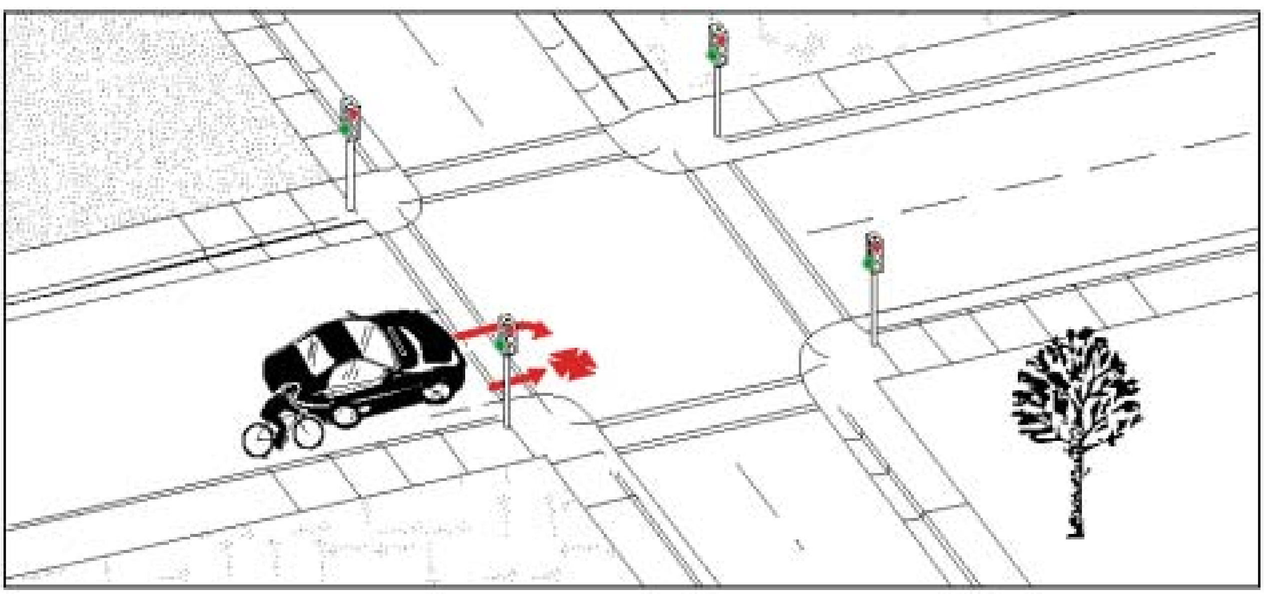
City of Toronto Bicycle/Motor-Vehicle Collision Study



Works and Emergency Services Department
Transportation Services Division
Transportation Infrastructure Management Section

2003

City of Toronto
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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.

Introduction

Safety is a primary concern in the design of any transportation system. The study of traffic safety failures — crashes[7] — can highlight possible design shortcomings, which can be addressed through engineering treatments. Infrastructure and vehicle design improvements are examples of the many types of safety counter-measures that can be implemented with the help of knowledge obtained through crash studies. Research that reveals behaviour patterns associated with the occurrence of crashes can yield important safety messages. These can be delivered through education, training, and public awareness programs, and can also aid in the development of traffic enforcement campaigns. The goal of all these initiatives is to improve traffic safety by reducing the occurrence of crashes and mitigating the severity of those that do occur.

In the past, traditional transportation planning tended to focus on the provision of safe facilities to accommodate an existing, and increasing, demand for motorised travel. Long-range planning that facilitates and encourages alternative travel modes is now becoming more prevalent, and is incorporated in Toronto's new Official Plan. Along with reducing the number of cycling crashes and injuries, a major objective in the field of bicycle transportation planning is to actively stimulate increased use of bicycles for routine trips. Hence, in addition to improving real safety for cyclists, the *appearance* of safety is important, since the perception of risk discourages bicycling in mixed traffic for many people.

Of the various possibilities for increasing everyday use of bicycles, perhaps the greatest potential lies in encouraging citizens who already cycle for pleasure to also use their bicycles for everyday personal transportation — for getting to work or school, and for shopping and visiting. For those who live close enough to their school or workplace for bicycle commuting to be feasible, the most frequently cited factor inhibiting them from doing so is the perception that riding in traffic is dangerous.[8] Efforts to address this problem — to promote cycling *and* to improve cycling safety — must rely on a solid understanding of the actual dangers involved.

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[7] Currently, traffic "accidents" are more often referred to as "crashes," to emphasise the notion that most are caused by a combination of potentially avoidable circumstances and/or actions. Bicycle crashes include both simple falls and collisions with other road users.

[8] Decima, 2000

In July of 1999, a year after the release of the Toronto Regional Coroner's report on Cycling Fatalities, the City's Transportation Services Division began a study of motor-vehicle collisions involving bicycles. The study looked at all the collisions between cyclists and motorists that were reported to police during 1997 and 1998. This report consists of two parts: Part I describes the Toronto Bicycle/Motor-Vehicle Collision Study, including the research methods and key findings. Part II presents the results of study's statistical and geographic analyses, in detail.

Chapter 1 of Part I provides some background information, placing the study in the context of a growing cycling community and increasing public concern over the safety of cycling in Toronto. The research approach is explained in Chapter 2, with descriptions of the data collected, the collision "typing" and statistical analysis processes, and the format used to present the results. The key findings are summarised in Chapter 3, beginning with some general findings regarding the collisions and the cyclists involved in them. The most frequently occurring types of collisions are then discussed individually, along with some of the less frequent types that tended to result in the most serious injuries. Chapter 4 pulls together some common findings that emerged from the analysis of the different types of collisions, in an attempt to highlight some of this city's most significant cycling safety issues. This leads to some suggestions for "next steps," in terms of possible applications of the knowledge that has emerged from this study, further analysis of the data, and potential future research.

Part II presents, for each type of collision in the typology, all the significant analysis results, as well as diagrams depicting typical collision configurations, and maps showing the location of each incident reported during the study period. The reader will find it useful to refer to these pages to supplement many of the discussions in Part I.

Chapter 1: Background

1.1 Trends in Bicycle Ridership and Collisions in Toronto

Toronto has relatively high levels of bicycle traffic on its downtown streets. On a typical weekday, bicycles make up roughly 5% of the downtown traffic (excluding expressways), while on some major streets, including Bloor Street West and Queen Street West, bicycles account for between 14% and 17 % of the vehicles.[9] Surveys indicate that 8% of core area residents use bicycles as their main means of travel to work.[10] In outer areas, bicycle use is much lower, and so the city-wide bicycle modal share is under 2% of all trips, as in most North American cities.

Several factors combine to make the use of bicycles for personal transportation quite practical and popular in central Toronto. Much of this portion of the city was laid out before the advent of the automobile, and the scale suits walking and cycling well. Main streets and transit lines are oriented parallel to the lakeshore on flat terrain, and the grid pattern is closely spaced. A diverse mix of residential and commercial development, including a thriving small-retail sector, means that shopping and other necessary trips can be quite short. The central area supports a large resident population, and there is a very high concentration of employment in the central business district. Thus, many residents enjoy short commute distances. Two large universities are located in downtown Toronto, as well as several colleges and medical institutions, which add to the commuter-cyclist population. The city is well served by public transit, especially in the central area, providing a convenient alternative on days when bicycling is not practical. These factors allow the residents of almost forty per cent of households within central Toronto, and over half of those in the core area, to do without regular access to a motor vehicle.[11] Recreational cycling is popular in all areas of the city, but most of Toronto's utilitarian cycling activity occurs in the central region, including the vast majority of bicycle trips to and from work.[12]

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[9] 1993 City of Toronto Central Area Cordon Count

[10] 1991 Central Area Residents Survey

[11] Transportation Tomorrow Survey, 1996

[12] Decima, 2000

While many commuters walk, cycle, or use public transit, a large number of motorists compete for space on the roads every day. Approximately 1,200 collisions between bicycles and motor vehicles are reported each year in Toronto, resulting in an average of three cycling fatalities and over a thousand personal injuries each year. While the number of collisions may seem high, bicycles are not significantly over-represented in traffic collisions. Cyclists are involved in just under two percent of all reported motor vehicle collisions, roughly equal to the bicycle's share of all trips in the City. Nevertheless, they account for eight percent of all collision-related personal injuries and five percent of traffic fatalities. In the central area, where bicycles account for approximately five percent of traffic, fourteen percent of collision-related personal injuries are sustained by cyclists.[13] While cyclists are much less likely to harm other road users, they are much more vulnerable to injury than are the occupants of motor vehicles. Hence, treating cyclists simply as operators of "ordinary" vehicles is not equitable, and is unlikely to promote an environment conducive to increasing bicycle-use.

