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Review of: Route Infrastructure and the Risk of Injuries to Bicyclists: A Case-Crossover Study

Teschke, Harris, Reynolds, Winters et al.
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Review by John Forester

1 General

The basic data for this study come from injured bicyclists reporting to the emergency rooms of hospitals in Toronto and Vancouver, Canada. This is supplemented by detailed information about the crash site, the route taken by the cyclist, and about another site along this route chosen randomly. The comparison between the crash sites and the non-crash sites, presumably combined by type of facility for all of the study subjects, provides the odds ratio between crashing and not crashing for facilities of each type. The calculations to produce odds ratios are done by statistical program packages with which I am not familiar. Therefore, this review assumes that these calculations are valid.

2 Selection by Emergency Room Presentation

Potential subjects who were not residents of the city or injured outside it were excluded. Victims of the worst injuries, either fatal or mentally disabling, were excluded because they could not provide the data. Victims of crashes that did not produce sufficient injury to warrant presentation at an emergency room were also omitted.

Very severe injuries are only a small proportion of all injuries, and that is particularly true for urban crashes (as distinct from rural crashes). Excluding them probably makes little difference to the final result. Excluding the very minor injuries makes no difference to conclusions on the basis of public health, but information about them might well have a large effect on conclusions about the safety of particular types of facility.

In summary, selection by presentation at emergency room is reasonable when studying public health, but it may well exclude data useful for engineering study of the safety of facilities.

3 Case-Crossover Technique

The concept of comparing the site where the cyclist crashed with another site through which he recently passed on the same trip is intended to eliminate the effect of individual internal variables such as cyclist skill or cycling style and of external variables such as weather. Although the Cyclist Interview Form lists six such sites, it appears that the only data used to calculate the odds ratios for the different facility types are:

1: The facility type at which the cyclist crashed
2: A facility type at which the cyclist did not crash, called the control site.

Obviously, the odds ratios between facility types cannot be calculated from the data from one trip. This can only be done by using the data from many trips. The mathematical accuracy of this computation depends on the validity of the statistical program package used.

4 Facility Types

The type of facility present at the site being inspected is determined from the characteristics supplied through a detailed set of questions. For intersections and the like, the questions pertain to the facility from which the cyclist approached the crash site. This means that if a cyclist riding along a bike lane incurs a crash in an intersection his crash is considered to be associated with bike-lane cycling, as it should be. The study identifies fourteen types of facility, as given in its Table 1. These descriptions are quite detailed, such as the first group: Major street with parked cars, with no bike infrastructure, with lane marked as shared, or with bike lane. The last type in the list is cycle track: Paved paths meant for cyclist use alongside major streets, separated by a physical barrier.

The types of facility appear to be clearly distinguished, but see the discussion later in this paper.

5 Crash Types

In determining the crash rate odds ratios the study uses all the crashes studied. These are listed in its Table 2, but here are relisted in order of frequency, as:
1: Car-bike collision: 33.5%
2: Surface defect or rail track: 24.6%
3: Other falls: 19.3%
4: Fall while trying to avoid collision: 8.7%
5: Collision with route infrastructure: 7.2%
6: Collision with person or animal: 6.7%

From one point of view how a cyclist incurs a broken arm may not be so much a public health issue as the fact that he incurred that injury. However, this study is intended to steer engineering decisions to installing the safer kinds of bicycling infrastructure. By mixing together all types of crashes, this study dilutes the engineering information that could distinguish the various types of bicycling infrastructure. For example, it is doubtful that the presence of rail tracks has a demonstrable relationship to only one or a few types of infrastructure. Furthermore, we already know from previous studies that rail tracks are dangerous for cyclists, and it is easy to discover where these are in any area. Therefore, the engineering solution is to make the crossings safe for cyclists, rather than to try to avoid the crossings by looking for some type of facility that avoids the crossings.

In summary, this study is not designed in a manner to develop engineering recommendations for bicycle facility types.

