Evaluation of Glenferrie Road 'Door Zone' Bicycle Lanes

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Contents

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Executive Summary

This report describes an evaluation of a trial "door zone" bicycle lane treatment implemented on Glenferrie Road in Hawthorn between Burwood Road and Barkers Road. The treatment covers a length of approximately 900 m on both sides of the road and was completed in March 2014. The project was funded under the innovative component of the Safer Road Infrastructure Program (SRIP) provided by the Transport Accident Commission.

The design has the primary objective of reducing the risks to bicycle riders of being involved in collisions with opening car doors. The design consists of a 600 mm wide green painted "preferred bicycle riding zone" positioned 800 mm from the parking edge line and a chevron buffer between the fairway line and outer tram track in the general purpose traffic lane.

A before-after evaluation was conducted using video observations of bicycle riders and motorists before and after treatment, and interviews of bicycle riders and visitors to the precinct after the treatment was installed. The before period was in November/December 2013 and there were two after periods – in May 2014 and then again in November 2014.

The main results of the study were as follows:

- Cyclist lateral tracking:
  - Riders appear to have taken some time to adapt to the treatment; there was no statistically significant shift in cyclist lateral tracking immediately after the installation of the treatment in May 2014, but there was a shift in average lateral tracking and a reduction in the proportion riding within 0.8 m of parking in November 2014.
  - At two of the four sites for which before-treatment data is available there was a statistically significant and meaningful reduction in the proportion of riders travelling within 0.8 m of parking; at these two sites the proportion riding within 0.8 m decreased from 13 – 20% to less than 5% (a decrease of around three quarters).
  - There was a significant reduction in the variability in cyclist lateral tracking during both after periods; this appears to be attributable both to riders who previously used the general purpose traffic lane now riding within the preferred bicycle riding zone, and (at two of the four sites) to fewer riders travelling within 0.8 m of parking.
- Motorist lateral tracking:
  - Average motorist lateral tracking positions shifted towards the centreline by 0.16 to 0.28 m at three of the four sites. Furthermore, the proportion of motorists encroaching into the bicycle lane (left of the fairway line) decreased by around half after the treatment was installed.
  - There were conflicting results for the variability in motorist lateral tracking; at two sites the variability decreased and at the other two sites it increased. Why this would be the case is not clear.

- Parking positions:
    - The parking bays at three of the observed sites on the western side of the road were reduced in width from 2.3 m to 2.0 m as part of the treatment.
    - At two of these narrowed sites a statistically significant reduction in average parking offset from the kerb was measured of around 0.1 m. This suggests that narrowing a parking bay will shift parked vehicles to the left by a ratio of around 1/3.
    - No change in parking position was detected at the site where the parking bay remained at 2.1 m but parking linemarking Ts were replaced with a solid edge line.
- Road user perceptions:
    - Bicycle riders rated the treatment favourably; 75% felt more comfortable after the lanes were installed compared to 4% who felt less comfortable.
    - Bicycle riders appeared to understand the intent of the treatment and where the treatment was suggesting they should ride; 63% thought the intention was to encourage riding away from parked cars.
    - Other visitors to the precinct also appeared to look favourably upon the treatment, even if they did not fully understand its purpose; 87% of pedestrians were in favour of the treatment.
    - Motorists generally appeared to have a fair understanding of the risks associated with opening car doors into traffic, and their legal obligations when doing so; 63% of motorists thought (correctly) a motor vehicle occupant is primarily responsible in a collision between a car door and a rider.

Overall, it appears that the treatment is well understood and appreciated by both riders and non-riders, has reduced motorist encroachment into the bicycle lane and has encouraged riders to travel outside the "dooring zone". Our view is that these results are encouraging but not definitive. We say this because the observed changes were not consistent across all observed sites, and best practice would dictate that the results be independently reproducible at another location. However, the results are (in our view) sufficiently strong to justify (a) retaining the treatment at Glenferrie Road, and (b) considering additional trials at another site. Should the positive results be replicated elsewhere our view is that the treatment be considered for inclusion in a future update of the relevant engineering guidance.

It is suggested that consideration be given to trialling a section of roadway with a chevron marking between the parking bays and preferred bicycle riding zone. This may encourage less confident riders to ride farther away from parked cars, but may also have the perverse effect of leading to less conscientious dooring opening behaviours by motorists. In addition, it is suggested that an automatic bicycle counter be installed as standard practice as part of projects of this scale to provide robust exposure (counts) data. Finally, in the longer term an evaluation based on the police-reported crash statistics is recommended in order to ascertain any change in cyclist crash frequencies.

1 Introduction

1.1 Background

This report describes an evaluation of a "door zone" bicycle lane treatment applied to Glenferrie Road in Hawthorn (Burwood Road to Barkers Road). The site has a number of characteristics common to many inner Melbourne strip shopping precincts:

- high demand for motor traffic movements into and through the precinct but generally low traffic speeds (40 km/h speed limit),
- high demand for kerbside parking and high parking turnover (parking is generally restricted to two hours or less),
- high pedestrian volumes along the footpaths and across the roadway at both designated crossings and at mid-block locations,
- trams and motor vehicles sharing the general purpose traffic lane,
- kerb-to-kerb road widths of around 13.5 to 14.0 m, and
- a bicycle lane of around 1.5 m immediately adjacent to the kerbside parking.

These characteristics impose physical constraints on what can reasonably be done to facilitate the convenient and safe movement of people through this space while also maintaining the role of the precinct as a major destination.

In 2010 a fatal injury crash occurred when a bicycle rider was struck by an opening car door and fell into the path of a truck in the adjacent general purpose traffic lane (Coroners Court of Victoria 2011). In response to this crash, and in recognition that "car dooring" related crashes are the most common form of injury collision to bicycle riders in inner Melbourne (CDM Research 2012a; Parliament of Victoria 2012) the City of Boroondara and VicRoads developed an alternative bicycle lane treatment to try to address this issue. The present study was commissioned to evaluate this treatment.

1.2 Treatment description

The typical configuration of the bicycle lanes on Glenferrie Road before and after the treatment are shown in Figure 1.1. The pertinent characteristics of the bicycle lane before treatment are as follows:

- bicycle lane pavement symbols centred between the outer parking edge line and the yellow fairway line,
- nominal bicycle lane width (between the parking edge line and fairway line) of 1.5 m,
- varying parking bay delineation, from solid parking edge line (Figure 1.1(a) – western side near Glenferrie Station) to parking Ts (Figure 1.1(b) – eastern side near Linda Crescent), and
- parking bay widths of around 2.1 m on the eastern side of the road and up to 2.3 m on the western side (varying somewhat along the length).

The after treatment condition is markedly different:

- a continuous 0.6 m wide green "preferred bicycle riding space" is marked 0.8 m out from the parking outer edge line,
- the green surface treatment extends for the full 1.5 m width across unsignalised intersections,
- a 0.3 m wide white painted chevron buffer is marked in the general purpose lane, and
- parking bays are defined by a continuous white edge line (prior to treatment some bays were marked with parking Ts).

The intention of the design elements was as follows:

- Green preferred bicycle riding space:
    - encourage riders to travel farther away from parked cars (so reducing their likelihood of colliding with an opening car door),
    - increase the sense of subjective safety for riders by more clearly designating their exclusive space on the roadway,
    - retain a "standard" untreated surface directly adjacent parked cars in order to encourage motor vehicle occupants to continue to perceive the roadway as active and so take due care when opening their doors.
- Green surface at side streets:
    - encourage emerging and entering motorists to watch for bicycle riders,[1] and
    - increase the sense of subjective safety of bicycle riders.
- Chevron buffer:
    - encourage motorists in the general purpose travel lane to track farther to the right, so providing additional clearance from bicycle riders in the preferred bicycle riding space, and
    - improve the consistency of motorist lateral tracking by reducing the likelihood motorists will track to the left.

[1] There is some evidence from the use of this treatment at other sites in Melbourne that it decreases the level of conflict between motorists emerging from side streets and bicycle riders on the main road (Sinclair Knight Merz 2011).

■ Figure 1.1: Lane configuration before and after treatment

(a) Before treatment

(b) After treatment

1.3 Objectives of this study

The primary objective of this study was to assess the effectiveness of the project at improving objective and subjective safety for bicycle riders. We differentiate between these forms of safety in this study; objective safety being *actual* safety outcomes (i.e. injuries) and subjective safety being rider perceptions towards their own safety (in essence, their sense of comfort). As insufficient time has elapsed to compare crash frequencies a proxy-based approach was used to measure objective safety; that is, surrogate observed behaviours were measured and inferred to have positive or negative safety outcomes. Secondary objectives were to assess the change in motorist driving and parking behaviour, as well as an appreciation of how well road users understand the intent of the treatment.

1.4 Structure of this report

This report is structured as follows:

- Chapter 2 describes the measures of effectiveness and methodology used for this evaluation.
- Chapter 3 briefly reviews the crash history for bicycle riders in the treated area.
- Chapter 4 presents results from cyclist lateral tracking, motorist lateral tracking and motorist parking positions.
- Chapter 5 presents the results of the intercept survey on bicycle rider and visitor perceptions and understanding of the treatment.
- Chapter 6 discusses the meaning and possible implications of the fieldwork and data collection.
- Chapter 7 presents recommendations for possible improvements to this treatment based on the evaluation, and more general recommendations.

2 Methodology

2.1 Background

Ideally, one would use police-reported crash statistics as a means of objectively evaluating the treatment.[2] However, the frequency at which these events occur (and are reported to police) is low – there having been three car dooring crashes in the five years from 2008 to 2012. Nonetheless, it may be possible to observe a statistically significant change in dooring crash frequency over a reasonable post-evaluation period. However "reasonable" would still imply several years of post-treatment data to be required (likely to be 2-3 years as an absolute minimum). Such a crash based evaluation could be considered in due course.

It is also likely that over a period of several years cyclist volumes will change along the route, which will influence the crash frequency but not necessarily the risk. In other words, it is possible that the treatment (or other external factors) will lead to an increase in cycling travel along Glenferrie Road which would, all else being equal, be expected to increase the crash frequency. However, the presence of the treatment may reduce the risk per trip – even though the total number of crashes increases. As there is no permanent bicycle counter on Glenferrie Road it will be difficult to establish an exposure measure to control for this exposure effect[3].

2.2 Measures of effectiveness

In lieu of using crash frequency or risk as measures of effectiveness, a number of proxy measures have been used as alternatives. These proxy measures have three primary advantages over crash measures:

- results can be obtained very soon after the treatment is installed (unlike crashes, for which a number of years will be required),
- they avoid the need to control for exposure (if a risk measure is desired), and
- they offer insight into the behavioural responses of the user groups.

This last benefit is particularly useful; not only is the objective of the evaluation to determine whether the treatment is *safer* but ideally it should offer some insight into *why* this may (or may not) be the case. This is particularly true given the experimental nature of this treatment; we require an understanding of what parts of the design appear to work well, and what parts work less well.

Proxy measures have at least one major drawback – the analyst is assuming the proxies are correlated with safety outcomes. This can be a significant problem, although in this particular study we would argue the chosen proxy measures are likely, on the balance of

[2] It is noted however that the majority of crashes involving bicycle riders (perhaps around 80%) are not reported to the police, and hence will not be captured within this dataset.

[3] It is not necessarily the case that exposure-controls would be required; the overall injury burden is represented by the number of crashes (and their severity) – it is ultimately this crash count which should be reduced (irrespective of the change in risk per trip).

probabilities, to be directly related to safety outcomes. In other words, if we see a shift in bicycle riders tracking away from parked cars it seems reasonable to expect this will lead to a reduction in car dooring crashes.

One single measure of effectiveness may provide only a partial picture of the overall impact of the treatment, and this partial picture may be biased (even if unintentionally). It is more useful and insightful to evaluate a treatment across a number of different measures. Furthermore, in real world evaluation studies it is likely that one or more measure will be compromised in some way that limits our ability to draw reasonable, defensible inferences. As such, it is prudent to identify multiple measures against which the treatment will be assessed and to consider them together in evaluating the treatment.

Taking into account these issues, five measures of effectiveness have been used to evaluate the treatment, as described in Table 2.1. Together, we would expect these five measures to provide insight into the likely safety outcomes of the treatment and insight into the behavioural adaptations riders and motorists are making as a result of the treatment. The intention is that together these measures will provide insight into the likely safety implications of the design, as well as pointing to potential improvements (if any) for future applications.

- Table 2.1: Measures of effectiveness

Measure	Definition of "success"	How?	When?	Comment
Cyclist lateral tracking	a. Increased average clearance between riders and parked cars b. Decreased proportion of riders riding within 1 m of parked cars	Video observations with subsequent manual processing	Before and after	Processing using pixel coordinates and geometric transformations to obtain as accurate a result as possible
Motorist lateral tracking	a. Average tracking position moves towards the road centreline. b. Decreased variability in lateral tracking positions	Video observations with subsequent manual processing	Before and after	Processing using pixel coordinates and geometric transformations to obtain as accurate a result as possible
Motorist parking position	Increased proportion of motorists park within the designated parking bay and do not encroach onto the roadway	Video observations with subsequent manual processing	Before and after	Processing using pixel coordinates and geometric transformations to obtain as accurate a result as possible
Cyclist perceptions	Proportion of riders who feel safer with the treatment exceeds those who feel less safe	Intercept interviews of riders along Glenferrie Road	After treatment	Interviews with riders at signalised intersections
Motorist understanding	At least 50% of motorists who parked or had driven along Glenferrie Road had noticed the green treatment. At least 50% of motorists who had noticed the green treatment recognised its' purpose as designating a bicycle lane.	Intercept interviews of pedestrians along Glenferrie Road who had driven to Glenferrie Road on the day of interview or sometime in the past two weeks.	After treatment	The proportion of visitors to Glenferrie Road who do so by car is <50%, reducing the success rate. To improve the efficiency of the survey respondents who had driven in the recent past (i.e. past month) were included as "motorists".

2.3 Method

Two methods of collecting the primary data for this evaluation were used:

- Video observations of bicycle rider and motorist behaviours, and
- Intercept surveys with pedestrians and bicycle riders on Glenferrie Road.

These methods are now discussed further.