Table 1.1: Cycling Fatalities and Injuries in Toronto (1992-2001)

Year	Fatalities	Injuries
1992	2	1,254
1993	4	1,247
1994	4	1,120
1995	1	1,144
1996	6	1,144
1997	4	1,397
1998	6	1,181
1999	2	1,029
2000	3	1,084
2001	0	1,100

As illustrated in Table 1.1, the number of cycling-related fatalities and injuries has been relatively constant over the past decade. While this is somewhat encouraging, considering that the number of cycling trips has increased, the injury rate for cyclists is still disproportionately high. It is essential that efforts to understand the causes of cycling collisions continue, and that the findings be incorporated in the processes of transportation planning and traffic operations.

[13] Lucas, 1998

Toronto's new Official Plan stresses the importance of making alternatives to automobile travel more viable as the city continues to grow. The long-term process of implementing the Toronto Bike Plan has begun, with the dual goals of doubling the number of bicycle trips within ten years and reducing cycling-related injuries and collisions. In order to achieve these objectives, we must learn as much as possible about how, why, and where bicycle/motor-vehicle collisions occur.

1.2 The Toronto Coroner's Report on Cycling Fatalities

During the summer of 1996, two cycling fatalities within a ten-day period attracted considerable public attention. As a result, Toronto's Regional Coroner assembled an ad-hoc committee to review the cycling fatalities that had occurred in the city over the previous decade. The committee's report, sub-titled "Recommendations for Reducing Cycling Injuries and Death," was released in July of 1998.[14] The Coroner stressed that "there is a disproportionate representation of bicycles in (personal injury) traffic collisions, relative to their numbers on the road, highlighting the need for appropriate programs designed to reduce cycling-related injuries." Furthermore, "(b)icycle collision reporting and the development of an adequate database for intelligent analysis must be recognized as important foundations." The Coroner's Report contained thirteen specific recommendations, one of which was that collision data should be studied in detail, to help create a more detailed understanding of the traffic safety problems affecting cyclists in the city:

> **C. Expert review of bicycle collisions and collision data**
>
> **Recommendation #4**
>
> That the City of Toronto, with the assistance of the Ontario Trauma Registry, the Ministry of Transportation and other interested parties, initiate a comprehensive study of bicycle usage and collisions within the City. The study would include:
>
> - probable causes of collisions (behavioural, geometric design, road condition, etc.)
> - high frequency collision locations
> - bicycle collision/injury trends
> - physical infrastructure improvements to prevent collisions (site specific or systemic changes)
> - educational messages for drivers, cyclists and the media
> - any other relevant issues

[14] Lucas, 1998

The Coroner recommended that the City commence an on-going, co-ordinated effort to understand the causes of local cycling fatalities and collisions:

> **Recommendation #5**
>
> That a multi-disciplinary team involving municipal staff, including traffic engineering, bicycle facility planning and bicycle safety training staff, and police and ambulance personnel be established to conduct an annual review of all cycling fatalities in the City of Toronto as well as bicycle collision data.

Among the Coroner's other recommendations were some specific suggestions as to how the information generated by this kind of research should be applied:

> **E. Collision prevention – enforcement**
>
> **Recommendation #10**
>
> That the Toronto Police Service, in partnership with the municipal Cycling Committee, expand targeted enforcement and education efforts towards specific behaviours (cyclists and drivers) which cause collisions, and use the media to raise awareness of these behaviours.

And:

> **G. Road design/facilities**
>
> **Recommendation #13**
>
> That The City of Toronto identify potentially dangerous locations for cyclists including high frequency accident locations and cyclist-identified problem areas where site-specific improvements can be made to prevent bicycle collisions.

In July of 1999, as part of the City's response to these recommendations, Transportation Services began The Toronto Bicycle/Motor-Vehicle Collision Study, focusing on the kind of cycling crashes that account for most serious cycling injuries. While cycling crashes that do not involve motor-vehicles can indeed cause injuries, information collected on such incidents — mainly by hospital emergency wards — is much less detailed than that available from motor-vehicle collision reports. When this study is supplemented with information from hospital records, we will be able to further develop our understanding of the scope of local cycling crash patterns.

The current study establishes a reliable method by which local collision data can be effectively analysed. As a follow-up to this study, Transportation Services is implementing a streamlined process by which statistics on motor-vehicle collisions involving cyclists can be collected and reviewed on an on-going basis. This could reveal trends in cycling collisions and injuries, trends that may reflect the impact of traffic enforcement and public awareness campaigns, improvements in cycling infrastructure, and other initiatives, as well as changes in the level of local cycling activity.

Some of this study's findings have already been applied, in programs that contribute to the implementation of several of the Coroner's recommendations. For example:

- In 2002, Toronto Police Services began incorporating information from the Collision Study, along with suggestions from the Toronto Cycling Committee, in their annual "Cycle Right" campaign, aimed at both cyclists and drivers.
- City council has adopted a by-law requiring taxicabs to display a sticker reminding cab drivers and passengers to look for bikes prior to opening the car door. The City's own vehicle fleet will also be fitted with these stickers during routine maintenance.
- A public awareness campaign, "Sidewalks are for Pedestrians," launched by the City in 2002, highlights the dangers to both cyclists and pedestrians when cyclists ride on the sidewalk.
- "CAN-BIKE" cyclist-training course materials have been updated, with the addition of a new chapter on collisions and crashes. Canadian instructors now have access to information that is more relevant to cities like Toronto.

The Collision Study's geographic analysis identified several street sections where certain types of collisions were very frequent, such as parts of College Street where dooring incidents are common. It also highlighted differences in collision patterns between central and outer areas of the city. However, identifying more specific high-frequency collision locations will require additional data. Unlike motor-vehicle collisions, car/bike collisions are not frequent enough to yield distinct local concentrations within the two-year period covered by the study. Additional data, from collisions that have occurred in subsequent years, may provide enough information to pinpoint problematic intersections and corridors. In addition, as the Coroner suggested, cyclists may be able to identify places where they feel that site-specific improvements might reduce collisions, based on their travel experiences. A systematic method of collecting this kind of information should be developed.

Chapter 2: Research Methods

Previous studies of bicycle crash incidents fall into three general categories: analysis of crash rates by the number of bicycle trips taken (or number of cyclists) within a particular area or population; analysis of crash rates by distance travelled by individual cyclists (or particular groups of cyclists); and crash-type frequency analysis. These categories complement one another, and each has its strengths and limitations. Cycling safety research is hampered by a general lack of detailed empirical information on levels of cycling activity. Most traffic counting machines do not detect bicycles reliably. Large-scale manual traffic counts are more informative, but are costly, so they are usually run for only one day per station. If a count is conducted during poor weather, it is likely to underestimate the usual level of bicycling activity. In many bicycle crash studies, therefore, the subjects' degree of exposure to crash risk can only be estimated.[15]

Measuring crash rates requires both collision data and exposure estimates, which are usually gathered through surveys. A survey by Lisa Aultman-Hall[16] collected both types of information. Respondents were asked to provide information on the distances they cycle, and to report all the crashes they experienced. Studies of this kind can provide much-needed information about the relative safety of different routes and cycling facilities. For Aultman-Hall's sample of 1,359 Toronto commuter cyclists, most crashes (collisions and falls) occurred on roadways, since that is where most cycling activity took place. However, crash rates *per kilometre* were significantly higher on sidewalks and multi-use paths. The study also found that crash rates were dependent on the riding habits of the cyclists, such as the weekly cycling distance and the type of cycling facilities preferred. Those who rode more exhibited lower crash rates. Cyclists who reported that they often ride on sidewalks exhibited higher crash rates, even on roads, than those who said they never ride on the sidewalk. This kind of information can help determine the type of safety messages that should be provided to all cyclists, and can also identify opportunities for infrastructure improvements.

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[15] "Exposure" is a function of the number of trips and the average trip length. Cyclists who make frequent and/or long trips are said to have a greater exposure to traffic hazards than those who cycle less.

[16] Doherty *et al*, 2000

Distance-based crash rates (or injury and/or fatality rates) for cyclists are sometimes compared with rates for other modes, to give an idea of their relative safety. However, since bicycle trips are usually shorter than auto trips, on average, it is perhaps more appropriate to compare them on a per-trip basis. These rates can also provide an indication of the relative safety of cycling in different places. For instance, the number of cyclist fatalities per 100 million bicycle trips in different countries ranges from lows of 1.6 in the Netherlands and 2.4 in Germany, up to 26 in the US.[17] Based on traffic fatality records, and travel estimates from the City's most recent large-scale cycling survey,[18] the cyclist fatality rate for the City of Toronto works out to between 6 and 10 fatalities per 100 million bicycle trips. The accuracy of such calculations is limited by a reliance on self-reported information — the personal accounts of cycling activity collected by surveys.

One of the benefits of this kind of survey-based crash research is that it captures information on all kinds of cycling accidents, including those that may not show up in police and hospital records. This provides a way of estimating the proportion of crashes that are not reported to authorities, so that the full spectrum of cycling accidents can be better understood. It also provides a sense of the relative significance of different kinds of crashes. Most surveys find that collisions typically result in more serious injuries, but that falls are more common.

