safe vehicles and, historically, the issue of seat belts sets forth the modern era of vehicle and road safety, so it seemed like a good place to begin. Section 3.2 covers safe roads by analyzing differences in the built environment, intersection designs, and street designs. Lastly, the focus shifts to safe road users by comparing differences in travel behavior and exposure, licensing, enforcement, and impaired driving.

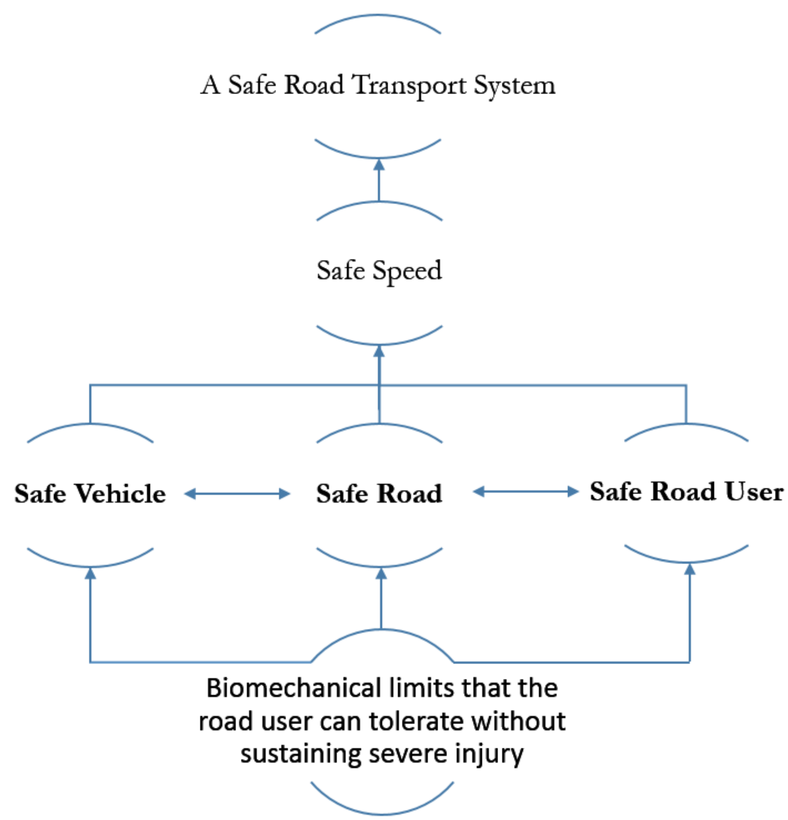

Figure 3.1 Model of a Safe Road Transport System (ITF, 2016)

3.1 SAFE VEHICLES

3.1.1 Vehicle Occupant Protection

Seat belts were required to be installed in new cars as of 1968 and 1969 in the United States and Australia, respectively (Australian Government, 2015). In 1974, Victoria, Australia, required the retrofitting of car models from 1964 through 1968, in which seat belt anchorages had previously been required (Milne, 1985). During this same period, the U.S. National Highway Traffic Safety Administration mandated seat belt ignition locks, which prevents an unbelted driver from starting the car, on all new cars starting in 1974 (Krafft, Kullgran, Lie, & Tingvall, 2006). Public outcry compelled Congress to rescind this requirement before the year was over.

In terms of potential occupant protection differences (such as air bags) between overall vehicle fleets in these countries, the data suggest that the overall fleets are similar in age. The average age of a registered vehicle in the United States is 11.5 years, compared with 10.1 years in Australia (Australian Bureau of Statistics, 2016; Naughton, 2015). Given similar vehicle safety standards between these countries, there are unlikely to be systematic differences on this front. However, there are likely to be greater differences in terms of vehicle size. In the United States, 59.5% of new car sales are SUVs or light trucks (Wall Street Journal, 2017). In Australia, SUVs and light trucks comprise only 46.2% of new vehicles (Australian Bureau of Statistics, 2016). While larger vehicles may help in terms of occupant protection, they can also inflict more damage (Jehle, Doshi, Consiglio, Wilson, & Desanno, 2013; Mayrose & Jehle, 2002).

While seat belt usage laws might logically fit under the safe road users' element, it is included within the larger discussion on vehicle occupant protection in this section for the sake of clarity. The first laws from these two countries requiring drivers to use seat belts came in Victoria, Australia, in 1970. By the end of 1973, the laws had spread nationwide in Australia (Milne, 1985). In terms of the seat belt laws we are familiar with today, the United States was a step behind Australia with the first seat belt law not being passed until 1986 in New York. Although New Hampshire still remains the lone holdout, all other U.S. states had mandatory seat belt laws in place by 1995 (IIHS, 2017b).

Despite the relative ubiquitousness of seat belt laws in both countries, there are some differences in enforcement and fines. While the seat belt law is a primary enforcement law (meaning that an officer can pull someone over just for violating the seat belt law) across Australia, it remains a secondary enforcement law (meaning that an officer would need to pull someone over for something besides the seat belt first) in 15 U.S. states (IIHS, 2017b). Moreover, the fine structure is quite different as well. As will be expanded upon in the enforcement section below, a seat belt violation in Queensland, for instance, would cost a driver $302 USD and would multiply based on the number of unbelted passengers[2]. In the United States, Texas has the largest seat belt fine of $200 USD; most are significantly less, averaging just $35 USD (IIHS, 2017b).

U.S. survey data from the 2016 National Occupant Protection Use Survey (NOPUS) estimate 88.5% seat belt usage, up from 83% in 2008 (NHTSA, 2016b). In terms of overall U.S. road safety outcomes, 47.6% of vehicle occupants killed in 2015 were not wearing seatbelts (NHTSA, 2017b). This does not include 1,945 people where restraint use was unknown. While usage data are harder to come by in Australia, rates from the early 2000s suggested a 95% usage rate (Fildes, Fitzharris, Koppel, & Vulcan, 2002). More recent observational studies suggest overall seat belt usage rates in Australia as high as 98% or 99% (Motor Accident Commission, 2017; Roads, 2013). The corresponding percent of vehicle occupants

[2] Australian dollars through the paper were converted to US dollars using a conversion rate of 1.25 Australian dollars for every U.S. dollar, which represents the exchange rate as of 7/31/17.

killed in Australia who were not wearing seatbelt is correspondingly lower than the United States, and ranges from 33% to 35% (Fildes et al., 2002; Motor Accident Commission, 2017).