2.3.1 Video observations

Video cameras were discretely positioned at three locations on Glenferrie Road to observe lateral tracking of bicycle riders and motorists (Figure 2.1):

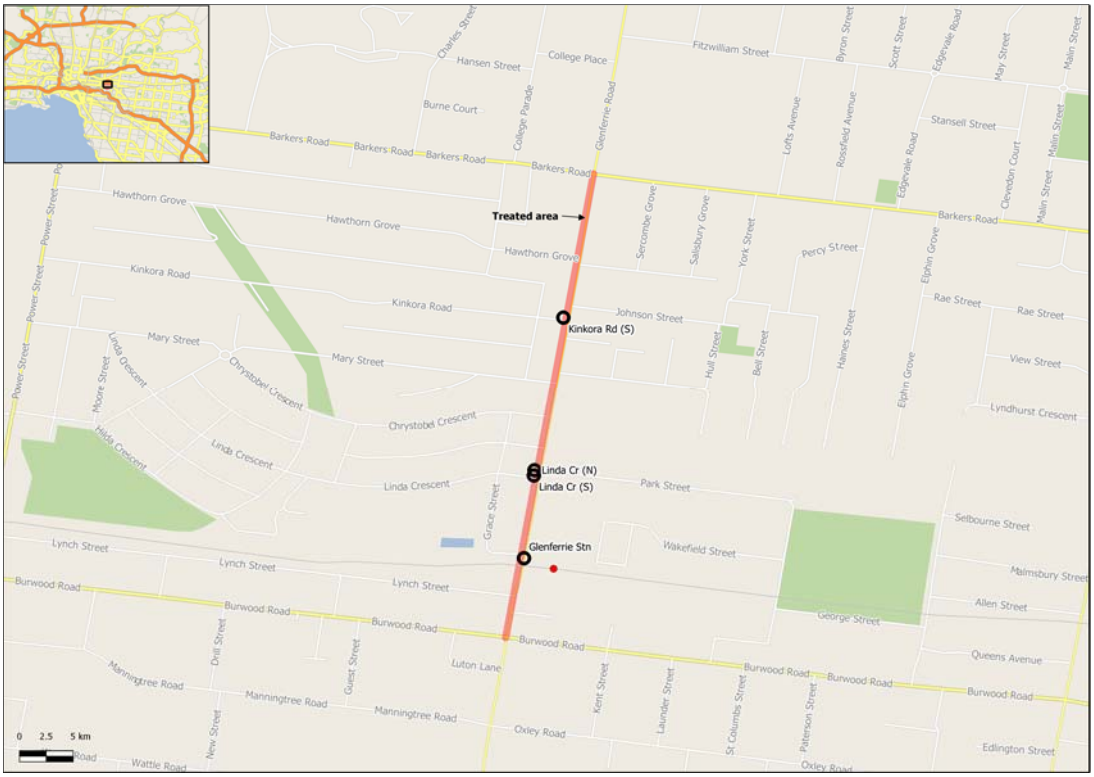
- Facing south at Linda Crescent (Figure 2.2(a), towards the Coles Supermarket),
- Facing north at Linda Crescent (Figure 2.2(b)),
- Facing south at Kinkora Road (Figure 2.2(c)), and
- Facing north at Glenferrie railway station (Figure 2.2(d)).

In addition, two additional sites were added around 100 m south of the intersection of Barkers Road near Hawthorn Grove (on both the east and west sides of Glenferrie Road) during the last of the observation periods in November 2014. The cameras were positioned such that they are highly unlikely to have been noticed by road users, so will not have influenced their behaviour.

The cameras were located on poles on kerb outstands near intersections so as to minimise the offset from the traffic on Glenferrie Road.[5] However, this also meant that in three cases the location at which rider and motorist tracking was observed was within 2-3 m upstream of where the green treatment widened to 1.5 m near the intersections. These sites may under-represent any change in cyclist lateral tracking due to the treatment compared to mid-block sites.

[5] Doing so minimised the need for geometric corrections to be made to the lateral tracking observations (although some correction was still required), as well as making it easier to accurately identify cyclist and motorist tracking from the video.

- Figure 2.1: Camera locations



- Figure 2.2: Screenshots from video cameras (after treatment)

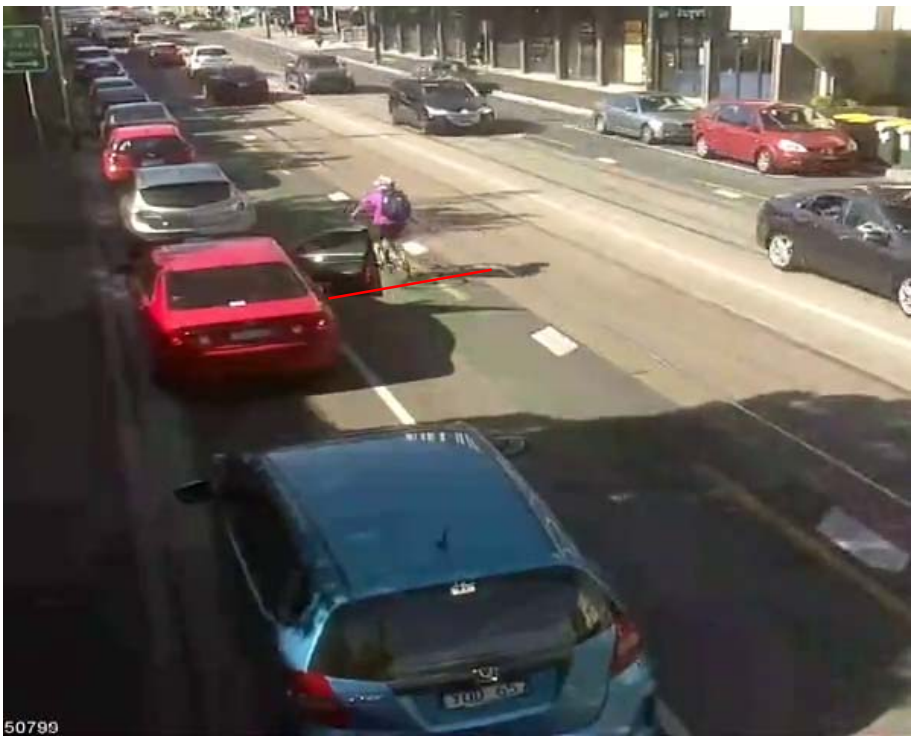
(a) Linda Crescent (facing south)

(b) Linda Crescent (facing north)

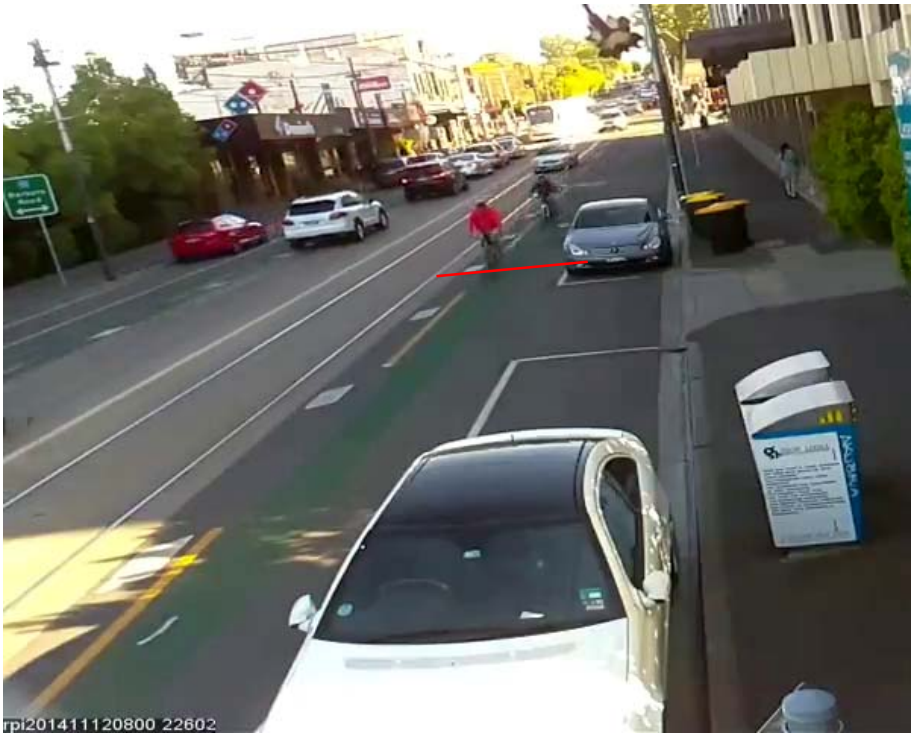
(c) Kinkora Road (facing south)

(d) Glenferrie station (facing north)

(e) Hawthorn Grove northbound (facing north)



(f) Hawthorn Grove southbound (facing north)



All sites were filmed simultaneously across 13 typical non-holiday weekdays:

- Before treatment:
    - Monday 28 October 2013
    - Tuesday 29 October 2013
    - Wednesday 6 November 2013
    - Thursday 7 November 2013
- After-1 treatment:
    - Thursday 1 May 2014
    - Friday 2 May 2014
    - Thursday 8 May 2014
    - Friday 9 May 2014.
- After-2 treatment:
    - Tuesday 11 November 2014
    - Wednesday 12 November 2014
    - Thursday 13 November 2014
    - Friday 14 November 2014
    - Saturday 15 November 2014

All sites were filmed from 7 am to 10 am and from 3 pm to 6 pm. These times captured the busiest times of day for bicycle riders, and also a time when motor vehicle and pedestrian demand is high. The after-1 period corresponded to about six weeks after the bicycle lanes were completed, so allowing some time for regular users to become accustomed to the treatment. The after-2 period was around 7 months after the treatment was completed, allowing further time for the treatment to "settle". As well as providing more time for road users to adapt to the treatment this also provided a more realistic assessment of the coloured pavement, which has discoloured somewhat over the intervening period. However, to counterbalance this reduction in the contrast of the green surface treatment the City of Boroondara installed a temporary variable messaging sign facing northbound traffic near Lynch Street over a period from Friday 31 October to Monday 10 November, corresponding to a period of around two weeks immediately prior to the after-2 observations. This sign displayed the message "Bikes: Avoid Doors / Ride on Green". It is likely that any effect observed during this period on cyclist lateral tracking could be partly attributable to this sign.

■ Figure 2.3: Temporary variable message sign near Lynch Street during early November 2014

Cyclist lateral tracking

A datum was defined for each video adjacent to the last kerbside parking bay in the videos. The location of the front bicycle wheel where it touched the road was used to measure the lateral position of bicycle riders relative to the parking edge line. These measurements were obtained by identifying the pixel coordinates of this position, along with the parking bay edge line and yellow fairway line along the datum. While not a highly precise measure of distance this approach provides a practical and unbiased indicator of where a rider is tracking within the bicycle lane adjacent to parked cars. The lateral tracking position of all bicycle riders riding straight on Glenferrie Road through the datum at each of the sites were measured.

At most sites parking occupancy was close to 100%; that is, on almost every observation of a rider passing a datum there was a vehicle parked directly adjacent in the kerbside parking. In a small minority of cases at the four southern sites (Glenferrie station, Linda Crescent North and South, Kinkora Road) where a vehicle was not parked directly alongside one or more vehicles were parked immediately upstream and downstream. As such, we would not expect the absence of parking to have an effect on the results. However, at both of the northern sites near Barkers Road parking occupancy was low before 8:30 am. In order to avoid unduly biasing the results observations were dropped where there was not a vehicle parked directly alongside the datum, or *both* immediately upstream *and* downstream.

Car parking

The position of parked cars within the parking bay was estimated in a similar manner to cyclist lateral tracking. At the datum the pixel coordinates of the parking bay edge line (or parking T) was obtained, as was the outer face of the front wheel of the vehicle where it touched the ground. This provides an indication of how far inside the parking bay the vehicle was parked (or, in the case of negative values, how far outside the bay the vehicle was parked). It is noted that motor vehicles will not be parked completely parallel to the kerb; if the vehicle is parked "nose in" this measurement will overstate the parking

compliance, and conversely if it is parked "nose out" the compliance will be understated. In practice, the difference is not likely to be of significance and in any case is (in most cases) within the margin of error of the measurement method. All parking events in the nearest parking bay at each site were measured during the observation period.

It is noted that the parking bays subject to observation were all adjacent to a kerb outstand. This outstand is likely to influence parking behaviour and discipline in ways different from mid-block parking bays. While the end parking bays are somewhat longer to compensate for the presence of the outstands the behaviours are not likely to be directly transferable to mid-block locations. Nonetheless, the outstands were present both before and after the installation of the bicycle lane so are not expected to have influenced the comparisons.

Motorist lateral tracking

One of the intentions with the design is to encourage motorists to track farther to the centre of the road and hence away from the bicycle lane. Furthermore, it is intended that this will reduce the *variability* of motorist lateral tracking and so improve *predictability* for all road users. Measuring all motorist movements to assess the effectiveness of the design to achieve this goal would be impractical. Instead, the first ten vehicles in each hour were observed at each site on each day – this provides an unbiased sample of observations across the days and times of day. Again, the same reference datum as for cyclist lateral tracking was used, and the reference for the motor vehicles was the left (kerbside) front wheel of the vehicles. Vehicles were classified by "car" or "truck" where a car would include light vans.

2.3.2 Intercept interviews

The purpose of the intercept surveys was (a) to explore how well road users understand the treatment, and (b) record how bicycle riders feel about the treatment. The intercept interviews were conducted *after* the treatment had been installed (in May 2014) with cyclists along Glenferrie Road at the northbound approach to the signalised intersection at Barkers Road between 3 pm and 6 pm on two weekdays, and southbound near Burwood Road between 7.30 am and 10.30 am on one weekday.