While such studies can capture a representative sample of the kinds of *incidents* affecting the cyclists surveyed, it is difficult to obtain a sample that is truly representative of the local cyclist *population*. Other studies have focused on specific locations, rather than on particular groups of cyclists. For instance, Wachtel and Lewiston counted the number of cyclists using the road versus the sidewalk, on three arterial roads in Palo Alto, California.[19] By comparing these numbers with police collision reports, they arrived at a measure of the relative safety of these different facilities. Strictly speaking, the findings apply only to the specific locations studied. More general results would require large amounts of data, which would take a long time to collect, given the relatively low levels of bicycle use in most North American cities. Studying conflicts ("close-calls") rather than actual crashes can yield similar information more quickly.

[17] Pucher and Dijkstra. 2000

[18] Decima, 2000

[19] Wachtel. and Lewiston, 1994

The majority of crash research done in the past has been of the third type, crash-type frequency analysis, of which this study is an example. One reason it is the most common is that it uses pre-existing databases (police accident reports and hospital records) which are usually quite detailed and extensive. However, these sources of data capture information on only a fraction of all crash incidents. Falls and minor collisions are rarely reported to police, and only those resulting in injuries appear in hospital records. Also, while collision frequency analysis can highlight sites where crashes are unusually frequent, it cannot tell us whether these are hazardous locations or simply heavily-used bicycle routes. Despite these limitations, such studies do capture a representative sample of the cyclists involved in collisions. That is, unlike surveys, there is no mechanism that might selectively discriminate against certain portions of local cycling population appearing in collision reports or hospital records.[20] Thus, the findings of collision frequency analysis provide reliable, detailed information that can be generalised with confidence. Furthermore, since collisions generally result in more serious injuries than do falls, and because the fear of collisions acts as a significant deterrent to cycling, they are of great interest to organisations that implement public safety initiatives, and promote cycling.

In a typical collision frequency analysis, a large number of collision reports are studied and classified according to a "crash typology," a system of categories, each of which defines a specific sequence of events that best describes a particular type of collision. The process generates summary statistics for the different collision types, and the cyclists and drivers involved. It allows investigators to uncover some of the factors that may have contributed to the occurrence of collisions, factors that may only stand out when the data is aggregated. The findings are useful in designing public awareness campaigns, driver- and cyclist-education materials, and traffic regulation enforcement programs. With enough data, collision frequency analysis can also identify "hot spots" where collisions occur unusually often, suggesting the need for operational or infrastructure modifications. It can also reveal areas where the reporting process and police officers' awareness of bicycle traffic safety issues might be improved. Addressing these concerns would help to improve the collection of basic data on bicycle collisions, a need that the Toronto Coroner identified after completing his study. It could also help improve relations between police and cyclists.

[20] Stutts and Hunter, 1998

2.1 Data Collection and Organisation

The Toronto Bicycle/Motor-Vehicle Collision Study consisted of three main stages: collection and organisation of the information, analysis of the data, and presentation of the analysis results in graphical format. The methods are based on the approach adopted by the U. S. National Highway Traffic Safety Administration.

Toronto's Traffic Data Centre and Safety Bureau maintains an electronic database containing information on all police-reported motor-vehicle collisions that occur in the city. It lists the date, time, and location of each incident, the age of the parties involved, the severity of any injuries sustained, as well as other basic information. Collision report numbers are also included for each entry, allowing electronic retrieval of the associated Motor-Vehicle Accident (MVA) reports, which contain many other important details. Most of the MVA reports contain a diagram depicting the configuration of the vehicles involved and a brief synopsis of the sequence of events, written by the investigating police officer. These were vital to the analysis of each incident.

After reviewing the available data, it was decided that collisions from the two most recent years for which records were available (1997 and 1998) should be analysed. Over 2,500 collisions involving cyclists were reported during this period, providing a robust sample size. Examining all the collisions that occurred over each complete twelve month period ensured that any seasonal variations in the prevalence of certain kinds of incidents would not affect the overall results. Some MVA reports were missing, while others were incomplete, so data for approximately 6% of the collisions is incomplete.

As each collision report was examined, the time of day, weather, and other basic facts were noted. The diagram and synopsis were carefully studied, in order to 'reconstruct' the incident. The collision was then assigned a "crash type" from the typology illustrated in table 2.1. The crash typology used here is based on one developed by the Federal Highway Administration (FHWA) for a 1996 collision analysis covering six U.S states (see Appendix A). That system consists of 38 different crash types, and is an updated version of a typology first developed by Cross and Fisher in 1977, for the U.S. National Highway Traffic Safety

Administration (see Hunter *et al*). The FHWA typology was used initially for this study, but after coding the data for one full year's collisions it became apparent that the classification system could be modified to better suit the local data. Our ability to compare findings with those of other studies that use the FHWA typology has not been significantly affected by the changes outlined below. (The relationships between the two typologies are detailed in Appendix A.)

The FHWA's category "Cyclist Strikes Stopped Vehicle" does not differentiate between situations where a cyclist simply runs into a parked car and those where a motorist suddenly opens a car-door, striking a passing cyclist. This type of incident is reported frequently in Toronto, so an additional category, "Motorist Opens Vehicle Door into Path of Cyclist," was created. On the other hand, some of the categories in the FHWA system pertain to collisions that are not frequently reported in Toronto ("Play Vehicle," "Wrong Way Motorist," and "Cyclist Right Turn," for example). These were collapsed into a miscellaneous category ("Other"). The resulting loss of detail was considered acceptable, since the small numbers of cases would have precluded any meaningful statistical analysis. Several other crash types in the FHWA system are distinguished by features that seem rather subjective: the categories "Motorist Overtaking — failed to detect cyclist," "Motorist Overtaking — cyclist path obstructed," and "Motorist Overtaking — misjudged passing space" all depend on statements from the driver. These were combined as a "Motorist Overtaking" category, reducing the total number of crash types to twenty-three, as listed in table 2.1. These categories are mutually exclusive and, along with the "Unknown" category for cases lacking complete information, account for all the cases.

Each crash type names the vehicular manoeuvres that most clearly describe the configuration of a particular kind of collision event. "Drive Out…" refers to the actions of the motorist, while "Ride Out…" refers to the actions of the cyclist. Where only one vehicle is mentioned in the crash type title, the other party can be assumed to have been proceeding "normally"(*i.e.,* straight ahead). For the cyclists, this could in some cases include riding along the sidewalk. Sidewalk cycling was therefore recorded as additional information necessary to fully describe the crash configuration. In some cases sidewalk cycling can also be considered a factor that may have contributed to the occurrence of the collision. This is because sight-lines at intersections (including driveways) are often restricted at the sidewalk. A cyclist crossing a roadway from the sidewalk, even at a moderate speed, can enter the motorist's field of view much more suddenly than a pedestrian would. Motorists scanning for pedestrians as they hastily negotiate an intersection may not expect to encounter cyclists in this part of the right-of-way. Cyclists on the sidewalk may not be able to see approaching motorists until the last moment, or may mistakenly assume that motorists have noticed them.

Environmental conditions, behavioural factors, and other external circumstances are often significant as well. Hence, as each collision was categorised, other factors that may have played a contributing role were also recorded. As the first few dozen reports were examined, a list of such factors that came up repeatedly was assembled (table 2.2).

Table 2.1

Collision Typology
1) Drive Out At Controlled Intersection
2) Drive Out From Lane or Driveway
3) Motorist Reversing
4) Motorist Right At Red Light
5) Motorist Right Turn (Not at Red Light)
6) Motorist Opens Vehicle Door in Cyclist's Path
7) Cyclist Strikes Stopped Vehicle
8) Motorist Left Turn – Facing Cyclist
9) Motorist Left Turn – In Front Of Cyclist
10) Motorist Overtaking
11) Ride Out At Mid-block
12) Ride Out At Controlled Intersection
13) Ride Out From Sidewalk
14) Ride Out From Lane or Driveway
15) Wrong Way Cyclist
16) Cyclist Left Turn In Front Of Traffic
17) Cyclist Left Turn – Facing Traffic
18) Cyclist Lost Control
19) Cyclist Caught in Intersection
20) Cyclist Overtaking
21) Drive Into/Out of On-Street Parking
22) Other (Not Classified)
23) Unknown

Table 2.2

Possible Contributing Factors
Cyclist riding on sidewalk or crosswalk
Darkness/poor visibility
Child cyclist (inexperience)
Sight lines obstructed
Motorist improper/unsafe lane change
Cyclist passing on right
Cyclist disobeying traffic control
Cyclist on wrong side of road
Motorist misjudged passing space
Motorist disobeying traffic control
Motorist discharging passenger in left lane
Cyclist path obstructed
Vehicular assault
Mechanical defect (bicycle)
Streetcar tracks
Cyclist impaired
Motorist impaired
Poor/wet road surface
Motorist failed to detect cyclist

Weather, light, and road surface conditions are examples of environmental factors that are routinely noted in the police reports. These data were recorded for analysis in every case, except when other factors eliminated the need — if the driver was charged with deliberately striking the cyclist, for example. Besides recording these variables as they appeared in the MVA reports (*e.g.,* "clear," "rain," "snow," "freezing rain"), they were also treated as binary variables (*e.g.,* wet/dry), for the purpose of assessing their statistical role as possible contributing factors. Whenever possible, the distinctions referred to above, which define the different types of "Motorist Overtaking" crash types in the FHWA typology, were also noted as possible contributing factors.

