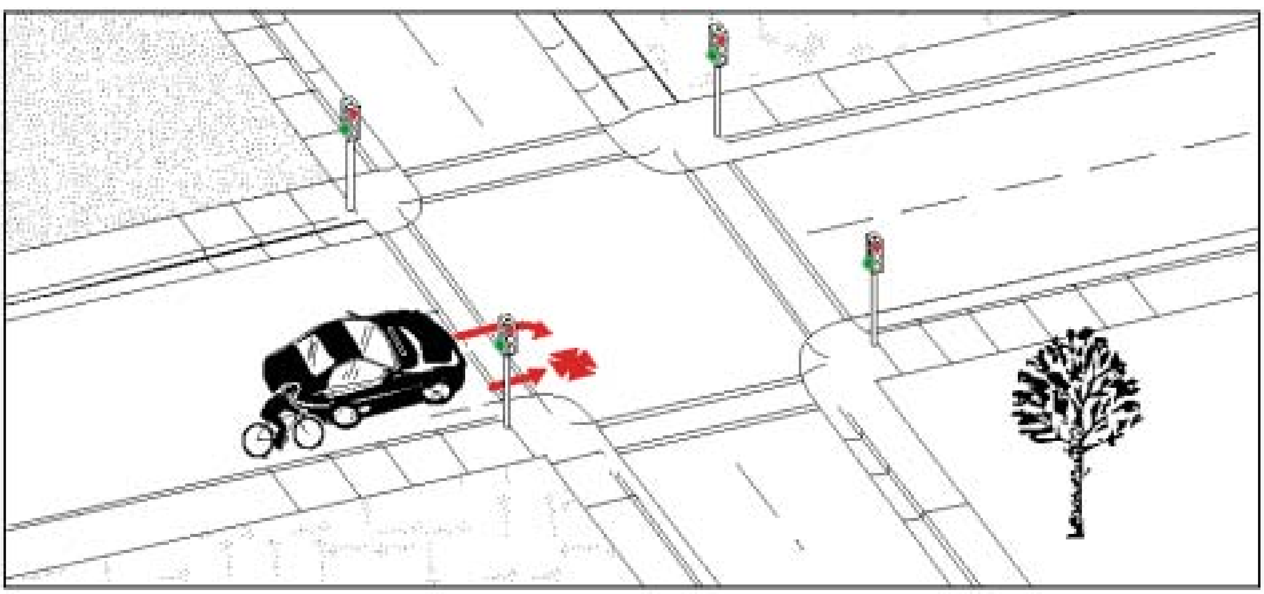
TORONTO

City of Toronto Bicycle/Motor-Vehicle Collision Study



Works and Emergency Services Department

Transportation Services Division

Transportation Infrastructure Management Section

2003

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The crash-type diagrams appearing in Chapter 3 and in Part II, were adapted from "Pedestrian and Bicycle Crash Analysis Tool." (CD-ROM) US Federal Highway Administration, courtesy of Carol Tan-Esse, University of North Carolina Highway Safety Research Center.

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Executive Summary

In 1997, following a series of fatal traffic collisions involving cyclists, Toronto's Regional Coroner conducted a review of the cycling fatalities in the city over the previous decade.[1] One of the Coroner's subsequent recommendations was that collision statistics should be studied in detail, to help understand and address cyclists' safety issues. In response, in July of 1999, the City of Toronto's Transportation Services Division began a study of collisions between cyclists and motor vehicles. The findings of that study are presented here.

The study examined the 2,572 car/bike collisions that occurred within the city between January 1, 1997 and December 31, 1998 and were reported to police. Consistent with the findings of other studies, the majority of collisions were found to have occurred at intersections (including driveway and lane entrances), and most of those involved motor-vehicle turning manoeuvres. Away from intersections, collisions most often involved motorists overtaking cyclists, or opening car doors in the paths of cyclists. In the central area of the city, the most frequent type of collision involved a motorist opening their door and striking a cyclist.