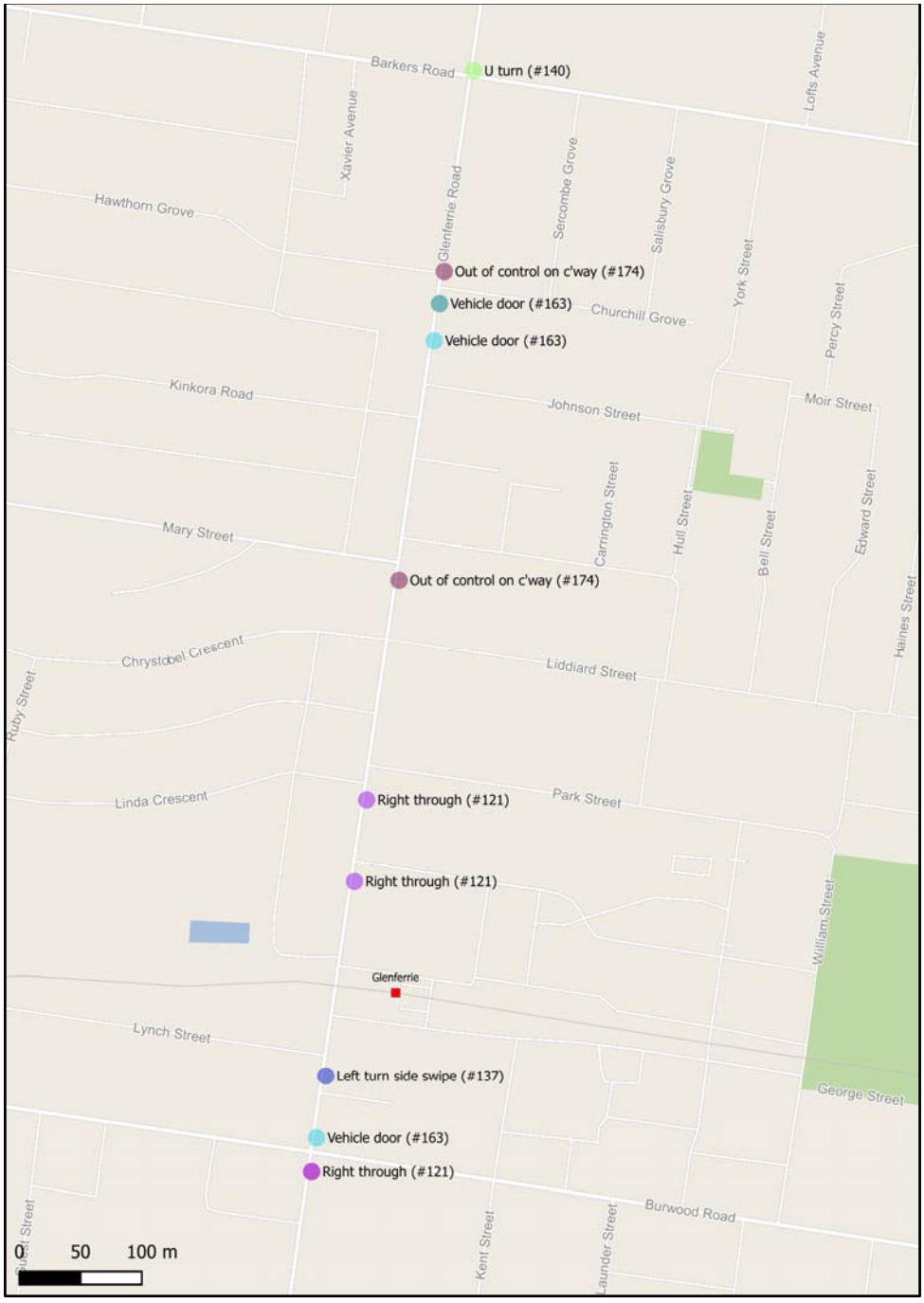
In addition to interviewing bicycle riders, pedestrians on the footpath were interviewed to ask (a) whether they'd noticed the treatment, and (b) what they think it is for. These responses were classified by the mode of access to the precinct (car driver, car passenger, train, tram, bicycle, walk). For those that had driven (either on the day or interview of in the previous month) we would ask what, if any, effect the green colour had on their door opening behaviour.

3 Crash history

There have been 12 police reported crashes involving bicycle riders in the study area overt the five year period between January 2008 and December 2012 (Figure 3.1). Of these, one was fatal (a car dooring collision) and three resulted in serious injury. The most common crash types were car dooring (3), right through (3) and out of control on the carriageway (2). Of the 10 crashes involving a bicycle rider and a motorist in all but two cases (a rear end and a left turn side swipe collision) the conflicting motorist was *ahead* of the bicycle rider. This is a fairly typical result for these types of locations.

It is noted that a large proportion of minor or no injury crashes are unreported, and so will not appear in the police crash statistics. However, the trend appears fairly clear – that conflicts tend to involve bicycle riders and motorists where the motorist is ahead of the rider and either emerges from their parked vehicle or turns across the path of the oncoming rider.

- Figure 3.1: Cyclist crash locations 2008-2012 (three digit codes are as per the definitions for classifying accidents)



4 Road user positions

4.1 Cyclist lateral tracking

The average and median cyclist tracking positions by site are provided in Table 4.1 before and after treatment[6]. The distribution of lateral tracking is illustrated in Figure 4.1 as a box plot and in Figure 4.2 as a kernel density estimate. The box plot illustrates the following results from the data:

- The interquartile range (that is, the difference between the 25th and 75th percentiles, illustrated by the box) is large relative to the difference in the means/medians between the before and after situations, suggesting the variance in lateral tracking is large relative to the changes attributable to the treatment.
- The whiskers (lines outside the boxes) represent 1.5 times the interquartile range, and again illustrate the comparatively large spread in the data.
- There appears to have been a reduction in the variance in the lateral tracking after treatment, as illustrated by the smaller interquartile ranges at most sites after treatment.
- Outliers are represented by open circles, and illustrate there are few observations within 0.5 m of the parking bay (as the parking bays were full almost all of the time this is as expected, as any closer would be physically impossible), and beyond 2 m (i.e. within the general purpose traffic lane).

The kernel density estimate[7] (Figure 4.2) provides additional insight into the distribution of lateral tracking positions. These distributions show the tendency after treatment towards more concentrated lateral tracking (i.e. the peak in the distribution is larger after treatment in most cases) and that the proportion of riders travelling to the right of the fairway line has decreased in some cases (Glenferrie station, Linda Crescent (North)) and is unchanged in others (Linda Crescent (South)).

We would suggest that the measures of central tendency (i.e. averages and medians) are not the preferred success metric for this treatment. Rather, what is most relevant is the proportion of riders travelling within the dooring zone and the proportion travelling within the green preferred operating space. The proportion of riders riding within the green preferred bicycle riding space increases after the treatment at all sites, although differences are only statistically significant at the 5% level at Linda Crescent (North) (Table 4.1). Most pertinently, the proportion of riders travelling within 0.8 m of the parking bay has reduced from 20% to 3% at Kinkora Road and 13% to 4% at Linda Crescent (North). Both of these differences are statistically significant and are of sufficient magnitude to be likely to have

[6] For simplicity only the after-2 period is presented in this table. The after-2 period in November 2014 best represents the after period given that it is over 6 months after the completion of the works, an identical time of year to the before period (November 2013) and (in general) has more observations than the after-1 period.

[7] This can be thought of as a smoothed frequency histogram.

practical significance[8]. The change in these proportions at the other two sites for which before-treatment data was available are insignificant.

The main conclusions we draw from the data is as follows:

- The average and median lateral offset from the parking bay changes only marginally at two of the four sites for which before data is available.
- The increase in the average tracking positions at Kinkora Road and Linda Crescent (North) are both statistically significant at the 5% level (Table 4.1 and Figure 4.3), and suggest riders have on average shifted farther from parking after treatment. However, the change of 5 cm at Linda Crescent is unlikely to be of practical significance, unlike the more significant 20 cm change at Kinkora Road.
- Comparing the after-1 and after-2 periods, there does appear to have been a shift in cyclist tracking away from parking at three of the four sites (only Glenferrie Road has not experienced a change). This suggests the treatment may have had a delayed effect on rider behaviour that took longer than six weeks to become established. Alternatively, or in addition, the presence of the variable messaging sign led to this improved rider behaviour.
- The variation in lateral tracking, as measured by the standard deviation, decreases at all four sites in the after-2 case compared to before treatment (Table 4.1 and Figure 4.2). These decreases are statistically significant at the 5% level for two of the four sites (Glenferrie station, Linda Crescent (North)). These results suggest the treatment has had the effect of concentrating riders along a narrower zone within the carriageway. It could be argued this improves predictability of the road environment for motorists and pedestrians, who can reasonably expect to see most riders within a fairly narrow and well defined road space.
- The proportion of riders tracking within the dooring zone (arbitrarily defined as up to 0.8 m from the parking bay, equivalent to the unpainted area in the after-treatment case) decreased at two of the four sites (Kinkora Road, Linda Crescent (North)) and remained essentially at unchanged at the other two for which before-treatment data was available (Glenferrie station, Linda Crescent (South)). The results from the two sites with statistically significant results are also of practical significance – they suggest a reduction of riding within the dooring zone of more than 75%.
- There is limited evidence to suggest the green preferred bicycle space (that is, 0.8 m to 1.4 m from parking) has encouraged riders to travel within this area. While there was an increase in the proportion of riders who did so at all four sites for which before-treatment data is available the increase was only significant at Linda Crescent (North) (Table 4.1 and Figure 4.5). The apparent inconsistency at Kinkora Road, where the proportion riding within the dooring zone has markedly decreased but the proportion riding within the green preferred bicycle space has not increased, is attributable to an increase in the proportion riding to the right of the green preferred bicycle space (Figure 4.2).

[8] That is, the measured change is of such a magnitude that we may expect there to be positive impacts on rider safety insofar as there has been a meaningful reduction in rider exposure to dooring at these two sites.

- It is plausible that riders are travelling farther from parked cars in the downhill direction than while travelling uphill. At the steepest sites immediately north of Hawthorn Grove the proportion riding within 0.8 m of parking was 3% on the east (downhill) side of the road and 13% on the west (uphill) side of the road. This is consistent with our expectations that riders travelling closer to motor traffic speeds are more able to mix with traffic, and also perhaps an awareness that at higher speeds a riders' ability to evade an opening door is diminished[9].

Overall, these results are suggestive of three outcomes:

- riders appear to have taken some time to adapt to the treatment, such that a six week period after construction was insufficient to observe significant shifts in lateral tracking,
- the treatment appears to be effective at reducing the proportion of riders travelling within the dooring zone at two of the sites (Kinkora Road and Linda Crescent (North)), where the proportion riding within the dooring zone decreased by more than three quarters, and
- the treatment has decreased the variability in cyclist lateral tracking.

We would note that the absence of a detectable change in tracking within the dooring zone at two of the sites does not necessarily imply the treatment has had no effect. Indeed, if the sample sizes were much larger we would almost certainly be able to detect an effect. Furthermore, the direction of change observed in this data is consistent with the design intent – of reducing the proportion of riders travelling within this area. However, the lack of statistical significance means that such interpretations should be treated with caution – the observed changes are just as likely to be due to sampling variability.

[9] It is also possible that riders are aware that the consequences of colliding with an open door at higher speeds may be more severe, and so are responding accordingly.

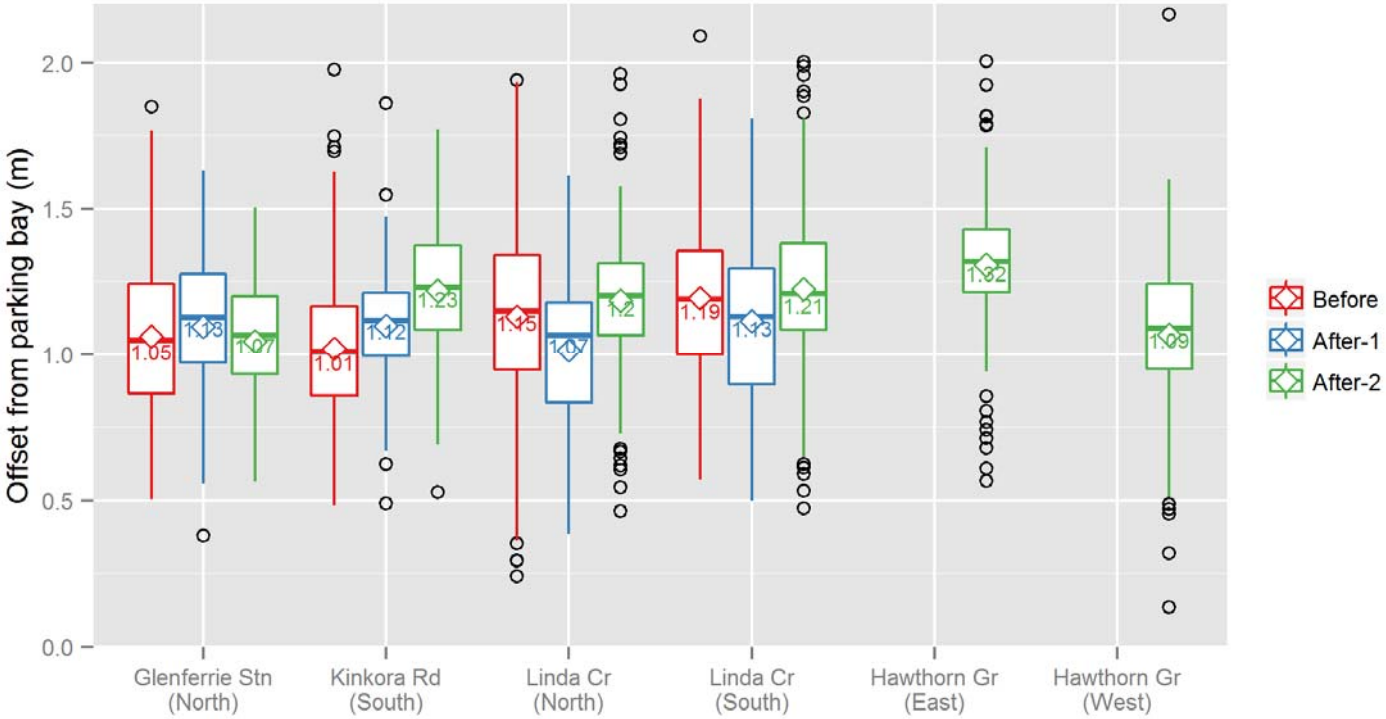
■ Table 4.1: Cyclist lateral tracking

Site	Treatment	No. obs	Lateral offset relative to parking bay			% within	% within
			Average (m)	Median (m)	Std. dev. (m)	0.8 m	green space
Glenferrie station (north)	Before	56	1.06	1.05	0.30	20%	66%
	After-2	67	1.05	1.07	0.22	18%	79%
	Difference	–	-0.01	+0.02	-0.08 *	-2%	+13%
			(t =0.36, p=0.72)	(Z=-0.16, p=0.87)	(F=1.79, p=0.02)	(χ^2=0.00, p=0.99)	(χ^2=2.02, p=0.16)
Kinkora Rd (south)	Before	188	1.02	1.01	0.25	20%	74%
	After-2	139	1.22	1.23	0.22	3%	78%
	Difference	–	+0.20 **	+0.22 **	-0.03	-17% **	+4%
			(t=-7.54, p<0.00)	(Z=-7.43, p<0.00)	(F=-1.28, p=0.13)	(χ^2=19.93, p<0.00)	(χ^2=0.42, p=0.51)
Linda Cr (north)	Before	174	1.13	1.15	0.32	13%	68%
	After-2	300	1.19	1.20	0.21	4%	85%
	Difference	–	+0.06 **	+0.05 *	-0.09 **	-9% **	+17% **
			(t=-2.00, p=0.05)	(Z=-1.79, p=0.07)	(F=2.21, p<0.00)	(χ^2=12.37, p<0.00)	(χ^2=17.27, p<0.00)
Linda Cr (south)	Before	162	1.19	1.19	0.28	8%	72%
	After-2	323	1.23	1.21	0.25	5%	72%
	Difference	–	+0.04	+0.02	-0.03	-3%	+0%
			(t=1.21, p=0.23)	(Z=-1.45, p=0.15)	(F=1.23, p=0.12)	(χ^2=1.69, p=0.19)	(χ^2=0.01, p=0.93)
Hawthorn Gr (East)	After-2	245	1.31	1.32	0.21	3%	66%
Hawthorn Gr (West)	After-2	225	1.07	1.09	0.25	13%	82%