Clearly, the solution is not as simple as seat belts because many of these deaths also include alcohol or other contributing factors. However, seat belt laws seem to make a difference in terms of usage, as evidenced by the varied U.S. usage rates, ranging from 69.5% in New Hampshire – where there is no seat belt law – to as high as 97.3% in California (NHTSA, 2016b). Nevertheless, seat belts have proven to be an effective means of preventing death, and those that do not use seat belts are eight times more likely to die in a road crash (CARRS-Q, 2016).

3.2 Safe Roads

3.2.1 Built Environment

With more than 60% of its population living in the vicinity of its eight capital cities, Australia is often cited as one of the most urbanized countries in the world (United Nations, 2014). In terms of road safety, higher levels of urbanization typically correspond with better road safety outcomes, particularly in terms of fatal and severe crashes (W. H. Lucy, 2003; William H. Lucy & Lewis, 2009). In a recent paper, for example, the author looked at more than 20 years of U.S. fatality data and found that residents of the most rural areas had road fatality rates more than six times those of their urban counterparts (Marshall & Ferenchak, 2017). The possible reasons for such differences include lower levels of access to emergency medical services (W. H. Lucy, 2003), the likelihood of higher vehicle speeds (Rakauskas, Ward, & Gerberich, 2009) increased per-capita driving (Litman & Fitzroy, 2005), less transit use (Litman, 2016), as well as differences with respect to alcohol consumption (Voas, Tippetts, & Fisher, 2000), vehicle type (Rakauskas et al., 2009), and seat belt norms (Lerner et al., 2001; Wells, Williams, & Farmer, 2002).

How urbanized is Australia compared with the United States? Given that there is no single standard for differentiating urban from rural, it is difficult to answer this definitively. On the whole, Australia is pretty sparsely populated with only 7.2 people per square mile (2.8 people per sq. km). The United States averages 87.4 people per square mile (33.7 people per sq. km). However, these numbers do not account for the how the population is distributed. In other words, simply calculating the average population density of the country does not necessarily equate to what would be the population density experienced by the average person. As a result, it is common for researchers to also calculate population-weighted population densities—or the perceived population densities—to better compare relative built environment differences (Richardson, Brunton, & Roddis, 1999; Spencer, Gill, & Schmahmann, 2015). For example, say there are two buses, each with a 50-passenger capacity. For the sake of this example, one bus is carrying 49 passengers and the second has only one passenger. Averaging the two would tell us that the average bus carries 25 passengers and is half full. However, if we consider what the average bus experience is like from the perception of the passengers, one passenger sits on a bus that is almost completely empty while 49 passengers are on a bus that is nearly full. Thus, the average passenger is experiencing a much fuller bus than a simple average might suggest (in this case, the passenger-weighted demand, which represents the perceived experience of the average passenger, would be just over 48 passengers).

The same problem can arise with population density calculations, particularly in places with non-uniform distributions of populations such as the United States and Australia. Instead of an average population density of 7.2 people per square mile (2.8 people per sq. km), Australia's population-weighted population density is 6,717 people per square mile (2,593 per sq. km). In the United States, the average population density of 87.4 people per square mile (33.7 people per sq. km) jumps to 5,369 people per square mile (2,073 people per sq. km). Given the national averages, one would think that the United States is approximately 12 times denser than Australia. However, based on the population densities that people experience on a daily basis, Australia is just over 25% denser than the United States.

In the United States, 54% of road fatalities occur in rural areas (NHTSA, 2015). Given that only 18.4% of Americans live in rural areas, they are significantly overrepresented in terms of road fatalities (World Bank, 2017). While these numbers do not account for the possibility of urban residents dying in rural crashes (or vice versa), rural residents are still two times more likely to be in a fatal car crash when controlling for the home ZIP Code of the driver (Marshall & Ferenchak, 2017). In Australia, the percentage of road fatalities in rural areas was a bit lower at 48% (CARRS-Q, 2012); however, only 10.6% of Australians live in rural areas (World Bank, 2017).

Given these numbers, the rural road fatality rates for each country are 36.4 deaths per 100,000 population in the United States versus 24.0 in Australia. Even though Australia's rural areas are considerably safer than those in the United States, neither figure is commendable, and both remain much higher than their overall national fatality rates of 12.4 and 5.3 for the United States and Australia, respectively.

The trends in both countries suggest that they are becoming more and more urban, which, based on the existing literature, should lead to better road safety outcomes. In 1960, for instance, Australia's percentage of rural residents was 18.5%, just over what the United States is now (World Bank, 2017). In the United States in 1960, approximately 30% of the population was rural (compared with 18.4% now) (World Bank, 2017). However, while both counties are becoming relatively more urban over time, the raw number of rural residents in both countries climbed with the addition of nearly five million new rural residents over this time span in the United States, as compared with just over 600,000 new rural residents in Australia (World Bank, 2017). The United States and Australia now have rural populations of over 59 million and 2.5 million, respectively. With more than 23 times the rural population, the United States likely experiences higher levels of exposure in more dangerous areas.

3.2.2 Intersection Design

When it comes to intersection design, the use of roundabouts in Australia is noteworthy. A recent international intersection analysis found that the United States averages one roundabout for every 1,118 intersections while Australia averages one for every 65 intersections (Metcalfe, 2016). This is more than a 17-fold difference in the relative prevalence of roundabouts. In terms of road safety, roundabouts eliminate many conflict points and the most dangerous types of crashes found in a conventional intersection. Roundabouts may see more sideswipe or rear-end crashes, but these crash types are less likely to result in a fatal or severe injury. The AASHTO Highway Safety Manual states that when compared with conventional intersections, roundabouts experience 78% to 82% fewer serious injury or fatality crashes (AASHTO, 2010).

Since 1990, Australia has been funding what is known as the Black Spot Program that focuses on reducing road fatalities at hazardous locations. The annual budget for the current iteration of the program exceeds $100 million while funding approximately 350 interventions annually. The most recent evaluation report looked at seven years of data and found roundabouts to be their most effective treatment (BITRE, 2012). Their data suggest a 70% reduction in fatalities and a 50% reduction in the number of total crashes after transitioning from a conventional intersection to a roundabout. Although these figures do not control for regression to the mean, the program makes a concerted effort to account for this issue during the project selection phase.