Not surprisingly, the frequency of bicycle collisions appears to correlate with traffic volume and bicycling activity patterns. Collisions occurred most frequently in summer, and in central parts of the city, where bicycle use is most common. Collisions were concentrated mainly on arterial roads, particularly the central east-west routes. The vast majority of collisions happened in dry weather conditions. Most occurred in daylight, particularly during rush hours, especially the evening peak, between 3 p.m. and 7 p.m.

The study's research methods generally followed the approach recommended by the U.S Federal Highway Administration (FHWA), in which collisions are classified according to their physical configuration, by "crash type[2]." The FHWA's car/bike collision classification system consists of 38 different crash types. This typology was used at the beginning of the Toronto

[1] Lucas, W. 1998. *'A Report on Cycling Fatalities in Toronto 1986-1996: Recommendations for Reducing Cycling Injuries and Death.'* Toronto: City of Toronto.

[2] Crashes include both single-vehicle accidents and collisions with other road users. In this report, the terms "crash" and "collision" are both used to refer to the incidents studied here.

study, but was later adapted to suit the local data, resulting in a new typology with 23 collision types (see Table I). The categories are defined by the driver- or cyclist-actions that describe each event most succinctly. Categories named "Ride Out…" refer to the actions of a cyclist, while "Drive Out…" refers to the actions of a motorist. Although they may refer to the actions of only one party, these labels are not intended to assign fault. Indeed, it is possible that a cyclist could have been wholly or partially at fault in a "Drive Out…" collision (if he or she rode off the sidewalk into a crosswalk and collided with a vehicle that had moved into the crosswalk area after stopping, for example), and vice versa.

As each collision was assigned a category, the position of the cyclist (road or sidewalk) was also noted. This provided a more complete description of the configuration of each incident, and enabled the assessment of sidewalk cycling as a possible contributing factor in each type of collision. In addition to recording the environmental conditions (weather, light, and road conditions, etc.) for each and every collision, environmental and behavioural factors were also noted whenever it seemed that they might have contributed to the occurrence of the collision. All the "possible contributing factors" that were recorded are listed in Table II.

Almost 30% of the cyclists involved in reported motor vehicle collisions were cycling on the sidewalk immediately prior to their collisions, making this the most frequent "possible contributing factor."[3] Sidewalk cycling was much more common in collisions involving cyclists under age eighteen than those involving adult cyclists. It was also more widespread in collisions that occurred outside the city's central area.[4] Sidewalk cycling (or cycling across an intersection within the crosswalk) was especially prevalent in three collision types that are characterised by similar motorist actions: "Drive-out at controlled intersection," "Drive-out from lane or driveway," and "Motorist right-turn at a red light". In many of these incidents, the motorist either failed to stop before crossing the sidewalk or crosswalk, or proceeded forward, after stopping, into the path of the on-coming cyclist. The combination of these two types of behaviour (on the part of both the cyclist and the motorist) seems to have played a role in a significant number of collisions. Findings such as these can be useful when designing specific public safety messages

[3] When crash types that never involve sidewalk cycling are excluded, this fraction rises to over 50%.

[4] For the purposes of this study, the central area is defined as the area lying roughly between High Park and the eastern Beaches, south of Saint Clair Avenue.

for both drivers and cyclists. Information about the areas and ages for which certain actions are most problematic can be used to focus the delivery of such messages to particular audiences.

Table I lists the various collision types in order of decreasing frequency. Each type is sub-divided according to the position of the cyclist. (Note that, in most cases in which the cyclist emerged from a lane or driveway, it is not known if they had been cycling on the sidewalk.) The number of fatalities and major injuries resulting from each type of collision is listed, providing an indication of the impact of each type on the well-being of the local cycling population.