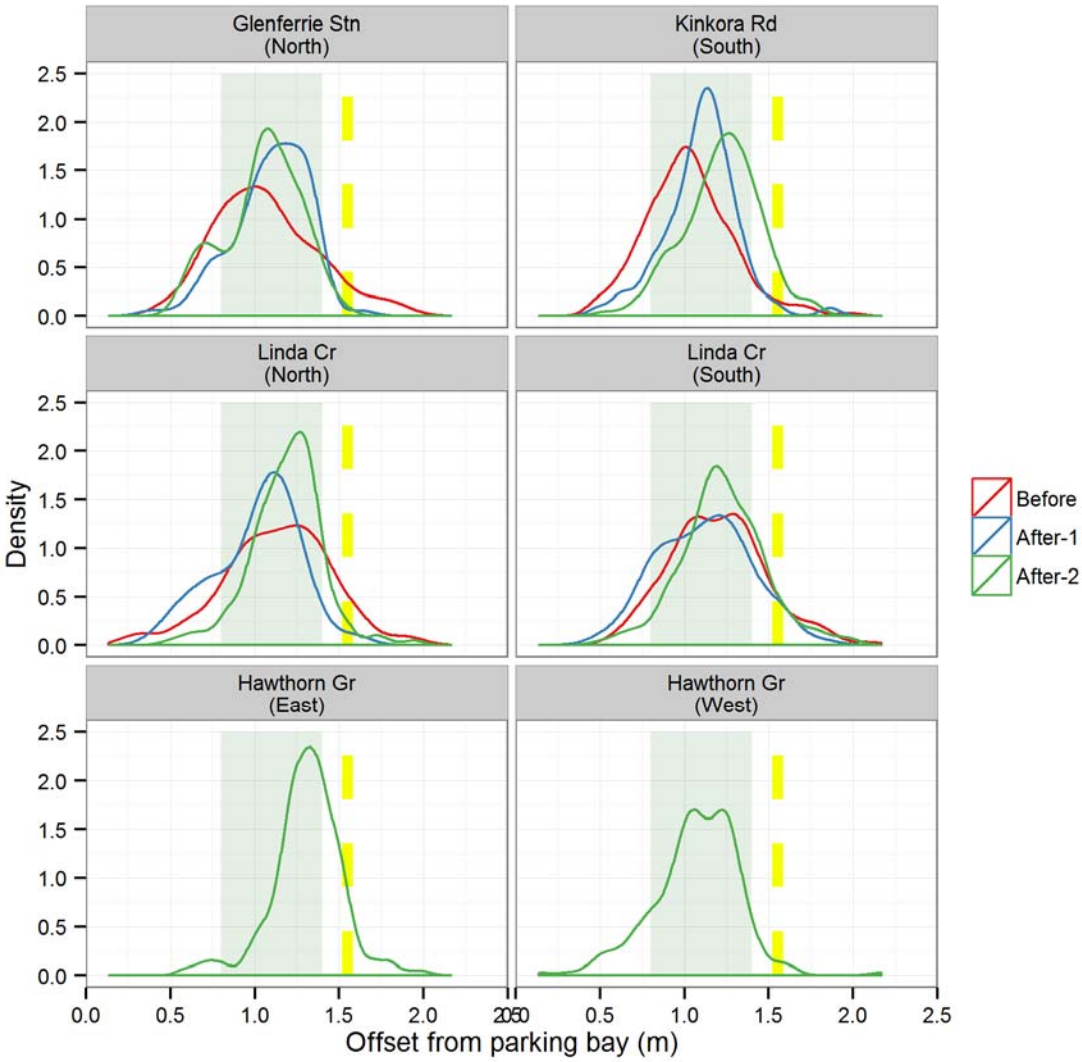
* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

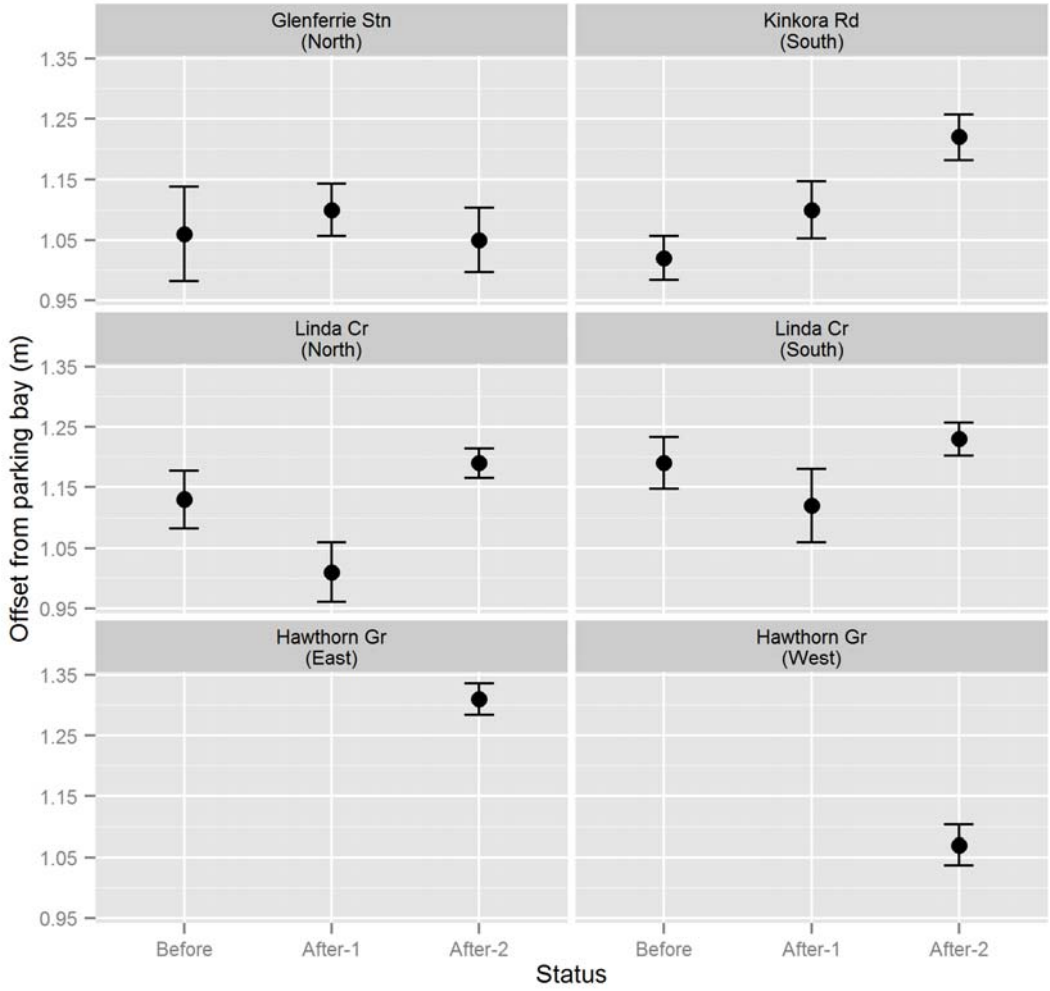
- Figure 4.1: Cyclist lateral tracking boxplot



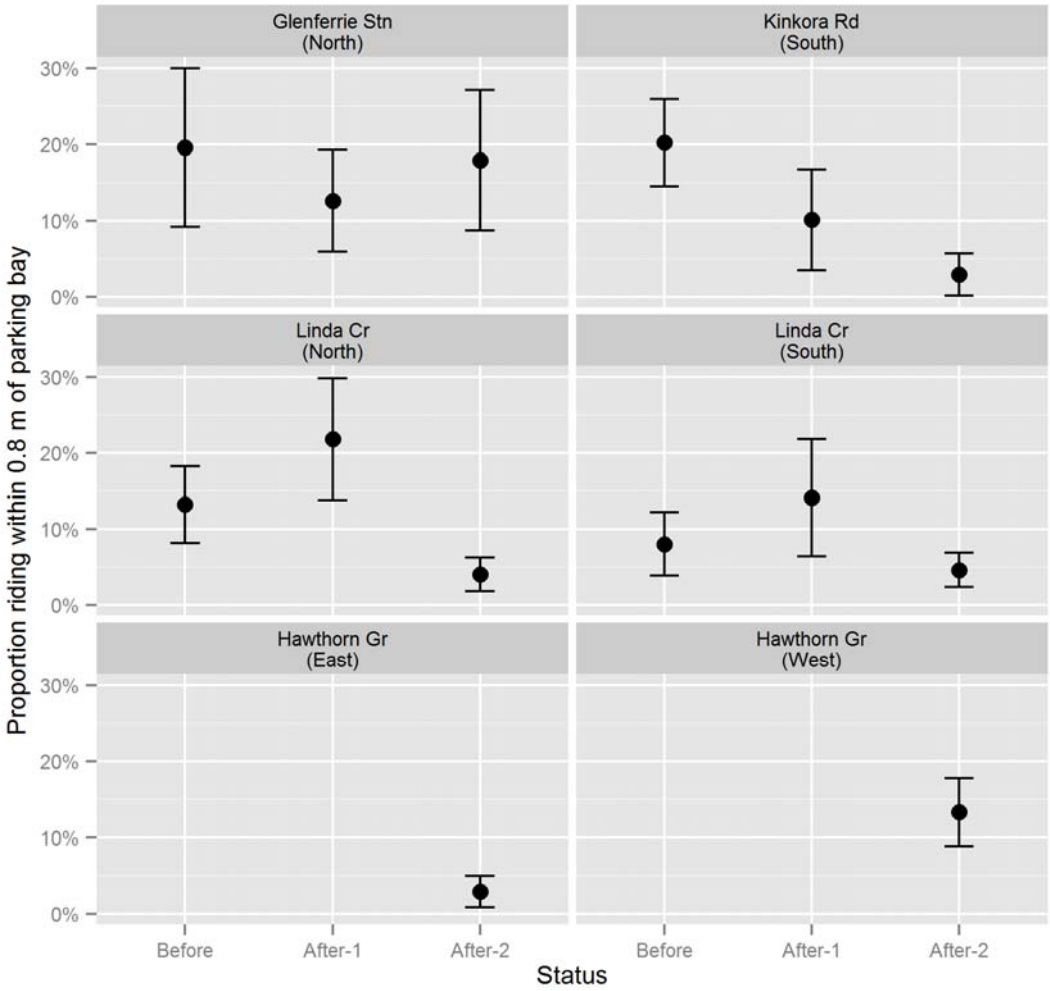
- Figure 4.2: Cyclist lateral tracking kernel density estimates



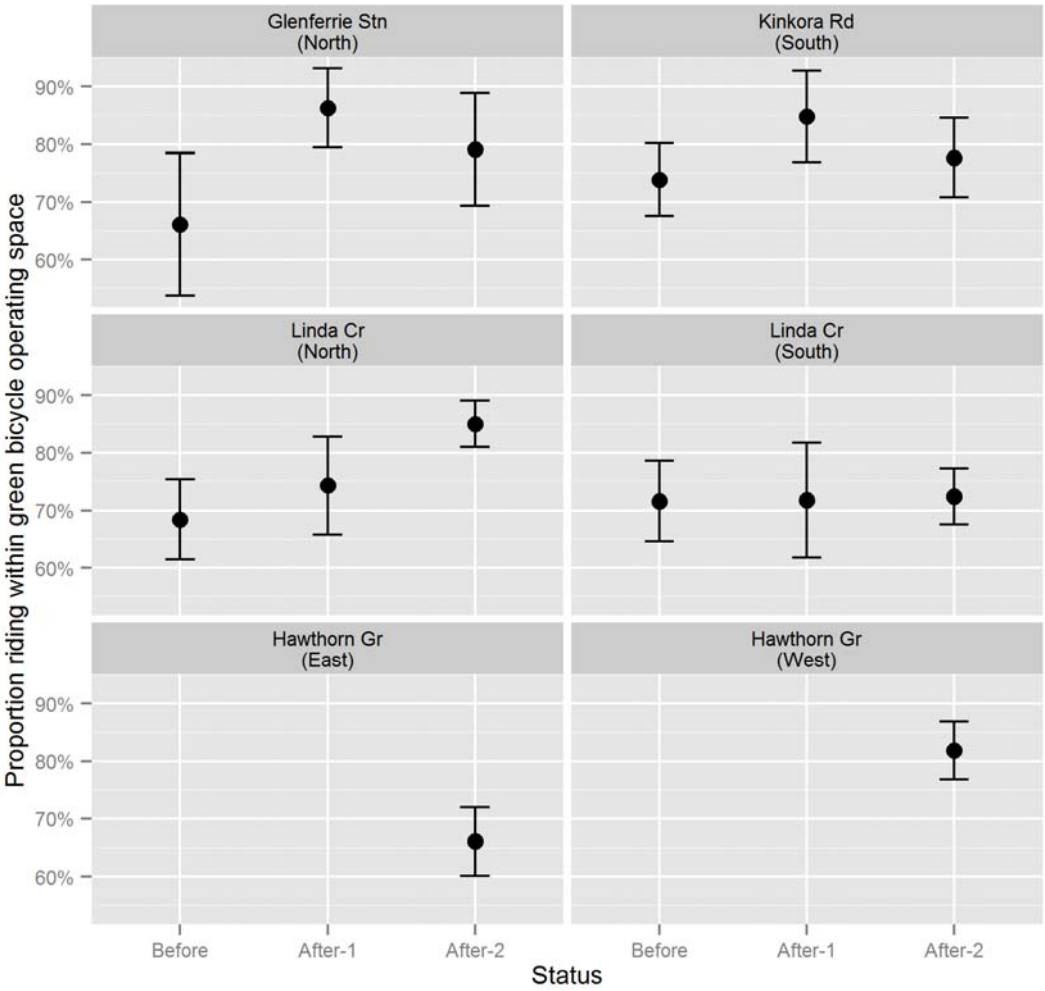
- Figure 4.3: Average cyclist lateral tracking by site and status (error bars are two standard errors)



- Figure 4.4: Proportion of riders tracking within 0.8 m of parking bay by site and status (error bars are two standard errors)



■ Figure 4.5: Proportion of riders tracking within the preferred bicycle operating space (0.8 – 1.4 m from kerbside parking, error bars are two standard errors)



4.2 Motorist lateral tracking

The average and median motorist tracking positions by site are provided in Table 4.2 before treatment and during the after-1 period (i.e. some six weeks after construction). The distribution of lateral tracking is illustrated in Figure 4.6 as a box plot and in Figure 4.7 as a kernel density estimate. The main conclusions we draw from the data is as follows:

- The average motorist lateral tracking position moves towards the centreline by 0.16 to 0.28 m at three of the sites, and does not change to any significant extent at the Kinkora Road.
- The variation in motorist lateral tracking positions decreases at two sites (Glenferrie station and Kinkora Road) but appears to increase at the other two (Linda Crescent north and south). It is not clear how the treatment could lead to an increase in tracking variation, although it is noted that the absolute change in standard deviation is not large (around 0.09 m).