All roundabouts are not created equal. A well-designed roundabout, such as the one from Sydney, Australia, shown in Figure 3.2, forces cars entering the roundabout to slow down with horizontal deflection. When crashes do occur, they take place at slower speeds. While there are valid concerns about pedestrians at roundabouts, Australian designers typically set their crosswalks back considerably and use splitter islands, especially when the crossing is not a marked crosswalk. In such situations without a marked crosswalk, the driver has the right-of-way. It is not uncommon in Australia for a roundabout with four crossings to only stripe some of them, as shown in Figure 3.3. Drivers have the right-of-way at the two crossings without the striping on the right, while pedestrians have the right-of-way at the other two on the left.

Figure 3.2 Roundabout in Sydney, NSW, Australia

Figure 3.3 Roundabout with Marked Crossing on Left and Unmarked on Right (red arrow in inset picture indicates angle from which photo was taken)

Another advantage, one that is hard to overstate, is that Australian drivers seem to actually stop at unsignalized, marked crosswalks. In the United States, the results suggest that more than 50% of drivers do not stop or yield to pedestrians when waiting at a typical, unsignalized crosswalks (APR, 1998; Bertulis & Dulaski, 2014; Hunter, Stutts, Pein, & Cox, 1996; Kim, Peek-Asa, McArthur, & Kraus, 1999; Nasar, 2003), despite the fact that drivers in all states are legally obligated to do so (NCSL, 2016). While Australia has similar legal requirements, comparable compliance data were not available. My own investigation into this issue found 100% driver compliance at 10 different Australian marked, but unsignalized, crosswalks that included more than 250 pedestrian crossings that conflicted with an oncoming car. Admittedly, this is a small sample size, but it is a stark contrast from the United States and would clearly have safety implications well beyond roundabouts. It is also speaks to one of the common criticisms of roundabouts in the United States in that they do not work well for the visually impaired. Being able to depend upon drivers stopping at marked crosswalks would help that cause.

In terms of overall pedestrian fatalities, the most recent year of data shows that pedestrians comprise 12.3% of road fatalities in Australia, as compared with 15.3% in the United States. This difference does not seem significant, but given that Australia is more urban than the United States – and the corresponding higher levels of walking (walking commute mode shares of 4.5% for Australia versus 2.8% for the United States) – it is a difference worthy of future research (McCrindle Research, 2014; McKenzie, 2015). This is especially true since a recent San Francisco report finds that one-third of pedestrian fatalities occurred in a crosswalk when the pedestrian had the right-of-way (Elinson, 2013).

Another interesting Australian intersection treatment that can help crossing pedestrians as well as reduce turning vehicle conflicts is one known as the Melbourne Hook. While the hook turn maneuver is gaining traction for bicyclists in other places (such as in Denmark or even Canada, where it is called a perimeter-style turn), Melbourne in Victoria, Australia, also uses it for right-turning vehicles (cars drive on the left in Australia) and bicyclists in and around its Central Business District, as shown in Figure 3.4. Interestingly, the hook turns require drivers to make right turns from the left-most lane. This works when the light turns green, and cars looking to turn right queue at the far left side of the intersection, almost near where the opposing pedestrian crossing is placed. After the light turns red for the through traffic, the light will turn green for the opposing traffic with the queued cars leading the way. If the queueing area is full, then right-turning cars must wait for the next cycle. In terms of safety, the advantage is that there are no conflicts with the opposing through traffic, which was deemed especially important in Melbourne with the city's extensive tram network. While originally intended to help accommodate trams and not as a pedestrian safety intervention, the Melbourne Hook reduces the chance of hitting a crossing pedestrian because the hook turn eliminates the conflict that happens when vehicles are turning into a simultaneous walk phase. This type of crash, where pedestrians have the right-of-way, is especially common in cities where the turning vehicles need to consider crossing pedestrians while simultaneously looking for gaps in multiple lanes of opposing traffic (FHWA, 2006; New York City DOT, 2010). Another advantage is that the hook turn eliminates the need for a dedicated turn lane. This facilitates narrower roads and reduced pedestrian crossing distances. While Melbourne Hook road safety studies remain somewhat limited and do not consider pedestrians, the results suggest improved safety outcomes (Currie & Reynolds, 2011; O'Brien, 2000). Their usage is probably not extensive enough to have a considerable impact on national road safety statistics, but they are common in downtown Melbourne within a metropolitan area that houses 16.5% of Australia's overall population.

Figure 3.4 Queuing Area for Melbourne Hook Turn (image to right depicts official sign)

In terms of overall intersection safety, 20.3% of road fatalities in Australia occurred at intersections in 2014 (BITRE, 2016b). For the most recent year of U.S. data, 24.1% of fatalities occur at intersections (IIHS, 2016). While a significant difference, this probably underestimates the relative safety advantage of Australian intersections. Generally, the percent of road fatalities occurring at intersections is much higher in urban areas as opposed to rural. For instance, in the United States, 16% of road fatalities in rural areas occur at intersections, as compared with 32% in urban areas (IIHS, 2016). While a similar urban-rural breakdown of intersection-related crashes in Australia was not available, the fact that Australia is decidedly more urban – and also has a lower percentage of fatalities at intersections than the United States – suggests that the safety difference is likely greater than the statistics imply.

3.2.3 Street Design

Street designs in Australia tend to be relatively similar to the United States. Signage and road marking are not overly different, with some minor exceptions. For instance, when approaching an area with significant pedestrian activity or a pedestrian crossing – especially when sight distance might be limited by a curve, crest, or sag in the road – Australia uses zig-zag striping, as shown in Figure 3.5, to warn the driver that slowing down would be prudent.

Figure 3.5 Zig-zag Markings on the Approach to an Unsignalized, Marked Pedestrian Crossing in Sydney, Australia

Overall street widths within both countries vary considerably. It is common to find extremely narrow residential streets, especially in older cities in either country. It is also common to find overly wide streets in either country. Systematically comparing differences in street width at a national scale is difficult; as a result, I looked specifically at two more recently planned communities: Rouse Hill Regional Centre in Sydney’s western suburbs; and Stapleton, a relatively new community in Denver, CO, on the site of the old airport. In terms of street width and road safety, the research suggests negative safety implications of wider streets (Dumbaugh, 2005; Noland, 2000; Swift, Painter, & Goldstein, 1997), primarily because wider streets result in faster speeds (Daisa & Peers, 1997; Ivan, Garrick, & Hansen, 2009; Martens, Comte, & Kaptein, 1997). While the size of the effect is difficult to isolate, it can explain differences in road safety (Gattis, 2000; Gattis & Watts, 1999).