Table I: Car-Bike Collision Types — Number of Cases, Cyclists' Position, Major Injuries and Fatalities (1997- 98)

Collision Type	Number of Cases	% of Total	Cyclist's Position		Major Injuries	Fatal
			Sidewalk	Road		
Drive Out At Controlled Intersection	284	12.2%	51%	49%	8	0
Motorist Overtaking	277	11.9%	0	100%	7	4
Motorist Opens Vehicle Door	276	11.9%	0	100%	8	1
Motorist Left Turn – Facing Cyclist	248	10.7%	18%	82%	11	0
Motorist Right Turn (Not at Red Light)	224	9.6%	35%	65%	3	0
Motorist Right Turn At Red Light	179	7.7%	86%	14%	4	0
Drive Out From Lane or Driveway	179	7.7%	81%	19%	3	0
Ride Out At Controlled Intersection	65	2.8%	0	100%	3	2
Wrong Way Cyclist	59	2.5%	0	100%	2	0
Ride Out At Mid-block	51	2.2%	100%	0	4	1
Motorist Left Turn – In Front Of Cyclist	48	2.1%	48%	52%	2	0
Ride Out From Sidewalk	44	1.9%	100%	0	5	0
Cyclist Lost Control	44	1.9%	11%	89%	2	0
Cyclist Left Turn In Front Of Motorist	41	1.8%	0	100%	6	0
Cyclist Strikes Stopped Vehicle	39	1.7%	0	100%	1	0
Motorist Reversing	37	1.6%	46%	54%	0	0
Cyclist Overtaking	31	1.3%	0	100%	0	0
Cyclist Caught in Intersection	30	1.3%	3%	97%	0	0
Ride Out From Lane or Driveway	29	1.3%	Unknown		1	0
Drive Into/Out of On-Street Parking	28	1.2%	0	100%	0	0
Cyclist Left Turn – Facing Traffic	11	0.5%	0	100%	2	0
Other (Not classifiable)	101	4.3%	Unknown		9	2
Unknown (Insufficient Information)	247	-	Unknown		4	0
Totals:	2572		30%	70%	85	10

Table II lists nineteen factors that were found to have possibly contributed to the occurrence of collisions, again in order of decreasing frequency. While other factors may have played a role in some collisions, those on this list were observed repeatedly. Note that, while some of these factors (weather conditions, etc.) are known in almost all cases, others (such as disobeying traffic control) appear to have been reported less consistently. Thus it cannot be said, for instance, that more cyclists than motorists caused collisions by disobeying traffic control. Also, this table includes only those cases in which it was considered likely that a given variable may have played a contributing role in the occurrence of a collision. The actual numbers of collisions that took place in darkness, on wet roads, involved sidewalk cycling or children, is also known. For these variables, both numbers were used in the analysis process.

Table II: Possible Contributing Factors

Factor	Cases
Cyclist riding on sidewalk or crosswalk	629
Darkness/poor visibility	355
Child cyclist (inexperience)	132
Sight lines obstructed	72
Motorist improper/unsafe lane change	68
Cyclist passing on right	58
Cyclist disobeying traffic control	45
Cyclist on wrong side of road	43
Motorist misjudged passing space	37
Motorist disobeying traffic control	37
Motorist discharging passenger in left lane	22
Cyclist path obstructed	17
Vehicular assault	16
Mechanical defect (bicycle)	14
Streetcar tracks	14
Cyclist impaired	9
Poor/wet road surface	9
Motorist failed to detect cyclist	5
Motorist impaired	3

In contrast with many U.S. studies, which typically find that most car/bike collisions involve children, the majority of the cyclists captured by the Toronto study were adults. (However, the cyclist age profile for those collisions that occurred in outer areas of the city was very similar to those typically found in U.S. studies.) Compared to the age distribution of

Toronto's cycling population (as determined by surveys[5]), cyclists between the ages of 18 and 34 were significantly over-represented in car-bike collisions. Males were more often involved in collisions than females, perhaps in part because they tend to make longer and/or more frequent trips than female cyclists, on average.[6] Proportionally fewer males were found to be wearing a cycling helmet at the time of their crash. The data on the cyclists' injuries does not specify the type of injury, and did not reveal a relationship between helmet use and injury severity.