- The proportion of motorists tracking to the left of the fairway line, and so encroaching into the bicycle lane, decreases significantly at two of the four site (and marginally at another). The data suggests the treatment has roughly halved the frequency of motorist encroachment into the bicycle lane.
- At three of the four sites there was a significant decrease in the proportion of motorists tracking to the left of the inner tram track, although the majority of motorists continue to track to the left of the outer tram track.

Overall, the data is strongly suggestive that motorists track farther to the right after treatment and encroach less often into the bicycle operating space.

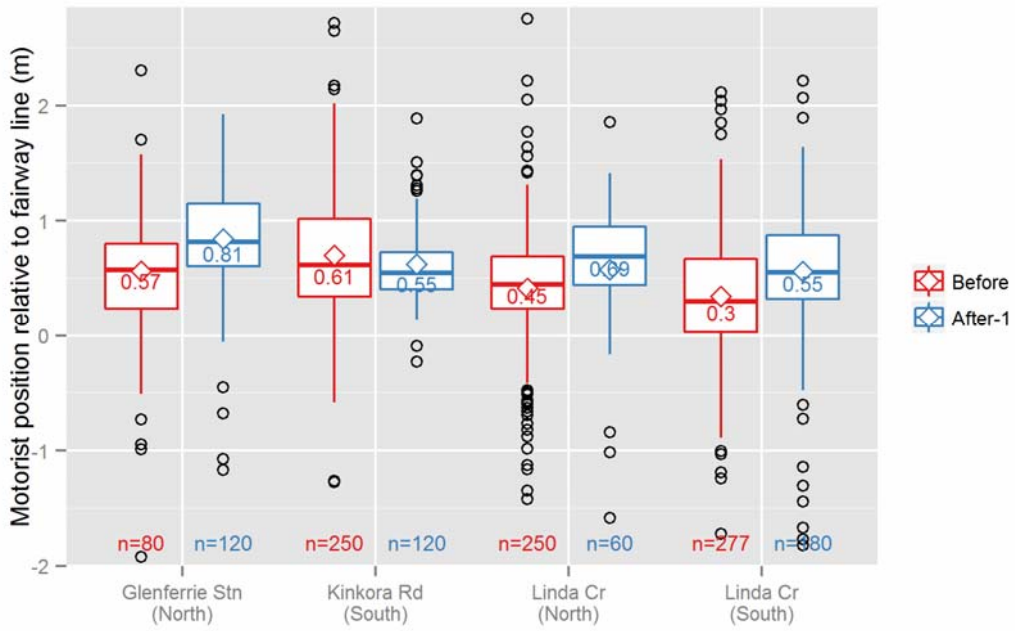
■ Table 4.2: Motorist lateral tracking

Site	Treatment	No. obs	Lateral offset relative to fairway line			% left of fairway line	% left of inner tram track
			Average (m)	Median (m)	Std. dev. (m)		
Glenferrie station (north)	Before	80	0.56	0.57	0.69	14%	78%
	After-1	120	0.84	0.81	0.51	5%	56%
	Difference	–	+0.28 **	+0.24	-0.18 **	-9% *	-22% **
			(t =-3.09, p<0.00)	(Z=-4.20, p<0.00)	(F=1.85, p<0.00)	(χ^2=3.67, p=0.06)	(χ^2=7.63, p=0.01)
Kinkora Rd (south)	Before	250	0.70	0.61	0.57	7%	69%
	After-1	120	0.62	0.55	0.36	2%	82%
	Difference	–	-0.08	-0.06	-0.21 **	-5% *	+13% **
			(t=1.53, p=0.13)	(Z=1.11, p=0.27)	(F=2.61, p<0.00)	(χ^2=3.40, p=0.07)	(χ^2=6.17, p=0.01)
Linda Cr (north)	Before	250	0.41	0.45	0.58	18%	85%
	After-1	60	0.57	0.69	0.66	10%	70%
	Difference	–	+0.16 *	+0.24 *	+0.08 **	-8%	-15% **
			(t=-1.75, p=0.08)	(Z=-3.53, p<0.00)	(F=0.77, p=0.18)	(χ^2=1.88, p=0.17)	(χ^2=6.65, p=0.01)
Linda Cr (south)	Before	277	0.34	0.30	0.54	23%	87%
	After-1	180	0.56	0.55	0.63	11%	76%
	Difference	–	+0.22 **	+0.25 *	+0.09 **	-12% **	-11% **
			(t=-3.80, p<0.00)	(Z=-5.24, p<0.00)	(F=0.75, p=0.03)	(χ^2=9.68, p<0.00)	(χ^2=7.67, p=0.01)

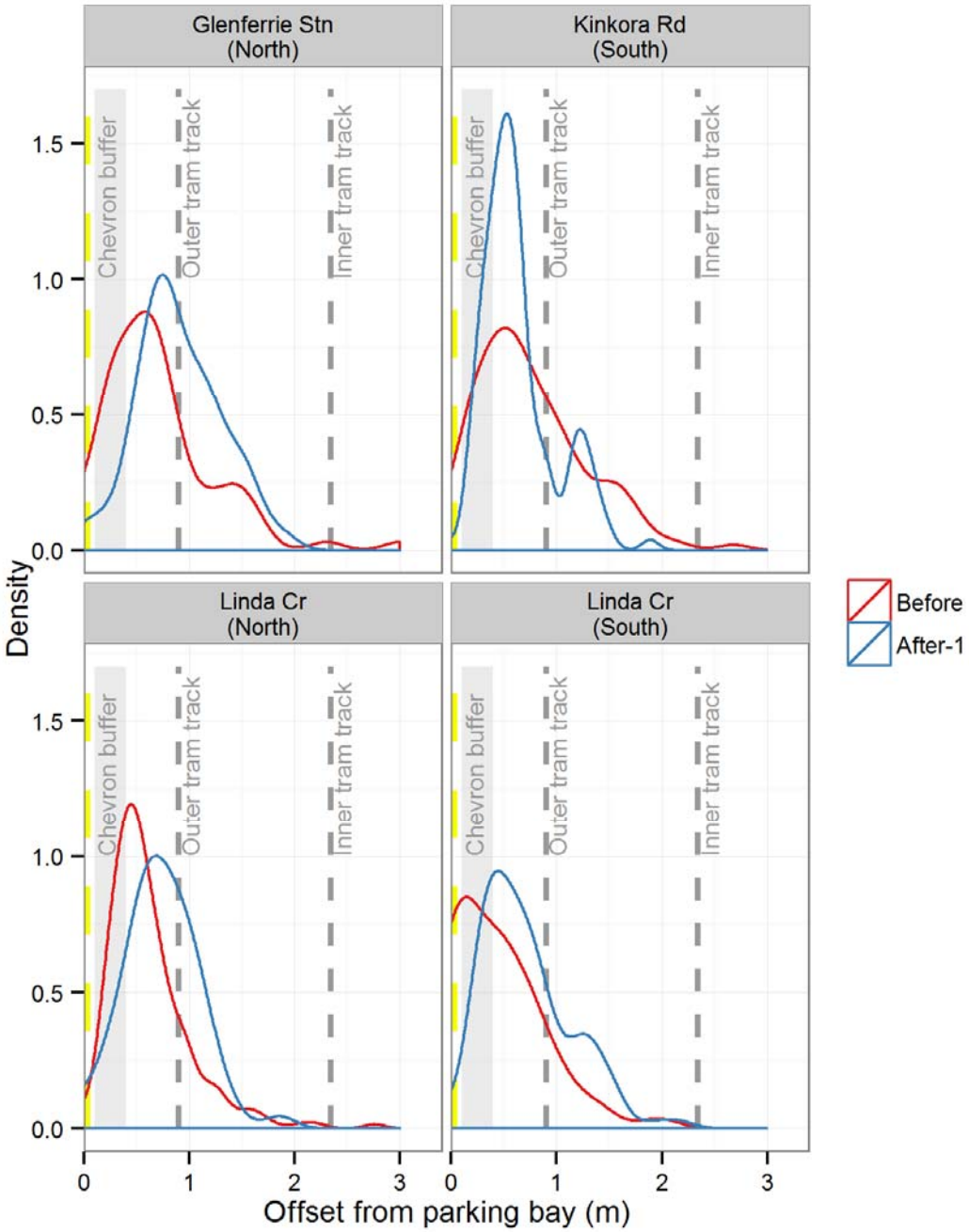
* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

- Figure 4.6: Motorist lateral tracking boxplot relative to fairway line (+ve values are towards the centreline)



■ Figure 4.7: Motorist lateral tracking kernel density estimates



4.3 Parking positions

The parking bays at each of the four sites differed in the before and after treatment cases, as summarised in Table 4.3. The relevant changes were to replace parking Ts with a solid edge line at the Glenferrie station site, and to narrow the bays at the other sites (which already had solid edge lines).

■ Table 4.3: Parking bays

	Before treatment		After treatment	
Site	**Bay width**	**Marking**	**Bay width**	**Marking**
Glenferrie stn (North)	2.1 m	Ts	2.1 m	Solid edge line
Kinkora Rd (South)	2.3 m	Solid edge line	2.0 m	Solid edge line
Linda Cr (North)	2.3 m	Solid edge line	2.0 m	Solid edge line
Linda Cr (South)	2.3 m	Solid edge line	2.0 m	Solid edge line

The parking position was measured from the outer side of the parked vehicle to the parking bay edge line (or parking T) during the before and after periods. As this was done from the video record, it's accuracy for any individual measurement is probably in the order of roughly +/-10 cm – it is not intended as a precise measure. The distance the vehicles were parked from the kerb face was not measured, and cannot be reliably estimated from this data as the vehicle widths were not measured.

The outer face of parked vehicles are presented relative to two datums; firstly, relative to the parking bay edge line (Figure 4.8) and secondly relative to the kerb face (Figure 4.9). Recall that the edge line moves towards the kerb by 0.3 m at the three sites on the western side of Glenferrie Road after treatment. The following conclusions can be drawn from this data:

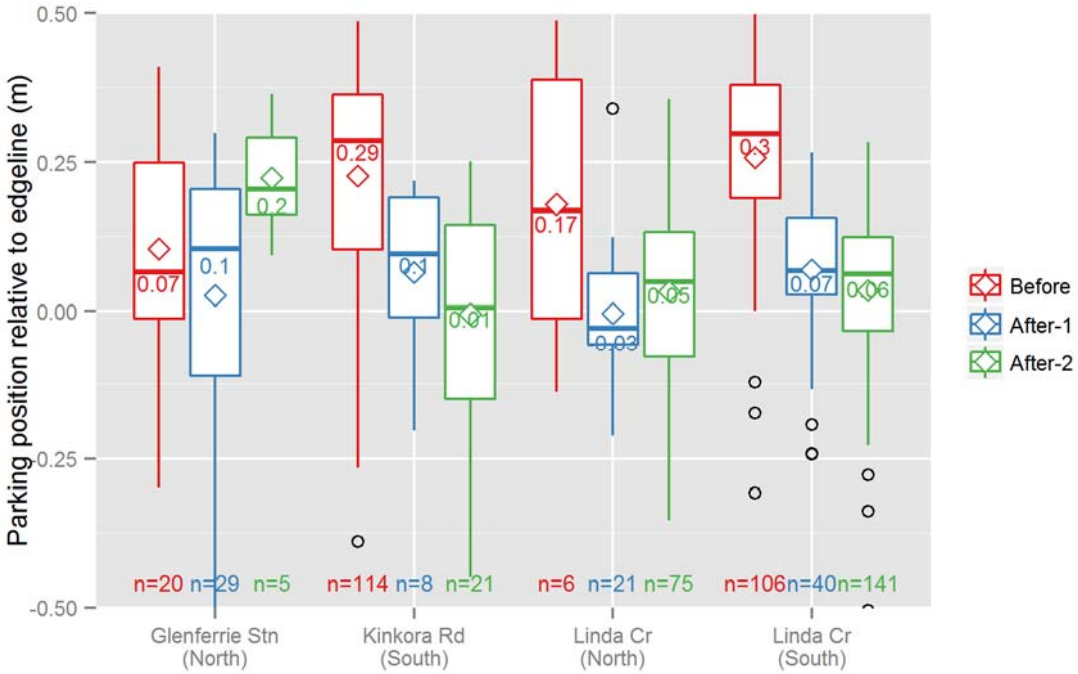
- There is no statistically significant change in parking position at the Glenferrie station site, where the bay width remained unchanged at 2.1 m but the parking Ts were replaced with a solid edge line.
- At the Linda Crescent (North) site the parking turnover was low due to motorists staying for long periods during the before period. This sample size means no statistically significant results can be drawn from this sample.
- The Linda Crescent (South) site outside the Coles Supermarket had fairly high levels of parking turnover during the observation periods, so facilitating robust comparisons. The average parking position moved closer to the edge line after treatment; from 0.26 m to 0.07 m ($M=0.19$, $t=7.05$, $p<0.00$) during the after-1 period and to 0.03 m in the after-2 period ($M=0.23$, $t=10.32$, $p<0.00$). At first glance, this appears to be a counterproductive result – motorists are parking closer to the edge line after treatment than before. However, all of this shift can be attributed to the narrowing of the parking bay from 2.3 m to 2.0 m; in other words a reduction in

parking bay width of 0.3 m has shifted the average vehicle around 0.1 m towards the kerb.[10] This is illustrated in Figure 4.9.