Both Rouse Hill and Stapleton are master planned developments located within well-established cities. Both are mixed use and include significant residential and commercial/retail as well as some industrial. Both are also representative of relatively new communities designed to accommodate cars but also with multimodal transportation at the forefront. This includes extensive pedestrian and bicycling networks as well as transit accessibility. In addition to good bus service, both will be connected to their downtowns via train; the A Line in Denver opened in 2016 while the Metro Northwest line opened in 2019.

Local and collector streets in both communities tend to be the most comparable because they have generally been designed for two-way traffic with on-street parking on both sides. Such a cross-section in the Rouse Hill neighborhood is designed to be 27.9’ (8.5 m) curb-to-curb; in Stapleton, a similar local street would be designed at 32’ (9.5 m) across (although 30’ or 9.1 m would be allowed on streets with fewer than three underground utilities, which is rare). Collector streets have an even greater disparity. Rouse Hill’s collector streets are designed to be 31.2’ (9.5 m) curb-to-curb, which is quite a bit less than the 38’ (11.6 m) widths of collector streets in Stapleton.

One reason for these differences might come in the application of the design speed concept. First off, design speed is essentially defined as the selected speed used to determine the geometric configuration of a street. In U.S. street design guidelines, it is further explained as follows (AASHTO, 2011):

> *Except for local street where speed controls are frequently included intentionally, every effort should be made to use as high a design speed as practical to attain a designed degree of safety.*

This line of thinking suggests that drivers, inevitably err, but when they do, the higher design speed selection essentially functions as a safety factor. The AASHTO Green Book goes on to say that "above-minimum design values should be used, where practical" (AASHTO, 2011). The 2011 version of the book added "particularly on high-speed facilities" to this statement as well as acknowledging that "on lower speed facilities, use of above-minimum design criteria may encourage travel at speeds higher than the design speed" (AASHTO, 2011). However, conventional thinking in the United States has historically been that higher design speeds are better.

In contrast, Australian guidelines suggest setting the design speed at just 10 km/h (6.2 mph) over the intended speed limit. The underlying intent is for speed limits to be self-enforcing, which represents a more active approach to street design and safety. In the case of Rouse Hill, this would mean a design speed of 40 km/h (24.9 mph) on local streets and 50 km/h (31.1 mph) on collectors (The Hills Shire Council, 2012). The AustRoads Guide to Road Design, which seems to be the Australian equivalent of the AASHTO Green Book, suggests design speeds of 10 km/h (50 km/h on local roads and 60 km/h on collectors and minor arterials) over the Rouse Hill guidelines. Other than for highways, most U.S. guidelines do not offer specific design speed suggestions, leaving the decision in the hands of the engineer. While a U.S. engineer could similarly select a design speed that comports with the intended speed limit, the guidelines seem to encourage higher values.

Related to the design speed issue, there is also a difference in the application of the 85th percentile speed concept. In the United States, the 85th percentile speed is intended to help set an appropriate speed limit at a number lower than the design speed (AASHTO, 2011). In Australia, the design speed is intended to be the same as the 85th percentile speed (The Hills Shire Council, 2012). Australia does not use the 85th percentile speed to set speed limits (L. Mooren, Grzebieta, & Job, 2011). While these sound like similar philosophies, the difference could be quite substantial, especially given the nature of design speed selection processes. If a U.S. engineer, for example, sets their design speed to be just 10 mph (16.1 km/h) over the intended speed limit and drivers happen to follow the design speed instead of the speed limit, which the research suggests is the case in most situations (Edquist, Rudin-Brown, & Lenne, 2009), then the protocol would be to increase the speed limit to match driver preference. Even if a U.S. municipality does not increase the speed limit to better match the 85th percentile speed, the reality is then that the posted speed limit would be significantly below the 85th percentile speed (Fitzpatrick, Carlson, Brewer, Wooldridge, & Miaou, 2004). In fact, NCHRP Report 504 found that only 23% of free-flow vehicles were at or below the posted speed limit on suburban and urban collector roads located across seven U.S. cities; on local roads, this percentage increased to 52%, but it still means that almost half of drivers exceeded the speed limit on local roads in populated areas (Fitzpatrick et al., 2004). Given the underlying design philosophies in Australia, where the 85th percentile speed is intended to be the same as the design speed, this is less likely to be the case. Such speed reductions can impact road safety outcomes, particularly with respect to fatal and severe injury crashes (Elvik, 1997; TRB, 1998; Weller, Schlag, Friedel, & Rammin, 2008). A 2004 meta-analysis by Elvik and Vaa, for instance, found that increasing the speed limit by 15 km/h (9.3 mph) would correspond to a 26% increase in fatal crashes (Elvik & Vaa, 2004).

3.3 Safe Road Users

3.3.1 Travel Behavior & Exposure

Since vehicle speeds were already covered in the street design section and the enforcement section adds more to this discussion, the travel behavior section instead focuses on differences in exposure with respect to distances driven and mode choices. Table 3.1 aggregates the data discussed in this section.

In terms of driving distances, the average U.S. driver travels nearly 13,500 miles (21,726 km) each year (FHWA, 2016), as compared with under 10,000 miles (16,093 km) per year in Australia (Morris, 2013). For the average driver, this equates to 28.4% fewer miles driven. All other things being equal, a driver with less exposure should have better road safety. If we normalize total national mileage by the entire population of each country, the United States drops to just under 10,000 miles (16,093 km) per year while Australia sits at 6,400 miles (10,300 km) per year. Lower levels of mobility are often assumed to be a negative; however, this assumption is not as critical when we are comparing two first-world countries. If the average Australian can fulfill their daily needs with 35% fewer miles driven, that can help explain some of the differences in road safety outcomes. How can Australians manage that? In more urban places, location efficiency can be a major advantage. For instance, the average American commutes 11.8 miles (19.0 km) to work as compared with 9.7 miles (15.6 km) for an Australian (BITRE, 2015a; Santos, McGuckin, Nakamoto, Gray, & Liss, 2011). Traveling an extra four miles (6.4 km) to work each day is potentially unnecessary exposure that, when multiplied by millions of people, can have significant road safety implications.