6 Insignificant Characteristics

The following site characteristics were found to be statistically insignificant:
1: Site at an intersection
2: Site at junctions
3: Bike signage
4: More than two traffic lanes
5: Sight distance

Since we know that the great majority of car-bike collisions occur at intersections and junctions, their statistical insignificance in this study appears to present an anomaly. I offer two suggestions for this anomaly. The first is that combining all other types of crash with the 33.5% that are car-bike collisions simply dilutes the relevant information. The second is that it shows that, for all facility types, intersections and junctions show approximately equal increases in crash rate over the non-intersection sections. Being equal across facility types, they don't show as being significant in this type of study.

This further demonstrates the failure to develop information that would lead to engineering improvements.

7 Significant Characteristics

The authors intended that this study would demonstrate the difference in crash rates between different types of bicycle infrastructure. Therefore, they phrased their discussion of results in this way. Bike lanes are a major type of bicycle infrastructure; the authors directed attention to those route types that included bike lanes. However, the presence of bike lanes showed only a small reduction in crash probability as shown by odds ratio. This is not surprising considering the estimate of the probable effectiveness of bike lanes made some forty years ago.

All the other significant differences, save one, were produced by characteristics that are not part of the bicycle infrastructure: presence or absence of parked cars, low traffic streets, absence of rail tracks, absence of construction activity, and absence of grades. Many other sources indicate that the grade effect is the higher speed produced by descents. It is not the high speed that is the problem; undoubtedly, most of the subjects possessed the skill of driving a vehicle at motoring speeds. It has been noted before this that both many special bicycling facilities and the typical style of cycling in traffic become more dangerous as cyclist speed increases.

However, the most significant is the presence or absence of parking.

In summary, typical bicycle infrastructure does little to reduce the crash rate, particularly when compared to the extent to which other normal road characteristics change the crash rate.

8 The Odd Case: Cycle Tracks

The authors report that by far the safest bicycle facility type is the cycle track. Indeed, their data show that, and that result is being trumpeted widely about. More than that, the authors argue that their result contradicts previous North American views. “The higher risk estimates for undifferentiated off-street routes observed in previous studies have been used to recommend against bike-specific infrastructure in Canada and the United States. [The reference given is Forester’s *Effective Cycling*.] This point of view has had a dominant influence on bike transportation facilities in North America for the last 40 years, and has resulted in the very different infrastructure available compared with continental European countries with higher cycling rates.” This is the common claim among bicycle advocates and bike planners that my [Forester’s] work has for forty years held back bicycle facility introduction into North America. The authors of this study share that ax to grind, and claim that their cycle track data disprove the unfavorable analysis I made of cycle tracks in the early 1970s.

There are three main claims. Cyclists recorded high crash rates for paths in general (labeled undifferentiated in this study). Well, there are many kinds of paths and of path usage; this is an amorphous claim.

More pertinent were the two engineering analyses based on:

1: The standard principles of traffic engineering and highway design
2: The statistics of the different types of car-bike collision
3: The traffic movements produced by two types of bicycle facility: bike lanes and cycle tracks (called sidepaths forty years ago)
4: The traffic movements required when each type of facility was installed on a normal city street with crossing and turning traffic at intersections and driveways

The bike-lane analysis demonstrated that bike lanes could not produce a major reduction in car-bike collision rate; their effect would be small, and, more likely, would produce a small increase in car-bike collision rate. It now appears that the observed small reductions have been produced by persuading cyclists who rode in the much more dangerous wrong-way and sidewalk manners to use the bike lane instead. This effect was not considered in the initial analysis.

The cycle-track (sidepath) analysis considered the normal turning and crossing movements at intersections and driveways that are required for city traffic to operate. When these are performed in a cycle track installation they produce conflicting car and bicycle movements that are not only dangerous in themselves but are beyond drivers’ (both motorists’ and cyclists’) capability to observe and prevent. The traffic-engineering changes required to prevent the effect of these added dangers would be expensive and would delay both cyclists and motorists.

Various bicycle advocates and bicycle planners have complained heatedly in professional publications that these analyses have prevented North American introduction of improved bicycle facilities. However, they have never been able to disprove these analyses. Therefore, they resort to ideological rather than traffic-engineering arguments.