- While there were many parking movements at Kinkora Road prior to treatment (n = 114) there were very in the after-1 period (n = 7) due to a few motor vehicles staying for very long periods (9 hours in one case). However, there were sufficient observations in the after-2 period (n=21) to allow comparisons. In the before period the average vehicle was parked roughly 0.22 m within the parking bay, afterwards the average position was roughly alongside the parking edge line. This difference is statistically significant (p<0.00). As for Linda Crescent, the change can largely be explained by the narrowing of the parking bay.

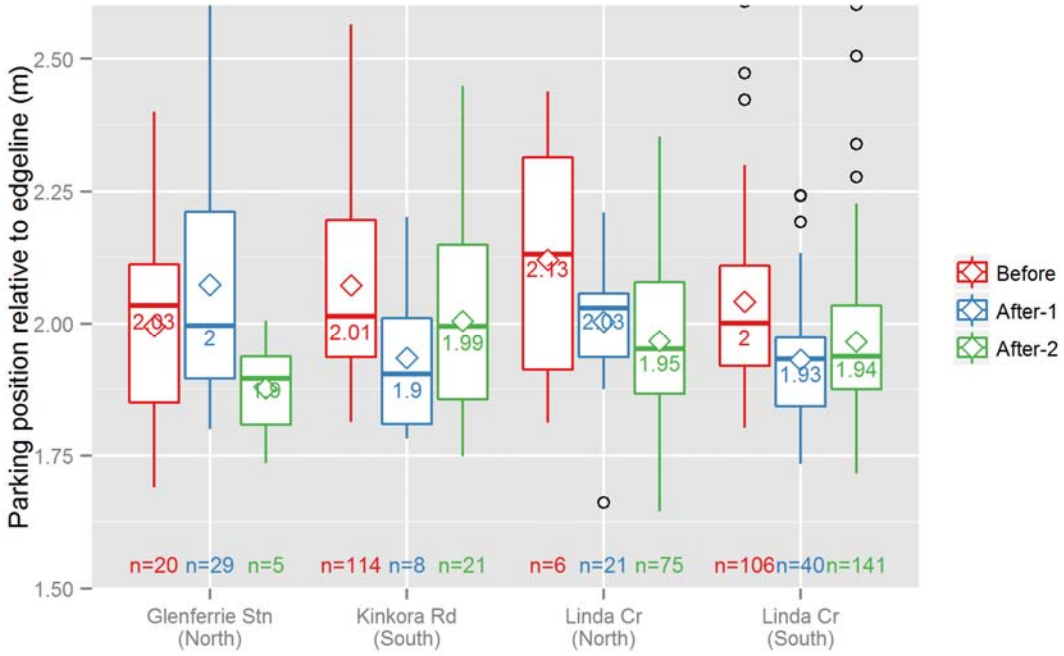
Overall, there is limited evidence (based on two sites) to suggest that narrowing the parking bays has had the desired effect of reducing the distance at which motorists' park from the kerb face.

■ Figure 4.8: Motorist parking boxplot relative to parking bay edge line (+ve values are towards the kerb)



[10] This ratio of 0.33 m/m for reduced parking bay width is similar to the 0.44 m/m found by Furth et al. (2010) in a more thorough study in Boston (USA).

- Figure 4.9: Motorist parking boxplot relative to kerb face



5 Road user perceptions

5.1 Overview

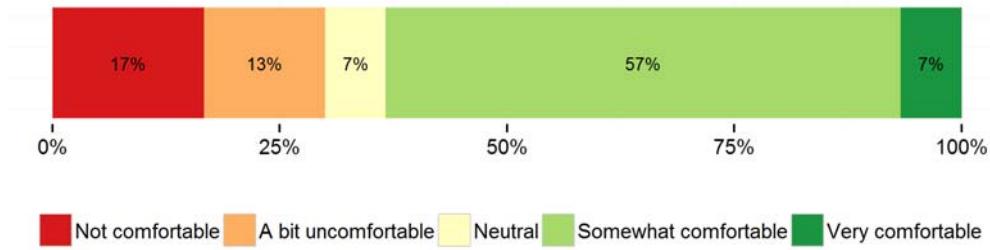
It was difficult to obtain a robust sample of bicycle riders as even during the peak hour (5 – 6 pm) there were no more than 15 riders heading in one direction. Interviews across multiple days and times of day (morning and evening) resulted in 30 complete cyclist interviews. While this is likely to represent an unbiased sample of riders, conclusions drawn from this sample need to be treated with some caution given the relatively low sample sizes.

Interviewing pedestrians was more practical, given their much greater volume than bicycle riders. A total sample of 55 pedestrians was achieved across the two interview days, giving a reasonable sample from which to draw conclusions.

5.2 Bicycle riders

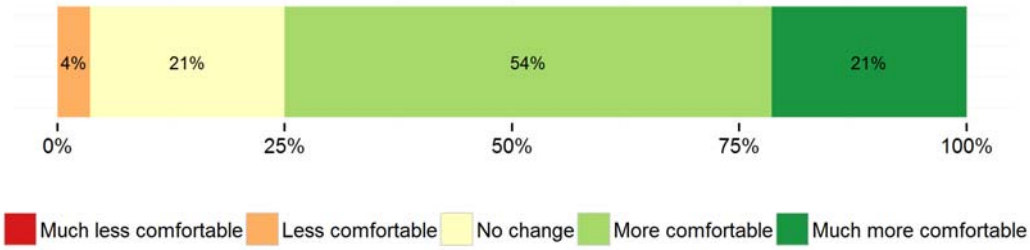
More riders indicated they felt comfortable riding along Glenferrie Road than uncomfortable (Figure 5.1).

- Figure 5.1: How comfortable to do you feel riding along here? (sample: bicycle riders, n = 30)



Most of the sample (28 riders, 93%) had ridden along Glenferrie Road before the treatment was installed. Of these riders, 71% (21 riders) indicated they felt more comfortable or much more comfortable than before. One respondent indicated they felt less comfortable.

- Figure 5.2: Do you think the new bike lane has made you feel more or less comfortable riding along here? (sample: bicycle riders who had ridden before the treatment was installed, n = 28)



Six riders from the sample (21%) indicated they rode differently following the treatment; three said they rode outside the dooring zone and another indicated they rode more confidently as they were no longer "as scared of the cars". When asked what they thought was the intention of the bicycle lanes, 30% did not know while most (63%) thought the intention was (correctly) to encourage riders to ride away from parked cars. Two respondents thought the intention was to encourage riders to travel closer to parked cars.

The majority of riders appear to understand the design intent; 25 of 30 riders (83%) thought (correctly) they were supposed to ride on the green surface, while four riders (13%) thought it was between the parking bay and green surface. This may suggest that a minority of riders do not fully understand the design intent. This is also reflected by the cyclist tracking data (Section 4.1), which suggests no significant change in the proportion of riders travelling in the dooring zone.

Riders were evenly split between those who felt motorists had not changed their behaviour (52%) and those who had not. Of the four who thought motorists had changed the way they behave the most commonly cited changes were motorists giving them more space (5) and generally being more careful (4).

Crash history

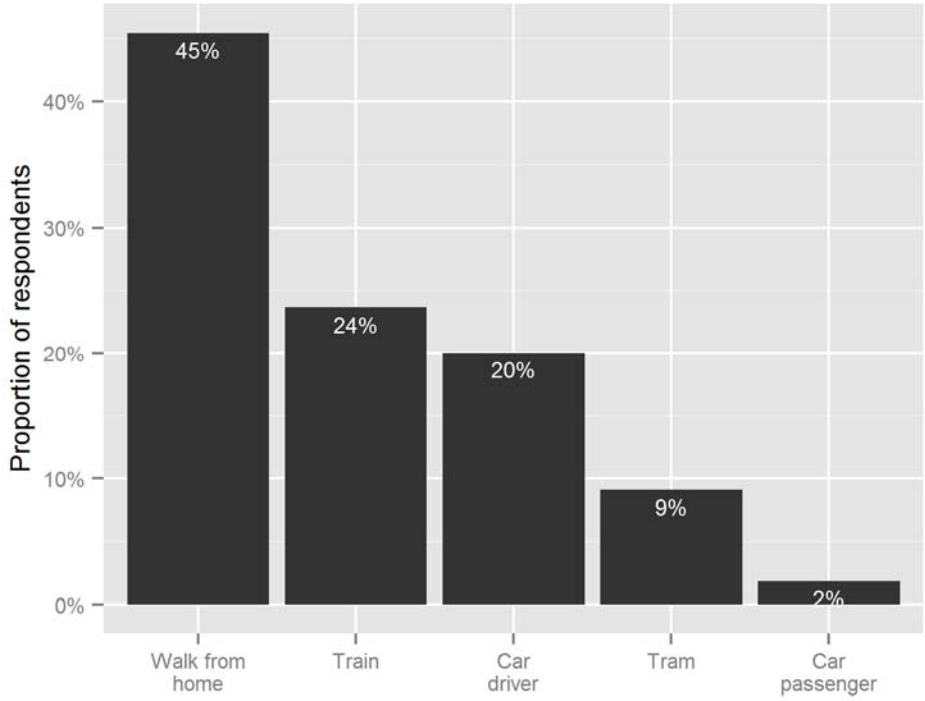
A minority of riders (three riders, 10% of the sample) reported having been involved in a collision along this section of Glenferrie Road over the previous 12 months; all said they had been involved in a collision and all had collided with a motorist turning left out of an unsignalised side street. In addition, one rider had also been involved in a collision with an opening car door and another was involved in a side swipe collision at a mid-block location. None required medical treatment as a result of the collision.

By contrast, two thirds of riders indicated they had experienced a near miss over the past 12 months (11 of 14). The most commonly cited near miss was with opening car doors (12, 40%), followed by motorists turning left out of unsignalised side streets (8, 27%), right turning motorists at unsignalised intersections (5, 17%), side swipes at mid-blocks (5, 17%) and left turning motorists at signalised intersections (4, 13%). The crash types reported by respondents appears similar to the police-reported crash data (Section 3), and reinforces the purpose of the design – to reduce car dooring and address right angled crashes at unsignalised intersections.

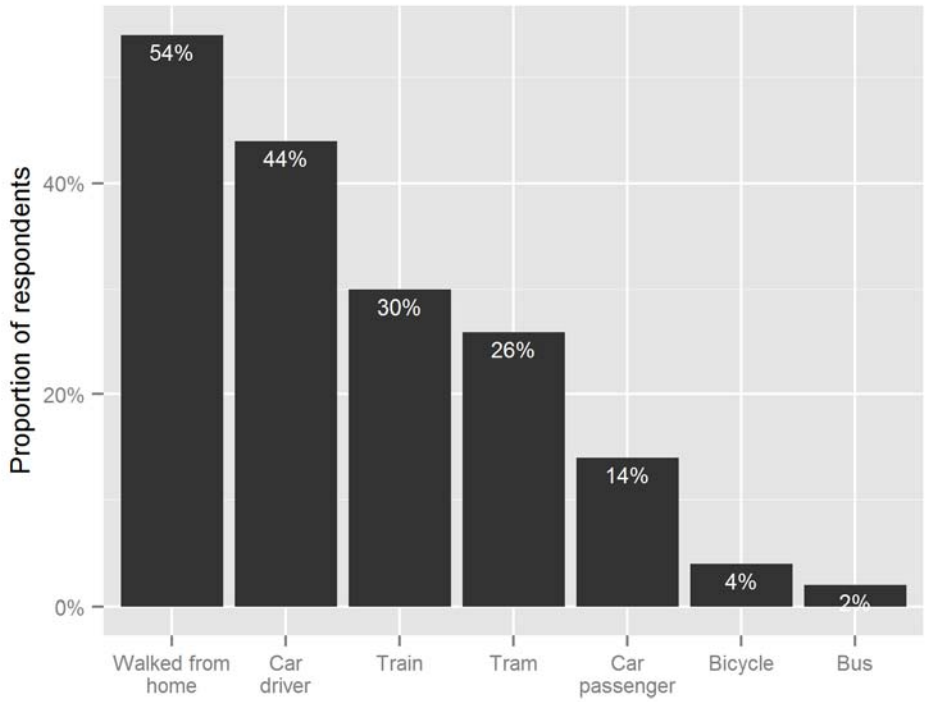
5.3 Pedestrians

Of the sample of 55 pedestrians just under half (45%) walked to Glenferrie Road from their home, 24% had arrived by train and 20% drove their car (Figure 5.3). None had ridden a bicycle. Of the 50 respondents who had come to Glenferrie Road at least once over the past month in addition to the day of interview walking and driving were the most common modes (Figure 5.4). A small minority (4%, 2 respondents) had travelled to Glenferrie Road by bicycle.

- Figure 5.3: How did you get to Glenferrie Road today? (sample: pedestrians, n = 55)

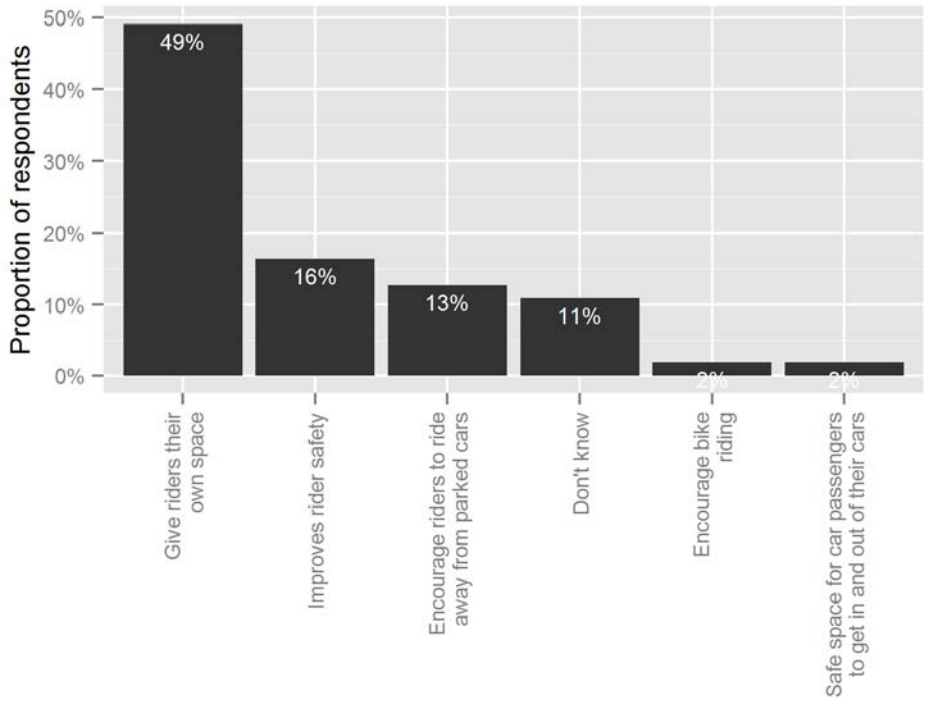


- Figure 5.4: How did you get to Glenferrie Road over the past month? (sample: pedestrians who have visited at least once in the past month, n = 50)



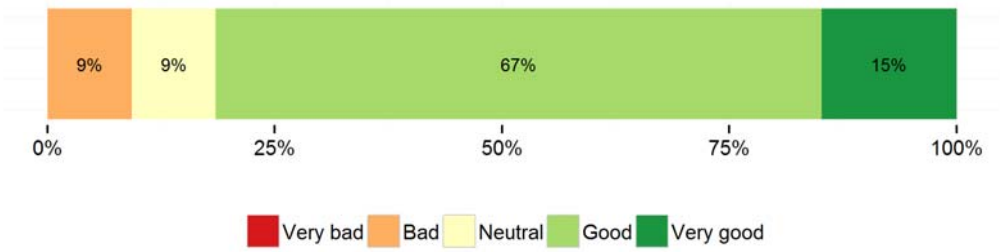
Most pedestrians has noticed the new bicycle lane (69%). When asked what they thought was the purpose of the lanes they most often cited giving riders their own space (Figure 5.5). Relatively few (13%) cited riding away from parked cars as a purpose.