Another reason for these differences is that driving is significantly more expensive in Australia. In the United States, the average annual cost of driving – including licensure, insurance, registration, taxes, depreciation, finance charges, maintenance, tires, and fuel – is $8,558 USD (BTS, 2016). Australia does not aggregate their costs in quite the same way, but a recent report suggests that the average annual cost of running a car ranges from $11,274 USD to $17,429 USD, depending upon where you live in Australia (J. Dowling, 2016). One big difference in the variable costs of driving is the cost of fuel. Recent U.S. data suggest an average gas price of $2.34 USD per gallon ($0.62 USD per liter) (AAA, 2017b). In Australia, an equivalent volume of regular gasoline would cost about $4.09 USD ($1.08 USD per liter), a 75% increase.

The U.S. federal gas tax is $0.184 USD per gallon ($0.049 USD per liter). The state gas taxes range from $0.1675 USD per gallon ($0.044 USD per liter) in South Carolina to $0.504 USD per gallon ($0.133 USD per liter) in Pennsylvania (Kaeding, 2017). Together, these taxes represent between 15% and 29.4% of the cost of gasoline in the United States. Moreover, these percentages continue to drop since the tax rates do not adjust to inflation. The Australian federal gas tax is currently $1.20 USD per gallon ($0.32 USD per liter), and it adjusts semi-annually to inflation (AAA, 2017a).

A recent report compared the costs of 14 cars and found that, due to issues such as market size and geographic isolation, cars cost approximately 35% more in Australia (N. Dowling, 2011). When combined with higher initial car costs, it is understandable that this may also play a factor in reduced driving – and thus exposure – in Australia.

Higher driving costs can also impact mode shares, which can further help explain differences in safety outcomes. Transit, for example, is typically a much safer mode of transportation than driving. With fewer than 0.06 fatalities per 100 million passenger transit miles (161M km) traveled, transit is approximately 19 times safer than driving (Politifact.com, 2011). Accordingly, a country with a relatively high percentage of people traveling by transit should be safer than the typical automobile-based country. For instance, an international study by Kenworthy and Laube concluded that places with higher transit use tended to have lower overall fatality rates (Kenworthy & Laube, 2000). Other researchers have found that per-capita fatality rates are lower with increased transit use and that residents of automobile-oriented communities have traffic fatality rates five times those living in transit-oriented communities (Litman, 2009, 2013; Stimpson, Wilson, Araz, & Pagan, 2014). One reason behind these results is that transit can substitute for driving. When comparing the commute mode shares of the United States to Australia, U.S. transit use sits at 5.2%, less than half that of Australia's 12.5% (BITRE, 2016a; Polzin, 2016).

Table 3.1 National Differences in Driving Distance, Commute Mode Shares, Car Ownership, Vehicle Fleet, and Enforcement Fines

	UNITED STATES	AUSTRALIA	*Difference*
Driving Distances			
Annual Mileage per Driver	13,476 mi. *21,687 km*	9,650 mi. *15,530 km*	*-28.4%*
Annual Mileage per Person	9,788 mi. *15,752 km*	6,378 mi. *10,264 km*	*-34.8%*
Daily Mileage per Driver	36.9 mi. *59.4 km*	26.4 mi. *42.5 km*	*-28.5%*
Daily Mileage per Person	26.8 mi. *43.2 km*	17.5 mi. *28.1 km*	*-34.8%*
Average Commute Distance	11.8 mi. *19.0 km*	9.7 mi. *15.6 km*	*-17.8%*
Commute Mode Shares			
% Driving	85.6 %	79.4 %	*-7.2%*
% Transit	5.2 %	12.5 %	*140.4%*
% Active Transportation	3.4 %	5.8 %	*70.6%*
% Work from Home	4.6 %	5.0 %	*8.7%*
Car Ownership & Vehicle Fleet			
% Households with Zero Cars	8.9 %	8.4 %	*-5.6%*
Avg. Age of Registered Vehicles	11.5 years	10.1 years	*-12.2%*
% SUV or Light Trucks	59.5 %	46.2 %	*-22.4%*
Cost of Gasoline (per gallon) *(per liter)*	$2.34 USD *$0.62 USD*	$4.09 USD *$1.08 USD*	*74.8%*
Example Enforcement Fines *(based upon Denver, Colorado & New South Wales)*			
Selt Belt Infraction	$65 USD	$260 USD	*300.0%*
Distracted Driving (e.g. cell phone)	$50 USD	$255 USD	*410.0%*
Running Red Light by Officer	$160 USD	$347 USD	*116.9%*
Running Red Light by Camera	$75 USD	$347 USD	*362.7%*
Speeding by Officer (10 mph over)	$151 USD	$212 USD	*40.4%*
Speeding by Camera (10 mph over	$40 USD	$212 USD	*430.0%*

Australians also rely upon active transportation modes at a far higher rate than Americans. When compared on a per-mile basis, both walking and bicycling are far more dangerous than driving (Mapes, 2009; John Pucher & Dijkstra, 2003). Using the same logic applied to transit, it stands to reason that countries with high levels of active transportation should have worse road safety records. Yet, this rarely turns out to be the case (Jacobsen, 2015; Jacobsen, Ragland, & Komanoff, 2015; Marshall & Garrick, 2011). For instance, the Netherlands – with one of the highest active transportation rates in the world – is also one of our safest countries with only 3.4 fatalities per 100,000 population. The reasons for this vary but include shifts in driver expectations and behaviors due to the increased chance of encountering pedestrians and bicyclists, built environment differences, demographic changes, and vehicle speeds. It also speaks to the increased level of urbanity in Australia as compared with the United States.

3.3.2 Driver Licensure

Another possible explanation of the road safety outcome differences between the United States and Australia could come with differences in acquiring driver's licenses, particularly with teens and older populations, two of the most over-represented age groups in road fatalities (NHTSA, 2017c, 2017d).