Some behavioural factors, such as cycling on the sidewalk or on the wrong side of the road, were clearly apparent from the diagrams in the reports. Others, such as disobeying traffic control devices or failing to yield the right-of-way, were noted in code boxes, mentioned in the written synopses of the investigating officers, or could be inferred from charges laid. For each collision, as many as four of the possible contributing factors listed above were attributed. (In no case was it necessary or desirable to note more than four.) Recording these factors allowed for a detailed analysis of each type of crash, and compensated for any loss of information that might have resulted from combining some of the FWHA's categories.

For each collision, the severity of any injuries sustained by the cyclist was coded for analysis. This allowed us to identify the types of collisions that tend to result in the most severe injuries (see section 3.2). Injuries are recorded in the collision reports according to the Ontario Ministry of Transportation scheme illustrated in table 2.3, except that the thirty-day limit on the "fatal" class is not strictly adhered to by Toronto Police.

Table 2.3: Categories of Injuries

Injuries	Description
None	Uninjured person.
Minimal	Person did not go to hospital when leaving scene of accident. Includes minor abrasions, bruises and complaints of pain.
Minor	Person went to hospital and was treated in the emergency room but not admitted.
Major	Person admitted to hospital. Includes person admitted for observation.
Fatal	Person died within 30 days, as a result of the collision.

2.2 Data Analysis

As the data was assembled and coded, it formed a matrix consisting of a row for each incident and a column for each data variable. (A complete list of all the variables collected for analysis appears in Appendix B.) After generating summary statistics for the entire data set, the data was sorted in various ways to create sub-sets. By comparing the statistical characteristics of each such sub-set with the characteristics of the whole sample, features peculiar to each sub-sample can be identified. This reveals relationships between some of the variables. For instance, if the data is sorted by the age of the cyclists involved, it is possible to identify the kinds of crashes that seem to pose distinct problems for each age group; when sorted according to geographic area, different problems stand out in different areas; if the data is sorted by crash type, it is possible to identify the age groups that are disproportionately involved in each type of collision. Sorting by crash type also highlights any statistically common factors that may have contributed to each particular type of collision, which can lead to suggestions for possible counter-measures. The main focus of our analysis took the latter route — comparing the statistical characteristics of the different crash types. The analysis was facilitated by the use of a series of histograms (bar charts) to compare the distribution of particular variables among different sub-sets.

To use the variable "cyclist's age" as an example, if the ages of all the cyclists in any group are plotted in a histogram, it forms an "age profile." The age profile of the group of cyclists involved in one type of collision can be plotted against the age profile for all the cyclists in the entire study sample, to reveal age groups that are "over-represented" (*i.e.,* more frequently involved in that particular type of crash). This process was repeated with the other key variables, including weather, light and road surface conditions, and all the "possible contributing factors." The location of each collision was mapped, using Arcview GIS software, to facilitate the analysis of relationships between location, crash type, and the other variables. Statistics for each crash type were compared with statistics for the whole data set, using histograms in most cases. (Plotting the frequency distribution of a variable over one type of collision against its distribution over *all* collisions — as opposed to *all other* collisions — facilitates visual comparison of data for two or more crash types, since they are presented in relation to the same 'base line.') In this manner, the likelihood that each variable might have played a contributing role in each crash type was assessed.

While histograms provide a visual tool that is clear and easy to comprehend, more rigorous statistical tests are necessary to determine the significance of any apparent over-representations. For this purpose, cross-tabulations were performed for all the statistical statements made in this report, using SPSS software to apply Fisher's Exact Test. This was most important for crash types containing of a small number of cases, or for histograms exhibiting very small deviations from the base line. In cases where the sample size was large and a histogram clearly indicated a high degree of over- or under-representation, the statistical significance of the resulting statements was consistently found to be high.

2.3 Presentation of Analysis Results

The format used to present the analysis results (Chapter 4) loosely follows Carol Tan-Esse's treatment of the data from the 1996 FHWA study referred to above,[21] which includes a mix of histograms and tables. Histograms are particularly helpful for multi-category variables, like age and injury severity, and are used in this report to present detailed findings regarding these attributes, for every crash type. Histograms displaying environmental conditions have also been included, wherever an interesting result was found. For the "possible contributing factors," all of which are simple binary (yes/no) variables, any over-representations are highlighted simply by comparing a variable's frequency for a particular crash type with its average frequency over all crash types, in tabular format. Maps showing the locations of all the collisions of each type (for the two-year study period) are also included.

A useful feature of histograms is that each vertical bar can be made to represent a defined group, by adjusting the scale divisions (or "bin size") of the horizontal axis. Tan-Esse splits age data into seven groups: 0-9 (child), 10-14 (youth), 15-19 (teen), 20-24 (young adult), 25-44 (adult), 45-64 (mature adult), and 65 and over (elderly). Such formatting facilitates interpretation of the data, since the age distributions for each crash type can be easily visualised in terms of

[21] Tan, 1996

hypothetical "life stages." As an example, Figure 2.1 clearly reveals that the "adult" group is over-represented in a hypothetical "Crash Type X." The black bar representing cyclists age 25 to 44 involved in "Type X" collisions is much taller than its grey twin, which represents the same age group in collisions of *all* reported types. Of course, the definition of such age categories must have a basis in theory, or be supported by empirical evidence that different age groups consistently exhibit tangible differences in behaviour. Hypotheses about the cycling habits of different age groups can be tested by examining the degree of involvement of each age group in different types of collisions. With the help of histograms, many different crash types can be quickly and easily compared.

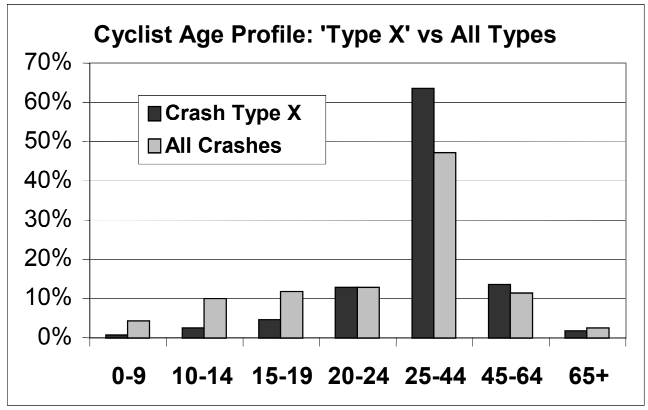

Figure 2.1

Another reason one might group distinct data, like the age of each cyclist, into a few relatively large intervals is to compensate for the random variations that can occur with small samples. On the other hand, when a *large* sample of distinct data is grouped into coarse categories, detail is inevitably lost. The FHWA study sample contained predominantly young riders, so it makes sense to split them into smaller age groups. However, almost half of the cyclists in the Toronto sample would fall into the FHWA's "adult" age group. This would hide any nuances that might arise *within* the "adult" category. For our sample, it is more informative to split the "adult" category into smaller sub-divisions. The large size of the bar representing the adult age group in Figure 2.1 also means that the differences between the other age groups are less striking, since they are compressed vertically. For these reasons, the Toronto sample was divided into uniform age categories, rather than hypothetical life stages. Because of the large size of the sample, many of the sub-samples (*e.g.* the seven most frequent collision types) contain sufficient cases to allow analysis using five-year intervals. Age data for the less frequent collision types, and other sub-groups containing fewer than 60 cases, is charted in ten-year age intervals.

2.4 Data Limitations and Reliability

The scope of this study was limited to an examination of collisions between motorists and cyclists that occurred within the city between January 1, 1997, and December 31, 1998, and were reported to the police. Estimates of the proportion of bicycle crashes that go unreported range as high as 90%.[22] While bicycle-only crashes and falls are rarely reported to police, studies of hospital records have also found that up to 60% of cyclists treated in hospital after a collision with a motor-vehicle did not report their collisions to police.[23] Collisions resulting in serious injuries are more likely to be reported than minor collisions involving little or no property damage or injuries. Thus, police records must certainly under-represent the frequency of car/bike collisions, while over-representing their average severity.

The MVA reports, the primary source of our information, are of two types. Most are prepared by police officers at the scene of the crash. Basic information is entered in a standard form (see Appendix B), which also has space for a diagram and written synopsis, where the officer provides his or her interpretation of the incident. A few (less than 5%) were prepared at Collision Reporting Centres, and include the statements of one or both of the parties involved. In both situations, there is potential for error, bias and/or misinformation. The study did reveal some shortcomings in the collision reporting forms. (Data on the use of bicycle lights, reflectors, helmets and other safety equipment, for example, is not collected consistently.) It also highlighted a few areas where police officers' awareness and appreciation of bicycle traffic safety issues might be improved.