■ Figure 5.5: What do you think is the purpose of the bicycle lanes? (sample: all pedestrians, n = 55)



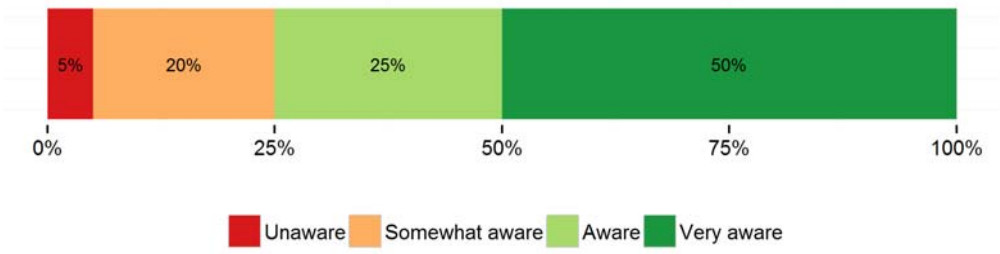
There was fairly widespread understanding that the appropriate place for riders to ride was on the green surface (78% of respondents), with 9% incorrectly stating it was between the parked cars and the green surface. There was also fairly widespread support for the lanes; almost two thirds of respondents thought they were good and a further 16% thought they were very good (Figure 5.6).

■ Figure 5.6: What is your opinion of the lanes? (sample: all pedestrians, n = 44)



Respondents who had driven to Glenferrie Road in the past month generally stated they had a high level of awareness of the presence of bicycle riders (Figure 5.7).

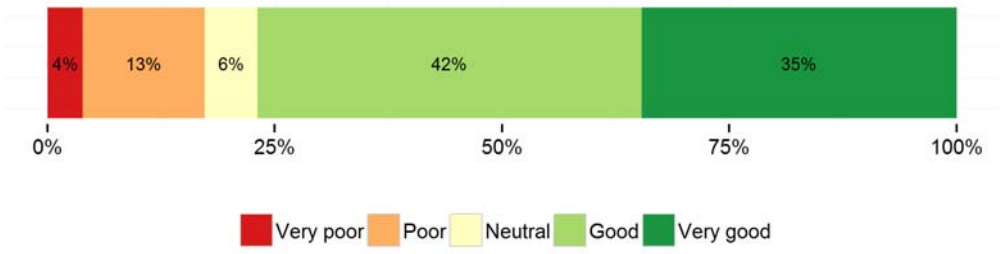
- Figure 5.7: How aware are you of bicycle riders when you drive along here? (sample: those who had driven along Glenferrie Road in the past month, n = 20)



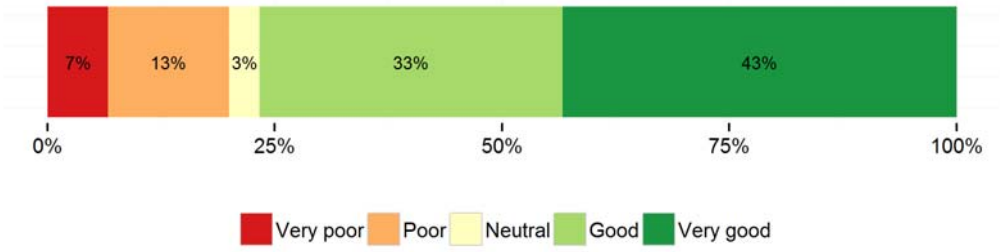
When asked who they thought had legal responsibility in a collision between a car door and a bicycle rider, around two thirds of pedestrians correctly identified the car occupant (68%) as primarily responsible. A further 12% thought both had equal responsibility and the remainder (20%) did not know. None thought the bicycle rider would be legally responsible.

After the completion of the interview the interviewer provided a subjective assessment of how aware they felt the respondent was of car dooring risks involving bicycle riders. This assessment suggested that almost half of pedestrians had a very good level of awareness (Figure 5.8). Similarly, they assessed almost have of respondents as having a high level of empathy towards the issue (Figure 5.9). While necessarily a subjective measure, this suggests that around three quarters of visitors to Glenferrie Road are at least superficially aware of the issue.

- Figure 5.8: Interviewer assessment of respondent awareness of car dooring (sample: all pedestrians, n = 52)



- Figure 5.9: Interviewer assessment of respondent empathy towards car dooring (sample: all pedestrians, n = 30)



6 Discussion

6.1 Overview

The purpose of this section is to provide an interpretation of the data analysis and possible implications. The results are summarised against the measures of effectiveness in Table 6.1. These results are discussed further in the following discussion.

■ Table 6.1: Measures of effectiveness summary results

Measure	Definition of "success"	Result
Cyclist lateral tracking	a. Increased average clearance between riders and parked cars b. Decreased proportion of riders riding within 1 m of parked cars	**(a)+(b): Partial success** – there is evidence to suggest a change in cyclist lateral tracking, and in the proportion of riders travelling within the dooring zone, at two of the four sites.
Motorist lateral tracking	a. Average tracking position moves towards the road centreline. b. Decreased variability in lateral tracking positions	**(a) Success -** Average tracking position moved 0.16 to 0.28 m towards the centreline at three of four sites. The frequency of motorist encroachment into the bicycle lane halved. **(b) Inconclusive** – the variability decreased at two sites and increased at two sites.
Motorist parking position	Increased proportion of motorists park within the designated parking bay and do not encroach onto the roadway	**Partial success** – two sites where the bay was narrowed showed a significant shift in average parking position towards the kerb. Sample sizes were generally insufficient at the other sites, and no effect was observed at the site where parking Ts were converted to solid edge lines.
Cyclist perceptions	Proportion of riders who feel safer with the treatment exceeds those who feel less safe	**Success** – 75% of riders felt more comfortable compared with 4% who felt less comfortable.
Motorist understanding	At least 50% of motorists who parked or had driven along Glenferrie Road had noticed the green treatment.	**Success** – while most cited the purpose as being to give riders their own space (49%) rather than to

Measure	Definition of "success"	Result
	At least 50% of motorists who had noticed the green treatment recognised its' purpose as designating a bicycle lane.	encourage riding away from parked cars (13%), most (87%) were in favour of the lanes.

6.2 Cyclist lateral tracking

As noted previously, the cyclist lateral tracking data suggests the following:

- riders appear to have taken some time to adapt to the treatment, such that a six week period after construction was insufficient to observe significant shifts in lateral tracking,
- after six months the treatment appears to have been effective at reducing the proportion of riders travelling within the dooring zone at two of the sites (Kinkora Road and Linda Crescent (North)), where the proportion riding within the dooring zone decreased by more than two thirds, and
- the treatment has decreased the variability in cyclist lateral tracking.

That riders may have taken up to six months to respond to the treatment is a significant finding in so far as it supports the assertion that road users take some time to adapt to modified road designs. Furthermore, or alternatively, it is noted that the after-2 period when the changes were detected coincided with the use of the variable messaging sign to the south of the study area encouraging riders to use the green bicycle lane (Figure 2.3). While it is impossible to separate these two effects we would suggest these results support the argument that a combination of infrastructure and education are more effective than only one measure.

The magnitude of the reduction in riders travelling within 0.8 m of parking is very significant; at Kinkora Road the reduction was from 20% to 3%, and at Linda Crescent (North) the reduction was from 13% to 4%. These reductions are likely to meaningfully reduce the likelihood of dooring collisions.

Interestingly, the average shift in lateral tracking away from parked cars at Kinkora Road (+0.20 m) and at Linda Crescent North (+0.06 m) was significantly less than the decrease in the parking bay widths from 2.3 m to 2.0 m. If riders were using a marking on the roadway to anchor their position (such as the yellow fairway line) we would expect a shift of around 0.30 m. Instead, we suggest two factors may be contributing to the lesser effect:

- riders are using parked cars as their reference, and positioning themselves in reference to the parked vehicles rather than the general purpose traffic lane, and
- the green preferred bicycle space is attracting riders from *both* to the left towards parked vehicles and to the right within the general purpose traffic lane.

In support of the latter influence we point to the distributions for Glenferrie station and Linda Crescent (North) shown in Figure 4.2. These distributions suggest that there has been a

combined effect whereby riders who would otherwise have travelled within 0.8 m of parking have shifted into the green preferred operating space *and* riders who were previously riding on or to the right of the fairway line have shifted left. We speculate that the treatment has made riders who otherwise felt more comfortable riding in the general purpose traffic lane now feel safer (or perhaps, compelled) to ride within the green bicycle lane. Given that this operating space is, notionally, outside the dooring zone we do not see this as having adverse safety implications.

It is acknowledged that the sites (aside from the Hawthorn Grove sites, for which only after data was available) were all located immediately upstream or downstream of a kerb outstand and/or unsignalised side street. These sites were all close to locations where the green surface treatment widens to 1.5 m (i.e. at unsignalised intersections and at the Glenferrie station tram stop). It seems plausible that riders approaching these areas will start to drift to the left before the end of the 0.6 m green coloured section of roadway. While this will put them into conflict with opening doors of parked cars at these locations it may not be representative of their positioning at mid-block locations. In other words, it is plausible that the detected effect at Linda Crescent and Kinkora Road could be even greater at mid-block locations. While this cannot be verified empirically, we would note that qualitative observations of rider behaviour did not suggest they were drifting to the left approaching the 1.5 m sections of bicycle lane. As such, we suggest any such effect may be minor.

The intercept surveys suggest that the majority of riders, and indeed the wider visitor population, broadly understand the intent of the design and where riders ought to be positioned. However, a minority (13% of riders) misidentified where they should ride as the unpainted asphalt between the parking bay and green surface. We speculate that for some riders this area remains the most comfortable space for them to ride (i.e. the highest level of subjective safety). This is contrary to the objective evidence, which would suggest the greatest risks on this road apply within this area. Again, while the stated level of understanding seems to be fairly good we speculate that some misunderstanding may be possible due to the standard width bicycle symbols on the pavement which stretch between this asphalt area and the green surface, and (possibly) that some riders think the green surface is an edge line defining the outer boundary of the bicycle lane.

Finally, it is noted that at two of the sites there was a statistically significant decrease in lateral tracking variability. Insofar as we would expect consistent tracking to produce a more predictable road environment for all road users this may have favourable safety outcomes. However, these improvements are more likely to come from reduced side swipe collisions (which, in any case, are already very infrequent). As such, we expect the safety benefits to riders to be modest.[12]

6.3 Sense of comfort

While the reduction of actual injury collisions is self-evidently a worthy objective, so too are treatments that are *perceived* by road users as being an improvement on the baseline. The

[12] We confine this commentary to the mid-block treatments; overall the treatment almost certainly has produced positive safety outcomes for riders due to the continuation of the green surface across unsignalised intersections.

intercept surveys found the significant majority of riders felt the treatment was an improvement, and even non-riders also indicated strong positive support. Insofar as the treatment contributes to meeting state and local government objectives to encourage riding the treatment should be considered a success. The challenge for the road authority is that these perceptions may not be reflecting any objective improvement in rider safety.

6.4 Car driver responses

6.4.1 Motorist lateral tracking

At three of the four sites the average motorist lateral tracking position moved by 0.16 to 0.28 m towards the centreline. Much of this shift was due to a substantial decrease in the proportion of motorists encroaching into the bicycle lane (to the left of the fairway line). These results tend to strongly suggest the treatment has had the desired effect of decreasing motorist encroachment into the bicycle lane. In turn, we would expect this to have positive impacts on bicycle riders' objective and subjective safety.

What is less encouraging is the inconclusive results with regard to tracking variability; two sites exhibited a statistically significant increase in variability while the other two exhibited a decrease in variability. It is not clear how the treatment could lead to an increase in variability, and so these results are treated with caution. Further work may be warranted, perhaps off a larger sample, to examine in more detail what is happening with the tracking variability.

It is noted that the Kinkora Road site tended to respond differently to the other three sites, and in ways that are not altogether consistent with our expectations. Data checks did not reveal any issues with the data collection for this site, but nonetheless some scepticism is warranted with regard to the motorist lateral tracking results at this site.

6.4.2 Parking position

This study was able to identify a measurable change in motorist parking behaviour relative to the kerb face at only one site (Linda Crescent (South)) in both after-treatment periods and at another site (Kinkora Road) during the after-2 period. There are at least three possible explanations for a failure to observe a difference at the other sites:

- The changes to the parking bay widths and parking bay delineation (parking T to solid edge line at one site) is insufficient to alter motorists' parking behaviour.
- The measurement method (distance measurement from the video record) is insufficiently accurate to measure what may be relatively small changes (in the order of centimetres).
- The sample size is insufficient.

Our feeling is that the latter two explanations are most likely to explain the lack of effect, at least at the site where the bays were reduced in width but no effect could be measured (Linda Crescent (North)). Ideally, one would manually measure a sample of parked vehicles onsite before and after treatment. This would provide much greater accuracy than the method used in this study. Furthermore, the sample size is clearly insufficient at two

sites (Linda Crescent (North) and Kinkora Road) and marginal at another (Glenferrie station) to have sufficient statistical power to observe any effect.