In the United States, driver's licensing rules vary greatly by state. In South Dakota, for example, the age of licensure is 14 years, 3 months. At the high end of the spectrum is New Jersey at 17 years. Almost every state runs a graduated licensing program that limits driving privileges (via curfews and passenger restrictions) for new or inexperienced drivers. Even with the graduated licensure programs, the minimum age of a full, unrestricted license is never greater than 18. While the age of licensure (excluding learner's permits) also varies by state in Australia – ranging from 16½ years old in the Northern Territory to 18 years old in Victoria, with 17 being the median age – the graduated licensure steps tend to be longer and much more restrictive.

Most Australian states have a four-stage process. With each of the first three phases, a special colored placard must be placed on the car that indicates the licensure status of the driver. For instance, in Victoria, it starts with a yellow learner's license, which allows for supervised driving that can be obtained at age 16. At age 18, after successfully holding a learner's permit for a full year, a candidate must then pass a computerized exam, a driving test, and an eye test to receive the P1 red probationary license. This P1 license limits both the size and power of the vehicle driven, bans all mobile devices usage regardless of being hands-free, prohibits towing, restricts the number of 16- to 21-year olds that can be in the car to one, and places the driver in the zero blood alcohol concentration (BAC) category (despite the fact that the legal drinking age is 18 in Australia). After one year of a good record with the red P1 probationary license, the driver automatically graduates to a green P2 probationary license. All of the P1 restrictions continue to apply except that peer passengers and towing are now allowed. After three years of a good record with a P2 license, the driver is then eligible for a full driver's license. Thus, the youngest that a driver can possibly obtain a full driver's license in Victoria is 22 years of age.

Multiple Australian states also have speed restrictions with each phase. For instance, in New South Wales, those with a learner's or P1 provisional license cannot drive over 90 km/h (55.9 mph), and those with a P2 provisional license cannot driver over 100 km/h (62.1 mph). This limitation applies regardless of the posted speed limit, and a violation would result in a three-month suspension.

Despite these extensive graduated licensure programs, young drivers are still over-represented in Australian road fatalities. However, the road fatality rate for the 15-24 age group has also dropped by nearly 43% over the last decade (BITRE, 2013). While some of these gains can probably be attributed to broader trends of lower licensure rates among young people, it is still headed in the right direction (Loader, 2015). The most recent figures show that the number of road deaths per 100,000 Australians aged 15-24 is 8.9; in the United States, the rate for the same age group (15-24) is 15.6 road fatalities per

100,000 population (BITRE, 2013; NHTSA, 2017d). This is significant disparity, and if the United States were able to equal this rate, it would save the lives of nearly 3,000 young Americans every year.

3.3.3 Enforcement

Traffic enforcement cameras (both red-light and speed) are becoming more common in the United States. In a recent report, the Washington, DC, metropolitan area had the most extensive program with 716 total traffic enforcement cameras, followed by the New York and Chicago metropolitan areas with 605 and 507 cameras, respectively (Kliff, 2017). The numbers then drop sharply to the next metropolitan area on the list, Dallas/Ft. Worth, with 270. Despite their proven safety benefits, traffic enforcement cameras remain a politically contentious issue, to the point where at least 10 states (such as Maine, Mississippi, New Hampshire, and West Virginia) have state laws prohibiting them (IIHS, 2017a).

In comparison, New South Wales, Australia, has 171 red-light cameras, 106 fixed speed cameras, and more than 1,000 locations on the annual mobile speed camera schedule (Transport for NSW, 2017b). These cameras cover more than 1,100 miles (1,770 km) of the roadway network. Victoria, which started its camera enforcement program in the late 1980s, now has 277 fixed cameras and approximately 2,000 mobile camera locations on its schedule (Victoria State Government, 2017a). In 2014, Victoria police added distracted driving cameras – shown in Figure 3.6 – that can capture images of drivers using their cell phones, eating, or putting on makeup from 2,300 feet (700 m) away (Moor & Devic, 2014). These cameras are now starting to be used in other Australian states. The United States does not seem to have made this leap, despite recent U.S. statistics suggesting that more than 10% of fatal crashes and 15% of injury crashes include distracted driving as a contributing factor (NHTSA, 2017a).

Figure 3.6 Distracted Driving Camera in Melbourne, Victoria, Australia
(Source: Herald Sun, Melbourne, Victoria, Australia)

The cost of a violation in Australia also tends to be much steeper than a comparative offense in the United States, as shown in Table 3.1. For instance, running a red light would cost $347 USD in New South Wales, Australia. Using a mobile device while driving would cost $255 USD, or $347 USD if in a school zone. Driving 10 km/h (6.2 mph) over the speed limit would cost $212 USD while driving more than 45 km/h (27 mph) over the speed limit would set you back $1,880 USD. Not wearing a seat belt would cost $260 USD, but it would jump to $1,097 USD if you had four unrestrained passengers in the car. In

Denver, CO, for instance, a camera-enforced speeding violation would cost $40 USD ($80 USD if in a school zone) and running a red light would cost $75 USD.

Another difference is that the most Australian states treat the demerits originating from cameras the same as a police officer pulling over the driver. All of the Australian examples would add significant demerit points and would even add double demerit points for mobile phone offenses or those that take place in a school zone. However, the Denver examples would not add points to your driving record unless you are pulled over by an officer.

Most of Australia also has relatively strict bicycling laws and fines. Running a red light, not stopping at a pedestrian crossing, or riding dangerously in New South Wales would cost $340 USD; not wearing a helmet would cost $255 USD, while all other offenses (including not carrying an ID or having a bell) would cost $85 USD. These fines are cumulative as well, so if you ran a red light without a helmet or bike bell, it could cost you $680 USD. Bicycling helmets have been mandatory in Victoria since 1990, and the other Australian states followed suit by 1992. The data suggest that Australians tend to follow the bicycling rules better than U.S. residents (Marshall, Piatkowski, & Johnson, 2017). Is bicycling also safer in Australia? It is difficult to say, but despite similar rates of bicycling in both countries (J. Pucher & Buehler, 2008), bicyclists comprise 3.9% of all road fatalities in Australia as compared with 2.3% in the United States (BITRE, 2015b; McKenzie, 2014). While the fatality numbers are over-representative of mode usage in both cases, Australia's relative record on bicyclist safety is significantly worse than that of the United States.