In cases of inconsistent or conflicting information, the primary investigator and the research supervisors were usually able to arrive at a plausible re-construction of the incident together. Indeed, it is important to remember that in *every* case, the crash-typing process involves a degree of re-construction. While the MVA reports contain a great deal of information, they are geared primarily for dealing with the sort of issues that arise following collisions between motor-vehicles — legal and insurance issues, and such. Thus, many details that might interest the

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[22] Aultman-Hall and Kaltenecker, 1999

[23] Stutts and Hunter, 1999

researcher are simply not available. The cyclist's perspective on what happened is particularly absent from this kind of data.

The collision typology was tested for reliability by having four separate investigators categorise a representative sample of the collisions. Even with minimal training, the investigators agreed on the choice of collision type in approximately 80% of cases. The size of the study sample (over 2,500 cases) was sufficient to allow for confident statements regarding the characteristics of the most frequent types of crash, and the relationships between many general factors. When presenting findings for collision types where the number of cases is small, low statistical confidence is noted, even if the patterns that emerged seemed consistent with 'common sense.' A larger database would provide a higher level of confidence at all levels, but especially for the investigation of interesting but small sub-samples.

Chapter 3: Key Findings

The findings of this study provide an overview of all the police-reported car/bike collisions that occurred in the city in 1997 and 1998, as well as detailed information about the most frequent kinds of collisions. These findings indicate which collision types are reported most frequently, and which ones typically result in the most severe injuries. They also identify features that appear to be characteristic of particular types of collisions, such as the areas of the city in which they seem to occur most frequently, the age groups that tend to be most often involved, and some of the behavioural and environmental factors that appear to play contributing roles. The statistics for each separate year were practically identical, suggesting that they are not simply random, but represent meaningful findings.

Summary statistics pertaining to characteristics of the entire set of collisions in the study are presented below. This is followed by discussions of the key findings with respect to the most frequent crash types. Detailed findings specific to each and every crash-type, including diagrams, charts, tables and maps, are presented in the final chapter. These should be referred to as an aid to understanding the discussions of the key findings in section 3.3 and in Chapter 4.

3.1 Characteristics of the Cyclists and Motorists Involved

Cyclist's Age

The 2,574 collision-involved cyclists in this study comprise a "sample" of Toronto's entire cycling population. Information on this sample can be compared with existing information about the city's cycling population, to highlight any 'distinguishing features' of the group of cyclists involved in reported collisions. (Are they younger, on average, than the typical Toronto cyclist? Are more of them male?…) In a similar way, the group of cyclists involved in one particular group of collisions comprises a "sub-sample" of the larger sample. In many of the following discussions, the age distribution (or age profile) of the whole set of cyclists in the study is used as a 'base-line' against which the age distributions for various sub-groups of cyclists are compared. This base line can be related to characteristics of the local cycling population, about which we have information from other sources. This helps the investigator conceptualise the meaning of the study's findings in relation to our understanding of the characteristics of the local cycling population as a whole.

The age profile of the cyclists in the whole study sample is charted in discrete detail (one-year increments) in Figure 3.1. The vast majority of the cyclists involved in collisions with motor vehicles in Toronto are adults (average age: 29.6).

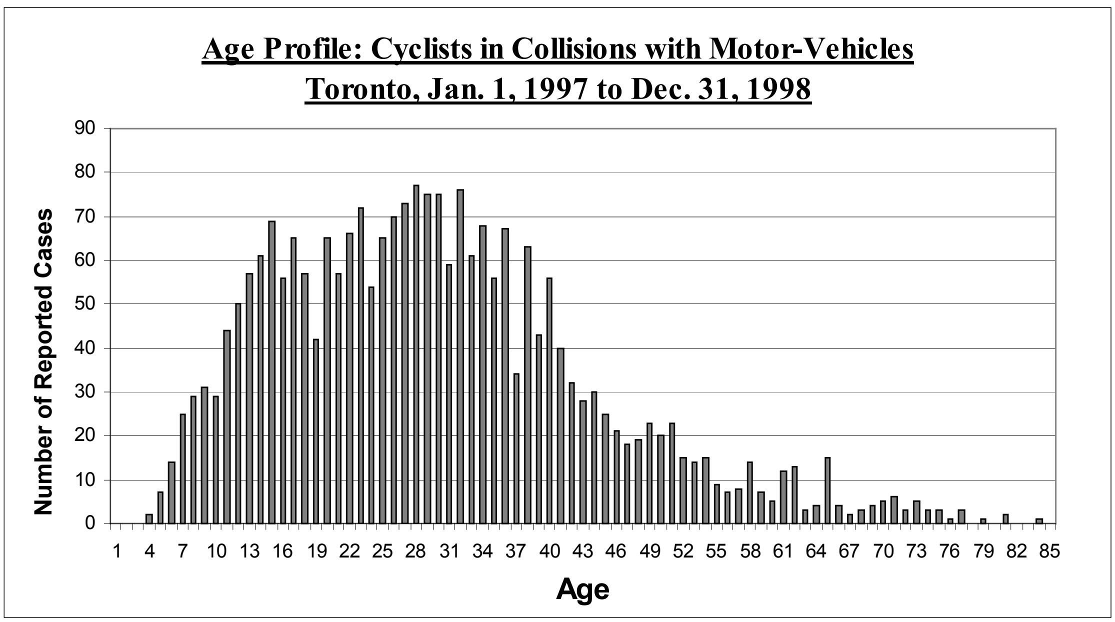


Figure 3.1

Information on Toronto's cycling population is periodically obtained by survey, with the most recent conducted in 1999. The Decima survey presents cyclist age data, sorted into five age categories, starting at age fifteen. When the age profile of the cyclists included in this study is compared with the age distributions of Toronto's cyclist population, it is apparent that young adult cyclists (age 18 to 34) are more likely to become involved in collisions than older cyclists (Figure 3.2). Teenage cyclists (age 15 to 17) are also slightly over-represented. While younger cyclists are often less experienced than older cyclists, and may also be more willing to take risks, the 18-34 age group probably cycles more frequently and/or farther than other groups. According to the Decima survey, Toronto's utilitarian cyclists tend to be younger than the recreational cyclists, on average. Utilitarian cyclists are more likely to ride in traffic, especially during rush hours, and hence they suffer greater exposure to the risk of collision.

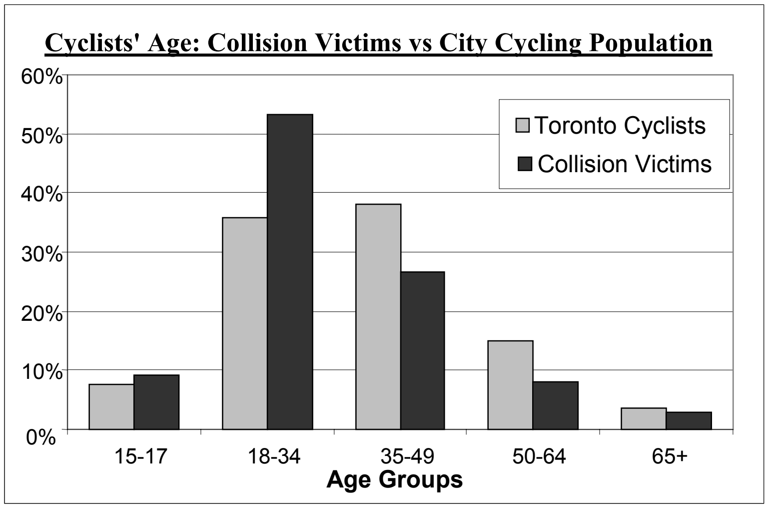


Figure 3.2

Cyclist's Sex

The sex of over ninety percent of the collision-involved cyclists in this study is known, and of these, 77% are males, 23% females. Recent surveys show that roughly half of Toronto's recreational cyclists and 60% of the utilitarian cyclists are male. The higher rate of collision involvement for males is very likely a function of exposure: surveys by Lisa Aultman-Hall and Decima Research both found that male commuter cyclists in Toronto ride farther and/or more often than females, on average, and therefore experience greater exposure to the risk of collision.

Helmet Use

Of 1,739 MVA reports containing information on helmet use, 541 (31%) indicated that the cyclist wore a helmet at the time of the collision. Of these, 71% are known to be male, (while males accounted for 77% of the entire sample) and 29% are female (while only 23% of the entire study sample are female). Helmet use was thus reported proportionally more often for females than for males. This may suggest that male cyclists are more tolerant of risk than females, on average, and could further account for their disproportionate involvement in collisions, mentioned above. Proportionally fewer teenage cyclists were reported to be wearing helmets (see Figure 3.3), even though helmets are required by law for cyclists under eighteen.