Some age groups exhibit disproportionately high involvement in particular types of collisions. For example, young cyclists (under age 16) were over-represented in collisions in which they rode into traffic from the sidewalk; drivers in their early thirties were more likely than others to open their car door and strike a cyclist; collisions that occurred while a motorist was making a left turn across the path of an on-coming cyclist tended to involve more elderly drivers than did other types of collisions. Such findings suggest that factors related to the typical travel patterns, cycling or driving habits and/or skills of these age groups might account for their higher involvement. This can provide clues about the underlying problems affecting *all* age groups in those types of collisions, and can suggest ideas for specific countermeasures. Age-related findings also can be used in the development and delivery of safety messages, public awareness campaigns, and skills training programs targeted at specific audiences.

By identifying the most frequent types of collisions, and those that tend to lead to more serious injuries, the findings of this study can help police develop more effective traffic-enforcement campaigns. For example, while there may be a perception that many cyclists recklessly disobey stop-signs and traffic signals, our analysis shows that less than 3% of collisions involve a cyclist failing to stop at a controlled intersection. Targeted stop-sign enforcement campaigns along busy cycling routes may result in large numbers of tickets being issued, but their effectiveness in improving traffic safety is questionable. Enforcement that focuses on driving and cycling infractions that are found to contribute most often to collisions and injuries can be expected to yield better results, in terms of improving safety, than campaigns that simply target infractions that are easy to enforce.

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[5] Decima Research Inc., 2000. *City of Toronto 1999 Cycling Study*. Toronto: City of Toronto.

[6] Decima, 2000. Also: Doherty, S.T., L. Aultman-Hall, and J. Swaynos. 2000. 'Commuter Cyclist Accident Patterns in Toronto and Ottawa.' *Journal of Transportation Engineering* Jan/Feb 2000: 21-26.

Some types of collisions are found to occur more frequently in the central area (*e.g.* Motorist Overtaking, Motorist Opening Door), while others are relatively more common in outer areas (*e.g.* Drive-Out at Lane or Driveway, Motorist Right Turn at Red Light). On a smaller scale, some street sections stand out, where the concentration of certain collision types seems especially high — for instance, several blocks on College Street where "dooring" incidents appear to be very frequent. This kind of information can also contribute to the efficient implementation of localised traffic enforcement, and can help to focus public education campaigns. Some of the study's findings have already been incorporated in the CANBIKE cycling skills course materials, providing specific safety information applicable to different types of urban environments. Location-related findings can also contribute the City's efforts to improve the road system, by providing information regarding the kinds of treatments that might be most effective in different parts of the city.

This study has generated a great deal of detailed information about how, why, and where car/bike collisions occur in Toronto. It has raised some important questions as well. To begin applying this knowledge and addressing these questions, next steps should include:

Identifying High Collision Locations/Corridors

The data for 1997 and '98 contains too few collisions to allow us to pin-point specific sites where unusually high numbers of collisions tend to occur. Geographic analysis should continue, using collision data from subsequent years.

Developing, Implementing, and Evaluating Specific Countermeasures

As problematic locations are identified, site-specific design improvements can be considered. Other countermeasures will include education and enforcement campaigns focussed on specific safety issues identified by this research.

On-going Analysis of Bicycle/Motor-Vehicle Collisions

The collision typology should be adapted so that collisions can be routinely categorised. This will facilitate monitoring of long-term trends in car/bike collision patterns and evaluation of countermeasures and other cycling programs.

Investigating Other Sources of Bicycle Crash Data

Information from hospital records may provide an important complement to the available police data. Surveys and other sources of information on cycling injuries should also be investigated, to provide a clearer sense of the full scope of the problem.

Making the Information Available

The most immediate task to follow this study will be to make the new information available to the organisations and individuals concerned with various aspects of travel safety and injury reduction, and to the general public. The detailed findings should be provided in formats that suit the needs of parents, teachers, health and safety educators, policy-makers, and the media, among others.

Reducing cycling collisions and injuries is necessary not only for reasons of public safety, but also in order to increase cycling's popular appeal. The perception that cycling is unsafe is a major deterrent to increased bicycle use, especially for commuting and routine travel. Our ability to promote more cycling will depend very much on the extent to which we are successful in reducing collisions and injuries, and increasing the perception that cycling is reasonably safe. This study is expected to contribute to the dual goals of the Toronto Bike Plan, to increase bicycle ridership while reducing cycling injuries.