3.3.4 Impaired Driving

Alcohol has long been a significant issue in terms of road safety outcomes, and these countries have their share of differences in terms of both policy and enforcement.

In terms of policy differences, the U.S. legal BAC limit is set at 0.08%. For commercial drivers, the limit is half that at 0.04%. Australia, notably, has lower BAC limits of 0.05%, which dates back to Victoria's initial law in 1966, and 0.02% for commercial drivers as well as for drivers of any truck over a certain weight. Moreover, the BAC limit is zero for drivers holding a driver's license from another country or anyone with a provisional license (although these are commonly enforced at 0.02%, which is consistent with the recommendation of the World Health Organization).

Despite the lower BAC limits that would classify more crashes as alcohol-related, Australia experiences a lower percentage of alcohol-related road fatalities. In the United States, 29% of 2015 traffic fatalities involved alcohol as a contributing crash factor (NHTSA, 2016a). This number has dropped significantly from over half of all road fatalities in 1990 to just over 42% in 2009 (Chambers, Liu, & Moore, 2012). Alcohol as a contributing factor in Australia's road fatalities, on the other hand, dropped from 44% in 1981, to 28% in 1999, and to 13% in 2015 (Australian Transport Safety Bureau, 2004; Transport Accident Commisson, 2016).

In addition to lower BAC limits, Australia is known for strict enforcement. Random breathalyzers are extremely common in Australia, having been around since 1976 in Victoria and in all states by 1988. For instance, in 1985, Tasmania conducted more than 200,000 random breathalyzer tests on a driving population of only 268,887 (Homel, 1990; Sutton, Farrar, & Campbell, 1986). With their random breath testing program, Australia seems to focus more on deterrence than maximizing arrests via a highly visible and intense approach.

Random drug testing is also becoming common in Australia; interestingly, the percentage of positive results is almost 10 times higher than for alcohol. For instance, New South Wales conducted over six million alcohol tests (finding less than 1% positive) and over 100,000 drug tests (finding approximately 10% positive) in 2015 (Transport for NSW, 2017a)[3]. While saliva-based drug testing is common in Australia – and current only able to test for three drugs: THC (i.e., cannabis), methamphetamine (i.e., speed, ice, or crystal meth) and MDMA (i.e., ecstasy) – law enforcement has the power to test for other drugs via blood testing. Blood tests are also mandatory for any driver admitted to a hospital with injuries suffered in a road crash. So while Australia tests for drugs all drivers killed in crashes, the United States only tested 57% of drivers killed in 2015 crashes (Hedlund, 2017). The data are harder to come by, but the initial reports suggest that U.S. drug-related crashes may be similar in numbers to alcohol-related crashes, if not more (Hedlund, 2017; Wheeler, 2015).

Related to the alcohol enforcement issue is the fact that alcohol is significantly more expensive in Australia than in the United States. Multiple cost of living indices suggest that ordering similar alcoholic drinks at a restaurant would cost 20% more in Australia than the United States (Adamovic, 2017; Sanyal, 2013). The larger difference comes when buying alcohol at a liquor store where beer or spirits cost approximately 40% more in Australia. Similar level wines, on the other hand, are slightly more expensive in Australia (~8%).

While the reasons behind these price differences are multi-fold, one contributing factor is the alcohol excise tax. The specifics are overly complicated for the purposes of this report (e.g., depending on alcohol volume and packaging, Australia has eight possible tax rates for beer alone); however, Australia generally has four federal alcohol taxes: an excise tax that varies semi-annually based on inflation, the Wine Equalisation Tax (WET) based on sales, a customs duty based on alcohol content and sales, and a 10% tax on all retail sales (Anderson, 2014; Chung, 2014). The bottom line is that these taxes combine to comprise a significant portion of the cost of alcohol in Australia. When compared to the United States, a liter of pure alcohol would come with a tax of $32 USD in Australia and only $2 USD in, for example, California (Hudson, 2013)

What does the cost of alcohol have to do with road safety? The authors of a meta-analysis of more than 100 studies reported significant elasticities between price and consumption of -0.46 for beer, -0.69 for wine, and -0.80 for spirits in addition to significant reductions in heavy drinking (Wagenaar, Salois, & Komro, 2009). Several longitudinal studies also suggest that a larger excise tax on alcohol can play a significant role in reducing related crashes (Saar, 2015; Son & Topyan, 2011).

[3] The primary reason behind testing for alcohol 60 times more than for drugs seems to be that the drug test takes approximately 10 times longer for police to administer.

4. DISCUSSION

4.1 Vision Zero Policies

Similar to the United States, Australia is a federation of semiautonomous states and territories, and the role of the federal government in road safety has essentially been limited to vehicle standards and infrastructure funding (Lori Mooren & Grzebieta, 2013). Nevertheless, Australia's National Road Safety Strategy established its version of Vision Zero – called the Safe System Approach – in November 2003 (Langford, 2009). Based upon the Vison Zero program first adopted by Sweden in 1997, albeit with less of a moral imperative, Australia's road safety strategy has now been adopted by all six Australian states and is the principal policy behind road safety efforts nationwide (L. Mooren et al., 2011; Williams & Haworth, 2007). Similar to Sweden's Vision Zero, the intent is to eliminate all traffic fatalities; for instance, Australia's current National Road Safety Strategy (2011 – 2020) states:

> *No person should be killed or seriously injured on Australia's roads.*

As opposed to the conventional, epidemiological approach to road safety – where dollar values are placed on health and life (and a certain number of fender benders equates to a fatality) in order to conduct cost/benefit analyses of interventions – the supposed paradigm shift is that traffic deaths and injuries are preventable and therefore unacceptable. Given the relative autonomy among Australian states, it is difficult to attribute specific interventions to their national safety program. In turn, this means that definitively linking Australia's road safety gains since the program begin to a national program is not realistic (L. Mooren et al., 2011). One of the keys to Australia's approach, however, is to shift responsibility from road users for their behavior on the roads to the engineers, planners, and policymakers. This includes actively managing vehicle speeds so that when crashes do occur, the chance of a fatality is reduced (Langford & Oxley, 2006). Much of the evidence found this in report suggests that Australia is moving in the right direction with respect to this particular issue.