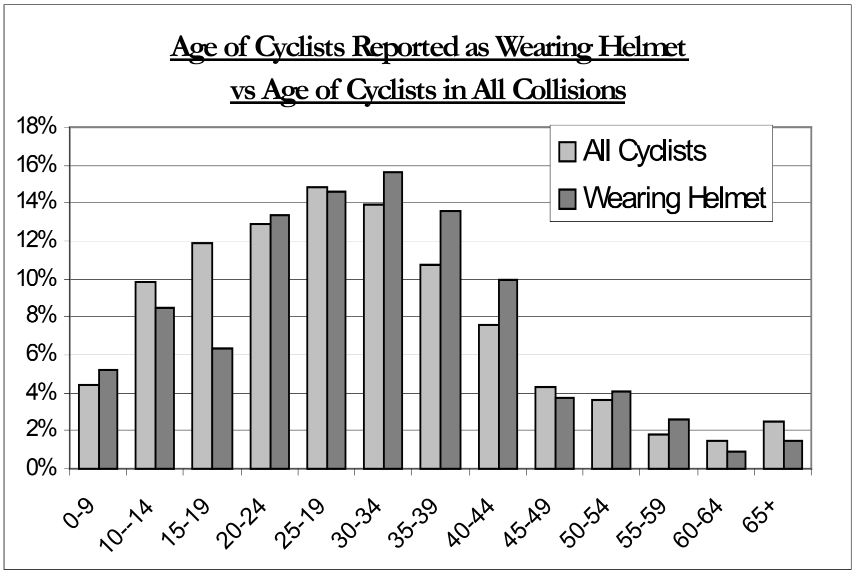


Figure 3.3

The rate of helmet use reported among the collision sample (31%) is lower than the rate suggested by a recent survey, in which 44% of Toronto cyclists indicated they "always wear a helmet."[24] While there are many possible explanations for the difference,[25] it may in part be a function of the way this information is entered in the MVA report forms. A box is available on the MVA form to indicate the type of safety equipment in use by each 'driver.' Options include lap belts, shoulder belts, air bags, child restraints, and helmets (represented by the code number "8"). Other codes that were sometimes entered in the safety equipment check-box include:

9 = Equipment not used but available
10 = No equipment available
00 = Use unknown
99 = Other safety equipment used

We are not confident that, when one of these four codes was entered or when the box was left blank, the cyclist was actually not wearing a helmet. Therefore, we are unable to report a reliable

[24] Decima, 2000

[25] Survey respondents may tend to over-report helmet-use; helmet-wearing cyclists may be more vigilant in avoiding risks of all kinds; recreational cyclists, who outnumber utilitarian cyclists, tend to use helmets more often, and to ride where they can enjoy less exposure to traffic (and most kinds of collisions).

figure representing the overall rate of helmet use. We were also unable to find a relationship between helmet use and injury severity. The effect of helmets in reducing head injuries is not apparent in our data, since the injury severity scheme used for MVA reports does not specify the type of injuries sustained.

Motorist's Age

The age profile of the set of motorists involved in car/bike collisions is plotted against that of motorists involved in all types of motor-vehicle collisions in Toronto in Figure 3.4. Car-bike collisions appear somewhat less likely to involve young drivers than motor vehicle collisions in general. While this under-representation might suggest that young drivers are better able to avoid collisions with cyclists (being perhaps more aware of cyclists' behaviour), it is more likely to be a result of their *over*-involvement in single-vehicle crashes.[26] In the absence of complete data on Toronto's motorist population, the age profile for all of Ontario's licensed drivers is included for comparison. Apart from the under-representation in collisions of license-holders under twenty and over fifty-five (who probably drive less than other motorists), there are no significant differences between the three profiles.

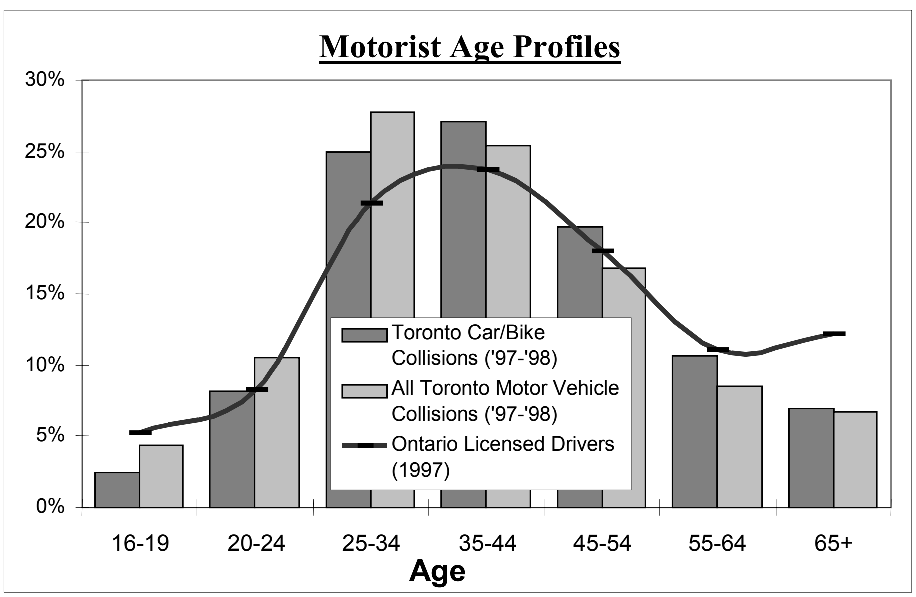


Figure 3.4

[26] Data from Toronto's Traffic Data Centre & Safety Bureau indicates that drivers age 25 to 34 are over-represented in single motor-vehicle crashes, compared to their involvement in collisions in general.

3.2 Characteristics of the Study Sample of Collisions

Statistical information concerning factors that may have contributed to the occurrence of collisions is most helpful in understanding the characteristics of different collision types, and is central to the discussions in section 3.3, below, regarding the most frequent collision types. Some of this information can also be used to characterise the whole sample of collisions. This section discusses the spatial and temporal distribution of the collisions in general, as well as apparent relationships between certain factors. In particular, relationships between sidewalk cycling, the age of the cyclists involved, and the location of the collisions (central or 'suburban') are discussed. The age distribution of cyclists in collisions that occurred at night is also presented, followed by a look at the type of motor vehicles most often involved in collisions with bicycles. Before going into detail with respect to the summary characteristics of individual types of collisions, the frequency distribution of collision types is presented, along with an analysis of the distribution of injuries among the various collision types. These provide a basis for evaluating the urgency of different safety issues and for prioritising potential countermeasures.

Temporal Distribution

Figure 3.5 depicts the relative frequency of collisions by time of day, along with hourly bicycle and motor-vehicle volumes, as recorded by a permanent traffic counter on Bloor Street East at Castle Frank Road. (Note that the vertical scale for collision frequency is arbitrary, representing the hourly distribution of all the collisions that occurred within the city from January 1, 1997 to December 31, 1998.) Collisions occur most frequently between 3:00 p.m. and 6:30 p.m. There is also a sharp peak around 8:00 a.m., and a small increase over the lunch hour. This is consistent with the daily pattern of bicycle and motor vehicle traffic volumes. It is also consistent with the daily pattern of motor vehicle collisions of all types (not shown). The chart does not show any increase in bicycle traffic at mid-day, which is probably a function of counter's location, at the western end of the Prince Edward Viaduct over the Don Valley. While there may be a general increase in bicycle traffic during lunch-time, there is apparently no such increase in bicycle trips across the viaduct. Unfortunately, the City does not yet maintain any other permanent traffic counters capable of detecting bicycles reliably.

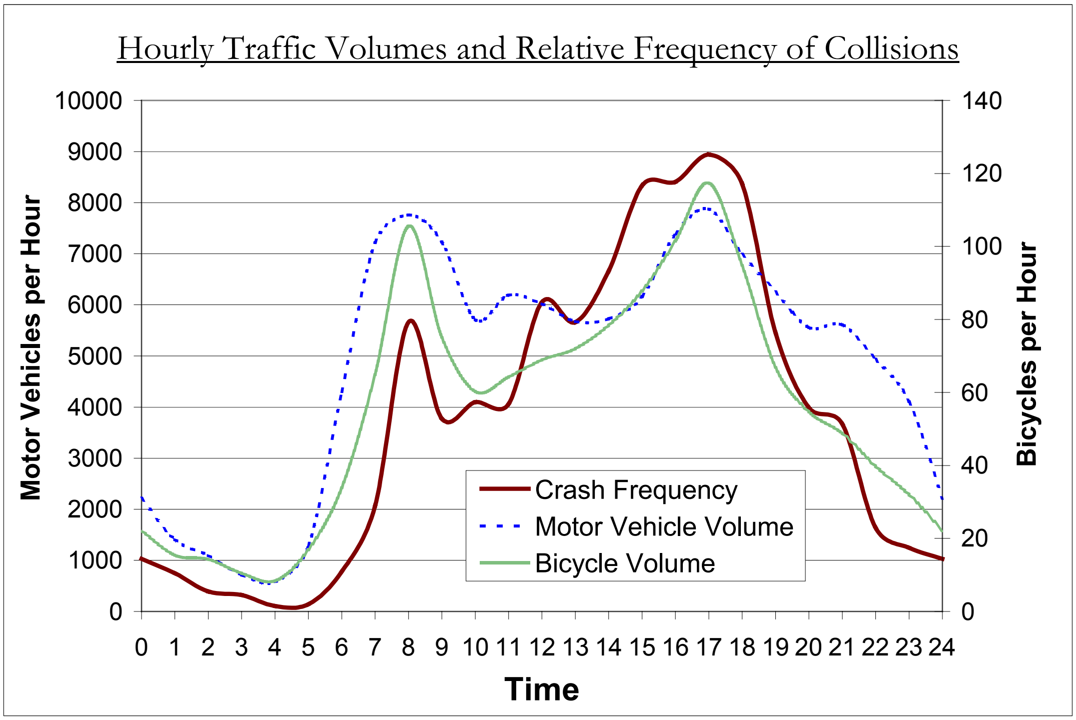


Figure 3.5

On average, there are nearly twice as many collisions per day during the week as on weekends, with Monday being the 'quietest' weekday (Figure 3.6).