There is some evidence to suggest that narrower parking bays encourage motorists to park closer to the kerb (Furth et al. 2010). That study observed that for every unit of parking bay width reduction there was a 44% reduction in offset from the kerb. At the Linda Crescent (South) site we observed an average shift of around 0.10 m for a width reduction of 0.30 m, or a shift of 33%. This seems to broadly support the findings of Furth et al. While the evidence is by no means definitive, it is suggestive that reducing parking bay widths shifts motorists towards the kerb by a ratio of 1:3, so freeing up road space for other uses.

6.4.3 Car occupant door opening behaviour

One of the most difficult questions concerning this type of treatment is whether it can encourage less conscientious behaviours by parking motorists, perhaps by encouraging them to park farther from the kerb or to open their doors with insufficient attention to road users. While the parking position can be measured empirically, it would be much more difficult to empirically assess motorist dooring opening behaviour. Moreover, the interviews suggest motorists have a fairly high level of awareness of the presence of motorists, and a reasonable understanding of the risks (and their responsibilities) of car dooring. How reliable these subjective assessments are cannot be determined.

What can reasonably be stated is that the treatment has not completely eliminated the risk of dooring[13]. Scenarios such as shown in Figure 6.1 after the door zone bicycle lane was installed illustrate the typical scenario that continues to occur, namely:

- A motorist parks their vehicle and begins to open their door, seemingly without having seen (and possibly not having looked) the rider approaching some 10 m behind the vehicle (Figure 6.1(a)).
- The rider beings to veer to the right to avoid the opening door, note the presence of the motorist in the traffic lane immediately to the right and behind the rider (Figure 6.1(b)).
- The door is fully open and the rider is positioned near the fairway line so as to safely clear the open door. The motorist in the traffic lane has seemingly moderated their speed to allow the rider through (Figure 6.1(c)). There is no indication that the occupant of the parked vehicle has seen or reacted to the presence of the rider.

In our view, this scenario represents the typical and worst-case scenario; if the rider had been slightly closer to the parked car, travelling faster or been less attentive they may have been unable to avoid the opening door. On striking the door there is a real prospect they may fall into the traffic lane and be struck by the vehicle immediately to their right. Even at the low traffic speeds present on this road there would be little opportunity for the motorist in the moving vehicle to have avoided the rider. This scenario is similar to that which resulted

[13] This statement is not intended as a criticism of the treatment; clearly, no infrastructure or legislation is likely to every *completely* eliminate an undesirable behaviour.

in the fatality aside from the obvious differences that the rider was fortunate enough not to have struck the door and, presumably, would be less likely to fall underneath a car than a truck. We suggest that such interactions are inconsistent with the Safe System principles that dictate that road user error should not result in serious or fatal injury. Clearly, in this case the timing and sequence of events was such that an injury was avoided. However, this appears to have been attributable primarily to chance – if the same situation were repeated many times there would appear to be a reasonable likelihood of collision and injury. In summary, it is our view that the 'door zone' bicycle lane does appear to reduce the likelihood of these types of events occurring but that there remain predictable risks of injury which are not prevented by the road design.

- Figure 6.1: Sequence illustrating evasive action by rider to avoid opening door

(a) Driver opens door, rider is at bottom of image

(b) Rider is to left of green riding zone and starts to veer to right to avoid door

(c) Following motorist yields to swerving rider

(d) Rider successfully evades open door

7 Recommendations

The results from this evaluation suggest the door zone bicycle lane design has been successful at reducing the risk of car dooring by encouraging riders to travel outside the dooring zone, and there is clear road user support for the treatment. We suggest the following modifications that may improve the primary objective (of encouraging riders to travel outside the dooring zone):

- Consider the use of a chevron buffer between the parking bay and green surface to reinforce the message to riders that this area is not recommended for riding.
    - This approach was used to treat Clarendon Street (East Melbourne, Figure 7.1), and demonstrated a high level of efficacy – although the lane was much wider in that case (CDM Research 2012b).[14]
    - A concern with this approach is that it may encourage less conscientious behaviours by car occupants when opening their doors. How strong this effect may be is unknown.
- Use smaller bicycle symbols centred in the preferred bicycle riding zone.
- Consider a solid edge line to the left of the preferred bicycle riding zone.

Figure 7.1: Clarendon Street (East Melbourne) buffered bicycle lane

More generally, we suggest two other modifications that would have ancillary benefits:

- Infrastructure of this scale should include the installation of an automatic bicycle counter as standard practice. This will help evaluate the attractiveness of a facility once installed, and (importantly) provide an exposure measure for crash risk analysis. The cost of such a device (under $10,000) is small relative to the project cost and provides very high quality data that is currently unavailable.[15] In turn, this

[14] In that treatment a 0.6 m buffer between the parking bay and a 1.5 m bicycle lane was used, with an additional 0.6 m buffer between the bicycle lane and general purpose traffic lane.

[15] We note that manual counts are not sufficient for evaluating the change in rider demand after a treatment is installed, or as an exposure measure. Short period counts are subject to very large variations which make their comparison over time highly unreliable.

would provide a more objective basis upon which to assess and prioritise future projects.

- Where a narrow bicycle lane of this type is installed ensure the surface is free of potential hazards. For example, there is a raised reflective pavement marker in the middle of the green pavement to mark the location of a fire hydrant adjacent to 798 Glenferrie Road. This is located exactly along the path that most riders will travel.

Further evaluation of the treatment would be warranted given the significance of the problem, and the challenges of identifying effective countermeasures. This work could include:

- a crash-based evaluation once a sufficient period of time has elapsed (at least three years), and
- observations of how far motorists open their door into traffic; although a fully open door extends from 0.9 to 1.3 m (depending on the model) there is no empirical data on how far motorists actually open their door, and hence the width of the "dooring zone" is ill defined.

8 References

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Appendix A: Bicycle rider survey

INTERVIEWER NOTE: this survey is only about Glenferrie Road from Burwood Road to Barkers Road, where the new bicycle lanes have been installed.

Good morning, we're doing a quick survey for VicRoads about riding on Glenferrie Road.

1. Would you like to take part?
    a. Yes
    b. No – thank and end

2. What is the main purpose of your bike ride today?
    a. Commuting to or from work (includes "working here")
    b. Work related business (e.g. visit client, conference etc.)
    c. Shopping
    d. Eating a meal at a café or restaurant
    e. Buying takeaway food or drinks
    f. Visiting a bar, pub or nightclub
    g. Personal business (medical, banking, hairdresser etc.)
    h. Meeting friend
    i. Attending school or university
    j. Entertainment (e.g. movies, theatre, show or museum)
    k. Sightseeing
    l. Just passing through (probe to ensure they're not in another category)
    m. Other – please specify

3. How often do you ride along here?
    a. Every weekday or more often
    b. 2 -4 times per week
    c. Once a week
    d. 2 -4 times a month
    e. Once a month
    f. Less than once a month
    g. Today is the first time

4. How comfortable do you feel riding this part of Glenferrie Road? *INTERVIEWER: only applies from Burwood Road to Barkers Road*
    a. Very comfortable
    b. Somewhat comfortable, OK, not too bad
    c. Neutral

d. A bit uncomfortable
e. Not comfortable at all
f. Don't know

5. A new bike lane was recently installed along this section of Glenferrie Road. Do you remember riding along here before the new bike lanes were installed in March of this year? *INTERVIEWER: only applies from Burwood Road to Barkers Road*
   a. Yes – I remember riding here before the lanes were installed
   b. No – I don't remember riding here before the lanes were installed
6. *IF Q5 = Yes:* Do you think the new bike lane has made you feel more or less comfortable riding along here?
   a. Much more comfortable
   b. More comfortable
   c. No change
   d. Less comfortable
   e. Much less comfortable
   f. Don't know
7. *IF Q5 = Yes:* When you ride along here now do you ride any differently than before the new bike lanes were installed? *(multi-response – do NOT read out)*
   a. Yes
   b. No
8. What do you do differently? *(multi-response – do NOT read out)*
   a. I ride slower
   b. I ride faster
   c. I ride farther out from parked cars
   d. I ride closer to parked cars
   e. Other – please specify
9. These bike lanes are different to most others in Melbourne. Where do you think you're supposed to ride in them?
   a. On the asphalt between the parked cars and the green surface
   b. In the green coloured part
   c. Between the yellow fairway line and the inner tram track
   d. Between the tram tracks
   e. Don't know
10. What do you think these lanes are encouraging riders to do? *(do NOT read out)*
   a. Ride closer to parked cars out of traffic
   b. Ride away from parked cars outside the "dooring zone"
   c. Ride faster
   d. Ride slower

   e. Other – please specify

11. *IF Q5 = Yes:* Have you noticed any change in the way in which car drivers react to bike riders?
    a. Yes
    b. No
12. *IF Q11 = Yes:* What changes have you noticed? *(multi-response)*
    a. Overtaking drivers give me **more** space
    b. Overtaking drivers give me **less** space
    c. Overtaking drivers travel **faster**
    d. Overtaking drivers travel **slower**
    e. Parked car occupants open their doors more carefully
    f. Parked car occupants open their doors less carefully
    g. Other – please specify
13. Have you been involved in any collision with motorists along Glenferrie Road while riding in the past 12 months? *Only from Burwood Road to Barkers Road*
    a. Yes
    b. No
14. *If Q13 = Yes:* What sort of collision were you involved in? *multi-response*
    a. Side swipe at mid block
    b. Rear end at mid block
    c. Opening parked car doors
    d. Left turning car at unsignalised intersection
    e. Right turning car at unsignalised intersection
    f. Left turning car at signalised intersection
    g. Right turning car at signalised intersection
    h. Other – please specify
15. *If Q13=Yes:* Were you injured?
    a. Yes
    b. No
16. *If Q13=Yes:* How seriously were you injured? *Select most severe if multiple injury events.*
    a. Minor, didn't need medical attention
    b. Went to a GP
    c. Visited a hospital A & E
    d. Admitted to hospital
    e. Other – please specify

17. Have you been involved in any near misses with motorists along Glenferrie Road while riding in the past 12 months? *Only from Burwood Road to Barkers Road*
    a. Yes
    b. No

18. What sort of near miss?
    a. Side swipe at mid block
    b. Rear end at mid block
    c. Opening parked car doors
    d. Left turning car at unsignalised intersection
    e. Right turning car at unsignalised intersection
    f. Left turning car at signalised intersection
    g. Right turning car at signalised intersection
    h. Other – please specify

19. *INTERVIEWER: Record gender*
    a. Male
    b. Female

20. *INTERVIEWER: Record age group*
    a. Under 30
    b. 30 - 49
    c. 50 +

21. *INTERVIEWER: Record clothing type*
    a. Cycling clothing
    b. Casual wear
    c. Sports wear
    d. Business wear
    e. Outdoor work wear
    f. Other – please specify

22. *INTERVIEWER: Record other relevant comments from respondent not covered elsewhere.*

Appendix B: Pedestrian survey

Good morning, we're doing a quick survey for VicRoads.

1. Would you like to take part?
    a. Yes
    b. No – thank and end

2. Can you tell me how you got to Glenferrie Road today?
    a. Walk from home
    b. Train
    c. Tram
    d. Bus
    e. Car – as driver
    f. Car – as passenger
    g. Bicycle
    h. Other – please specify

3. *If Q2=Car – as driver* Did you park your car here on Glenferrie Road, or elsewhere?
    a. On Glenferrie Road *(applies only to the on-street parallel parking)*
    b. Elsewhere *(could mean off-street car park, private car park, on a side street etc)*
4. *If Q3=On Glenferrie Rd* When you got out of your car after you parked did you do anything that you wouldn't do when you park elsewhere?
    a. Yes
    b. No
5. *If Q4=Yes* What did you do differently?
    a. I looked more for cars before opening my door
    b. I looked more for bikes before opening my door
    c. Other – please specify
6. How often do you come to Glenferrie Road?
    a. Every weekday or more often
    b. 2 -4 times per week
    c. Once a week
    d. 2 -4 times a month
    e. Once a month
    f. Less than once a month
    g. Today is the first time

7. *IF Q6=Once a month or more often* Thinking about all the times you've come here in the past month, how did you get here? *(read out)*
    a. Walk from home
    b. Car – as driver
    c. Car – as passenger
    d. Train
    e. Tram
    f. Bus
    g. Bicycle
    h. Other – please specify
8. VicRoads and the Council recently installed new bike lanes along this part of Glenferrie Road. Have you noticed them?
    a. Yes
    b. No
9. They're a bit different to normal bike lanes. What do you think they're supposed to do? *(multi-response, do NOT read out)*
    a. Don't know
    b. Encourage bike riding
    c. Give bike riders their own space
    d. Encourage bike riders to ride away from parked cars *(correct answer)*
    e. Give a space for car passengers to get in and out of their cars safely
10. Looking at these bike lanes, where do you think riders should ride?
    a. In the green coloured part
    b. On the asphalt between the parked cars and the green surface
    c. Between the yellow fairway line and the tram tracks
    d. Between the tram tracks
11. And what do you think people getting out of parked cars along here should do when they open their door? *(multi-response)*
    a. Look for cars
    b. Look for bikes
    c. Nothing
    d. Don't know
12. *If respondent answers Q9 incorrectly, or does not know then state: "The bike lanes are designed to encourage bike riders to ride away from parked cars to protect them from opening doors and to encourage car drivers to park as close to the kerb as possible".* Do you think this is a good or bad thing?
    a. Very good
    b. Good, OK, not bad, alright

c. Neutral
d. Bad
e. Very bad
f. Don't know
g. Other – please specify

13. Why do you say this? *(multi-response, do not prompt)*
    a. Safer for bike riders
    b. Safer for car occupants
    c. Holds up traffic
    d. Bikes shouldn't be allowed on this street
    e. Other – please specify

14. IF Q7= Car – as driver How aware would you say you are of the presence of bike riders when you open your car door on streets like Glenferrie Road?
    a. Very aware
    b. Aware
    c. Somewhat aware
    d. Unaware

15. Who do you think has legal responsibility in a collision between a bike rider and an open car door?
    a. The car occupant
    b. The bike rider
    c. It depends – please describe
    d. Don't know

16. *INTERVIEWER: Record gender*
    a. Male
    b. Female

17. *INTERVIEWER: Record age group*
    a. Under 30
    b. 30 - 49
    c. 50 +

18. INTERVIEWER: How would your rate the respondents' awareness of the dooring issue?
    a. Very poor
    b. Poor
    c. Neutral
    d. Good

e. Very good
f. Don't know

19. INTERVIEWER: How would you rate the respondents' empathy towards the dooring issue?
    a. Very poor
    b. Poor
    c. Neutral
    d. Good
    e. Very good
    f. Don't know

20. *INTERVIEWER: Record other relevant comments from respondent not covered elsewhere.*