In the United States, the U.S. Department of Transportation and the Federal Highway Administration initiated their Toward Zero Deaths program in 2015, more than a decade after Australia's version. Similar to Australia, the federal policy is by no means a mandate – especially because there is no meaningful funding tied to it – and a shift away from the conventional approach to road safety requires state and local support. Thus far, only a few states (e.g., Ohio and Oregon) have followed suit (Schmitt, 2016). Support has been stronger at the city level. Starting with New York City and San Francisco in 2014, variations of Vision Zero now include 26 U.S. cities and one county. Still, these cities represent a small fraction of the overall U.S. adoption of the program. Moreover, there is little evidence to suggest that these U.S. Vision Zero cities and states are doing much differently than they did before (Schmitt, 2016). However, it is still early and not one of the U.S.-based Vision Zero or Toward Zero Deaths programs has been around more than a few years. Thus, it is difficult to assess changes in road safety, especially those that might be related to infrastructure.

4.2 Governance & Other Institutional Factors

With such an investigation, it is also worth considering differences in governance and other institutional factors that may contribute to road safety outcomes. In a 2007 paper comparing the safety cultures of the United States and Australia, Williams and Haworth found that, in general, the Australian government seems more willing than the U.S. government to use a scientific approach to adopt policies intended to improve public safety (Williams & Haworth, 2007). In terms of Australia's widespread camera enforcement program, for instance, the research showed the safety benefits of its initial program, and based on empirical evidence of success, Australia continued to grow the program (Delaney, Ward, Cameron, & Williams, 2005). In the United States, the debate over camera enforcement and safety tends to get sidetracked by issues of politics, money, and privacy (Al-Turki, 2014). Also, if data do not exist, Australia seems willing to test programs, such as it has done with graduated driver's licensure and are currently doing with its point-to-point speed enforcement program on highways (Senserrick, 2007; Simpson, 2003).

Australia's approach to road safety even extends to cases when the policy could be perceived as intervening in people's lives, such as with random breathalyzers and mandatory helmet laws (Williams & Haworth, 2007). Australia also recently deployed an automatic number plate recognition (ANPR) program. While the ANPR program helps identify unregistered/uninsured vehicles and suspended/unlicensed drivers, it is able to "track vehicles in real time from one side of a city to the other with pinpoint accuracy" (Hannaford, 2015). Potentially invasive programs such as these – even when accompanied by a proven safety benefit – tend to be difficult politically in the United States.

A related advantage that Australia seems to enjoy is greater latitude in terms of implementation. With far fewer states and a greater consolidation of powers at the state level rather than at the county or municipal level, Australia can enact policies without as many people or groups involved in the decision-making process (Williams & Haworth, 2007). For instance, the current population distribution makes it possible for two Australian police departments – the states of New South Wales and Victoria – to make decisions for more than 55% of Australia's population (Williams & Haworth, 2007). Greater uniformity in policies and practice could play a role in Australia's improved outcomes. Moreover, most Australian states have bipartisan Parliamentary committees that are responsible for road safety efforts (Lori Mooren & Grzebieta, 2013), such as the Police and Public Safety Committee in Queensland and the Staysafe Committee in New South Wales. If a member of Parliament does not sit on such a committee, they have little role in these efforts because road safety does not often get addressed above the committee level (Lori Mooren & Grzebieta, 2013). Despite the limited Parliamentary role, road safety is a problem that requires cross-agency cooperation; thus, Australian states also tend to have formal agreements intended to promote such efforts. Overall, Australia tends to have a stronger culture of safety with more direct institutional pathways to achieve success.

5. CONCLUSIONS

The reality is that many U.S. engineers, planners, and policymakers look at some of the interventions coming out of the safest countries in world, such as Sweden and the Netherlands, and are often unwilling to make similar changes, even when there is an expected safety benefit. It is all too easy to make the argument that, for instance, Denver is not Copenhagen or Amsterdam, and thus, their approaches would never work here. Australia, however, is more similar to the United States in terms of transportation, land use, and culture than most European countries. Australia also has a much better road safety record than the United States, particularly in recent years. The question this report sought to answer is: why is this the case?

The results of this analysis suggest that a number of factors are playing a role in the better road safety outcomes of Australia as compared with the United States. The U.S. approach to better road safety tends to focus on issues such as seat belt usage and impaired driving (Schmitt, 2016). Australia not only seems to be doing a better job in those areas but has also made significant strides in programs related to curbing vehicle speeds, which is an issue at the heart of the movement to reduce fatalities. This includes safer roads via design-related differences in the use of roundabouts and narrower roads, policy-related differences in terms of how design speed is used to design self-enforcing roads, as well as a much stronger and more extensive speed camera enforcement program, which incentivizes safer road users. Whether intentional or not, the restrictive licensing programs and higher driving costs in Australia have helped reduce driving mileage and exposure, particularly by some of the most vulnerable drivers. When combined with a greater degree of urbanism and appropriate multimodal infrastructure, Australia's system tends to encourage road users toward safer modes of transportation, such as transit.

While transportation planners and engineers have control over some – but certainly not all – of these differences, a portion of Australia's road safety gains can be attributed to the behaviors of the road users themselves. For example, the evidence suggests that Australian drivers overwhelmingly stop for pedestrians in marked crosswalks, even those that are unsignalized. High fines and strong enforcement likely play a role, but with less than half of American drivers stopping for pedestrians in similar circumstances, Australians seem to take on more personal responsibility over more vulnerable road users, which has its safety benefits.

Australia also seems to possess a greater degree of political will and institutional support. This includes the broader reach of its Vision Zero-like policies that, if truly enacted, would represent a fundamental paradigm shift in our approach to how we plan and design transportation systems. Although neither the United States nor Australia has quite made that shift, Australia continues to move in the right direction – and is doing so at a much faster pace than the United States.

Transferring successful designs and policies from countries such as Australia to U.S. context requires a greater understanding of these countries than we currently have. This report is a start, but it was not able to cover every conceivable difference that might contribute to safety disparities, such as those that might be found with vehicle safety standards or disparities in emergency medical care and post-crash trauma care. Victoria, Australia, for instance, put a great deal of effort into integrating its road trauma management initiatives into its broader trauma management system (Victoria State Government, 2017b). Future research needs to continue gathering empirical evidence – particularly from countries such as Australia – regarding what actually makes our transportation systems safer and how we can save more lives. The United States also needs to be more willing to test these international approaches for itself.

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