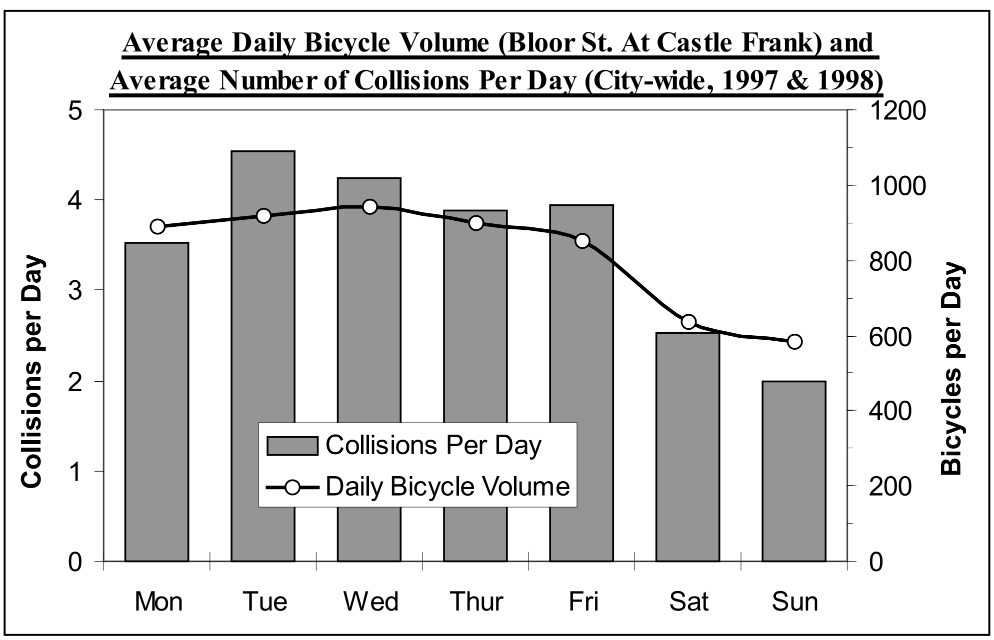


Fig. 3.6

The frequency of crashes also follows the general trend in cycling activity associated with seasonal weather patterns (Figure 3.7). The number of reported collisions rises from an average of about one per day in the winter, to around six or eight per day in the summer, with the highest number for this two-year period (twenty-two) occurring on July 2, 1997. According to various estimates, between 40% and 90% of car/bike collisions go unreported.[27] This would imply that anywhere from ten to eighty car/bike collisions occur in Toronto each summer weekday, perhaps well over a hundred on some days.

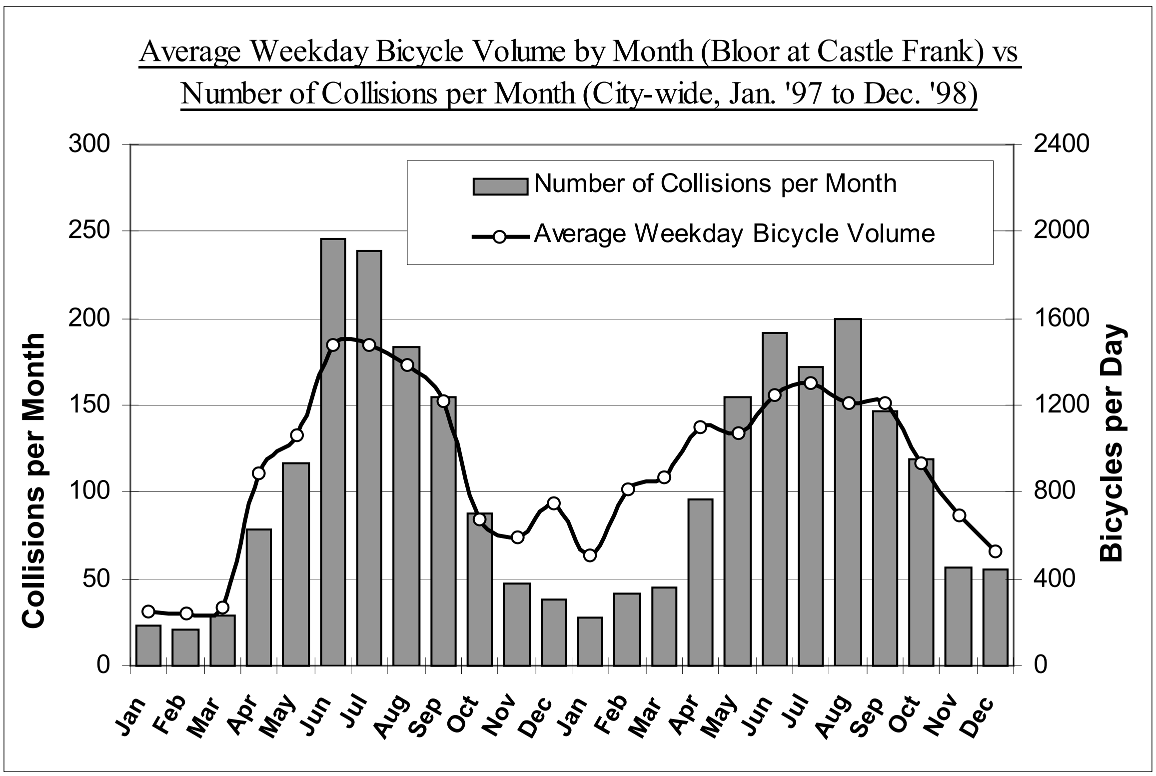


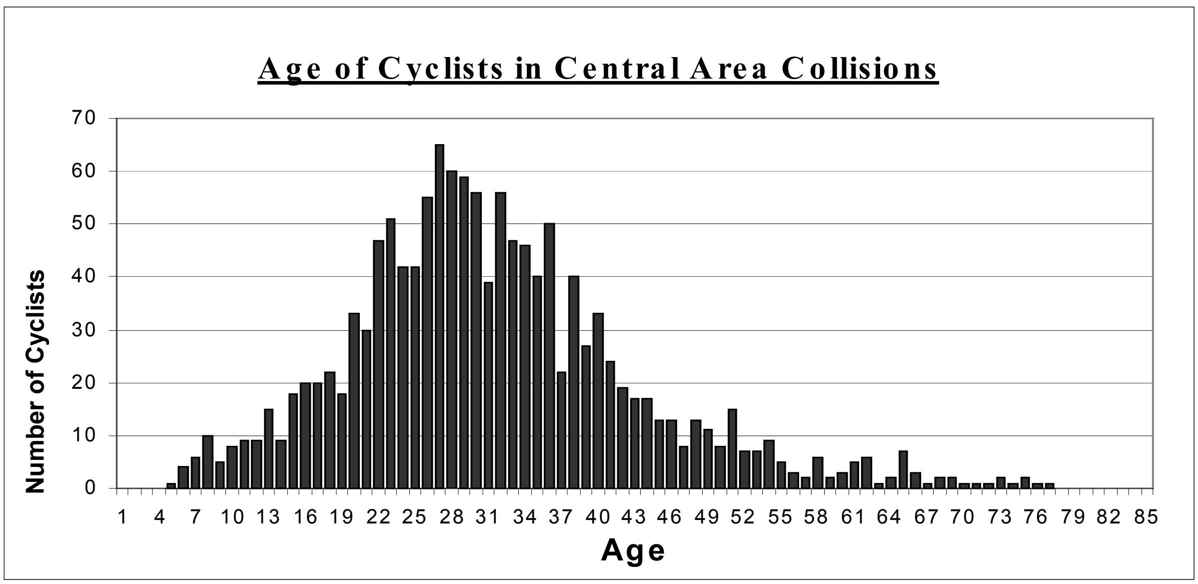
Figure 3.7

It is interesting to note that the frequency of collisions rises more sharply in summer and falls off more sharply in winter than does the bicycle volume. This might suggest that some cyclists who ride mainly in summer months are more likely to be involved in collisions than some of those who cycle during the winter. It may also suggest that some drivers tend to be more careful around cyclists in the winter.

[27] Stutts and Hunter, 1998

Spatial Distribution

All the collisions in the study are mapped in figure 3.9. The geographic distribution reflects the general pattern of cycling activity in the city. Collisions occur more frequently in the central area, where bicycle traffic volumes are highest, particularly on the east-west arterial roads. This may be due to the lack of minor east-west roads downtown, whereas there are many ‘quiet’ alternatives to the north-south arterial roads in this part of the city. Collisions are also relatively frequent along several arterial roads in outer areas. The cyclists involved in collisions in the outer areas are substantially younger, as a group, than those involved in collisions in the central part of the city (Figure 3.8).