The background of this controversy indicates that we should examine the rather extraordinary data about cycle tracks presented in the Teschke paper.

The crashes in this study occurred in some months of the years 2008 and 2009. The crashes all occurred within the cities of Vancouver or Toronto. Today, the Vancouver city website shows that cycle tracks exist on the Burrard Bridge, Hornby Street, and Dunsmuit Street. But the Hornby and Dunsmuir cycle tracks were installed in or after 2010. The Toronto Staff Report, Bikeway Network, 2011, says that their first cycle track is planned for installation in 2011 along the Bloor Viaduct.

In summary, the only cycle track existing in the study cities during the study dates was on Vancouver’s Burrard Bridge. This bridge is at a high level to allow ship passage, with long approaches at each end. Being a bridge it has no crossing or turning traffic to produce the conflicting traffic movements that make cycle tracks so dangerous. One motor lane was walled in by Jersey barriers, and pedestrians were limited to the opposite sidewalk. (It is no coincidence that Toronto’s first planned installation is on a probably similar bridge, the Bloor Viaduct.)

9 Causal Considerations

There are two reasonable purposes for making a study such as this.

One is to advise cyclists about the relative risks of the various types of bicycling facility as they have been installed in typical cities. This study does this in a crude way, although its lumping together of all kinds of risks in one scale conceals from the cyclist much information that would be useful to him. The authors do not claim that this is their purpose.

The other purpose is to advocate the installation of particular types of bicycling infrastructure, based on the combination of low risk and high popularity. The authors claim that this is their purpose. This assumes that whatever may be the causal effect of a facility will also have the same effect wherever that kind of facility is installed elsewhere. But this assumption depends on the further assumption that the causal effect is understood. Without that understanding, any assumption about the range of conditions under which this cause will produce this effect is not valid.

Indeed, there is no agreement about how the lowly bike-lane stripe produces the crash-reduction effect that its advocates claim for it. The engineering analysis says it cannot have much effect, while its advocates have never advanced any better reasoning.

The same goes for the cycle track. A plain cycle track installed alongside the typical urban roadway is said to provide an even higher degree of safety. However, the mechanism by which it will produce this effect has never been explained, not when the required movements of motorists, pedestrians, and cyclists are considered.

In summary, the safety effect of any proposed installation of a bicycling facility cannot be reasonably predicted without knowledge of how this type of facility will produce the desired effect. The subject paper presents no sign that its authors possess any such knowledge, and signs that they don't.

10 Conclusions

I find that this paper (Teschke et al, Route Infrastructure and the Risk of Injury to Bicyclists) does not deserve serious consideration for two kinds of defects: the combination of incompetent traffic-engineering with ideological argument. I offer two examples of this combination.

When considering the small reduction in crash rate produced by bike lanes versus the larger reduction produced by the absence of parked cars, the authors chose to advocate that produced by the bike lanes that they favor.

When considering the astonishing reduction in crash rate produced by cycle tracks, as shown by their data, the authors chose to proclaim that reduction as genuine for cycle tracks in general.

In the bike-lane issue, the authors chose to proclaim the effect of bike lanes, small though it was, rather than the larger effect of the absence of parking. That combines traffic-engineering incompetence with ideological propaganda.

In the much more impressive cycle-track issue, the authors proclaimed enormous crash reduction without informing the readers of the two relevant facts. First, that their data came from only one installation. Second, that that installation was not along a typical city street but in the only situation in which a plain cycle track could possibly be safe, a place without crossing or turning movements by motorists, cyclists, or pedestrians. The authors refer to the forty-year-old cycle-track controversy as if they had studied it, but clearly they don't understand it. It is clear that the authors have such faith in the cycle-track concept that its astonishing data failed to alert them to investigate why such data was reported.

The authors' failure to understand the difficulties of cycle tracks and the only conditions in which cycle tracks may be safe constitute traffic-engineering incompetence.

The authors' proclamation of the great safety of cycle tracks and their failure to be alerted to problems with the source of their cycle-track data demonstrate the improper influence of ideological considerations.