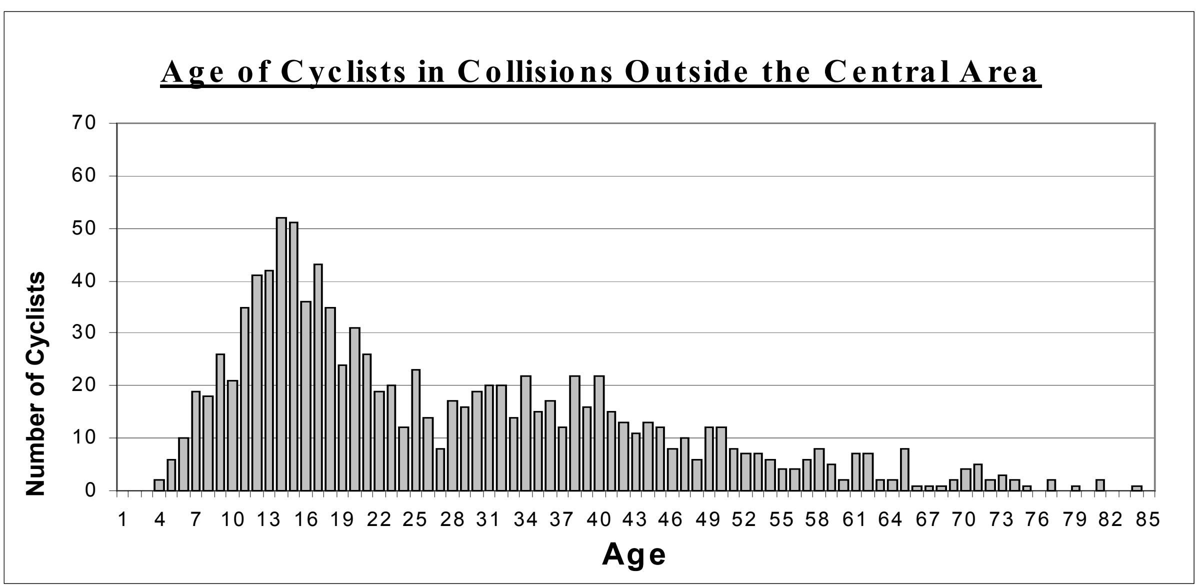


Figure 3.8

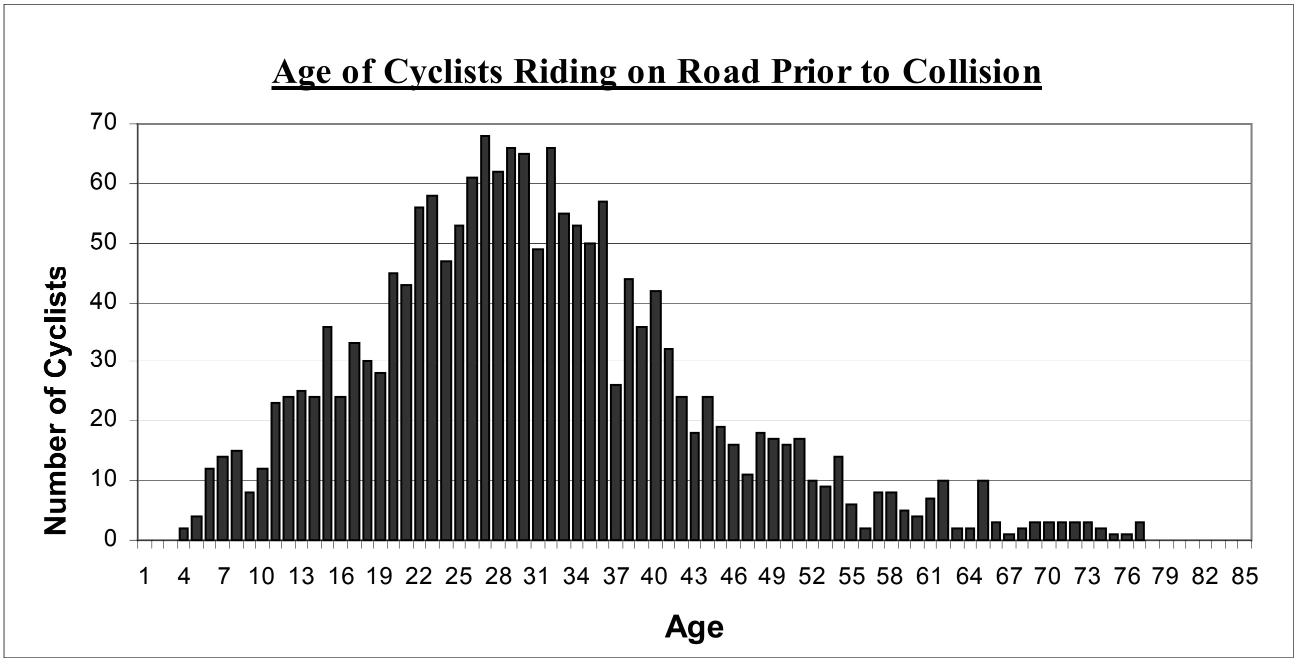
Figure 3.9: Locations of All Motor-Vehicle Collisions Involving Bicycles

Jan. 1, 1997 to Dec. 31, 1998.

(2558 Collision Locations Known)

Sidewalk Cycling

In almost thirty percent of all collisions, the cyclists were riding on the sidewalk immediately prior to the collision. Young cyclists were much more likely to have been riding on the sidewalk than were adults (Figure 3.10). In fact, over half (53%) of the collision-involved cyclists under age 18 were riding on the sidewalk, whereas only 21% of those 18 and over were.



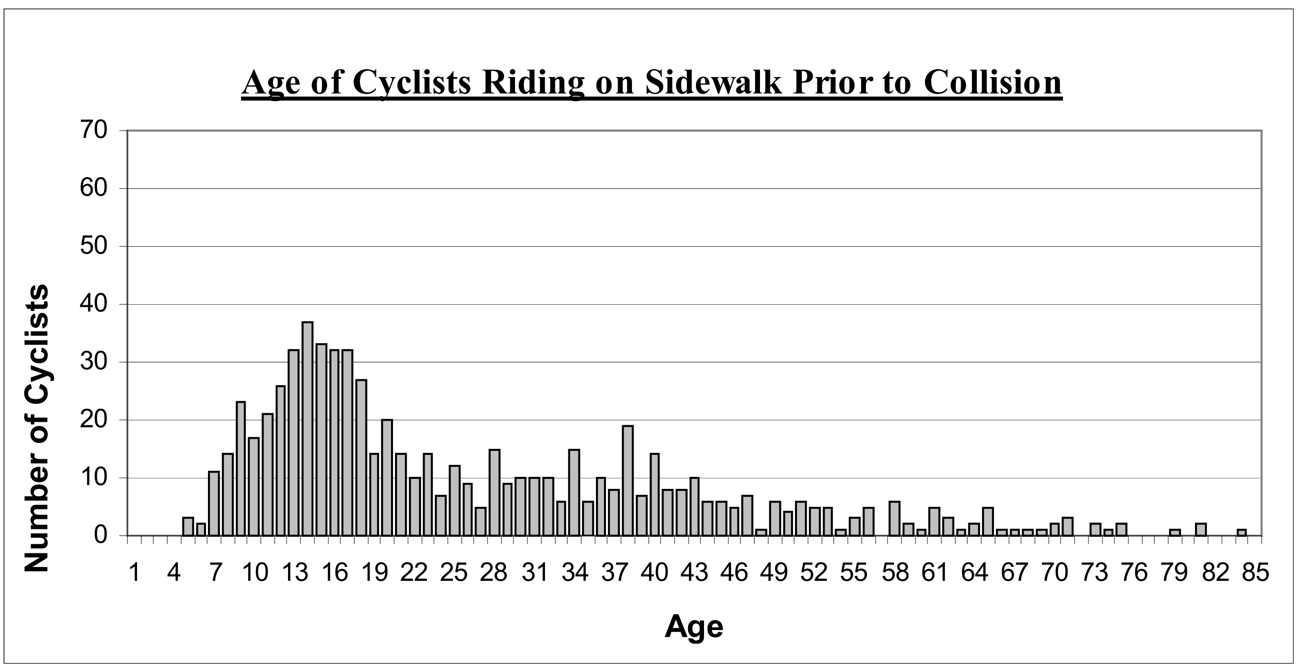


Figure 3.10

Forty-six percent of collisions in the outer areas of the city involved sidewalk cycling (522 cases), compared to only thirteen percent of the central area collisions (188 cases). This suggests that, in outer areas, either sidewalk cycling is much more prevalent or it is much more likely to lead to a collision than it is in the central area (Figures 3.11 and 3.12).

Fig. 3.11: Cyclist Riding on Road Prior to Collision (1848 Collisions)

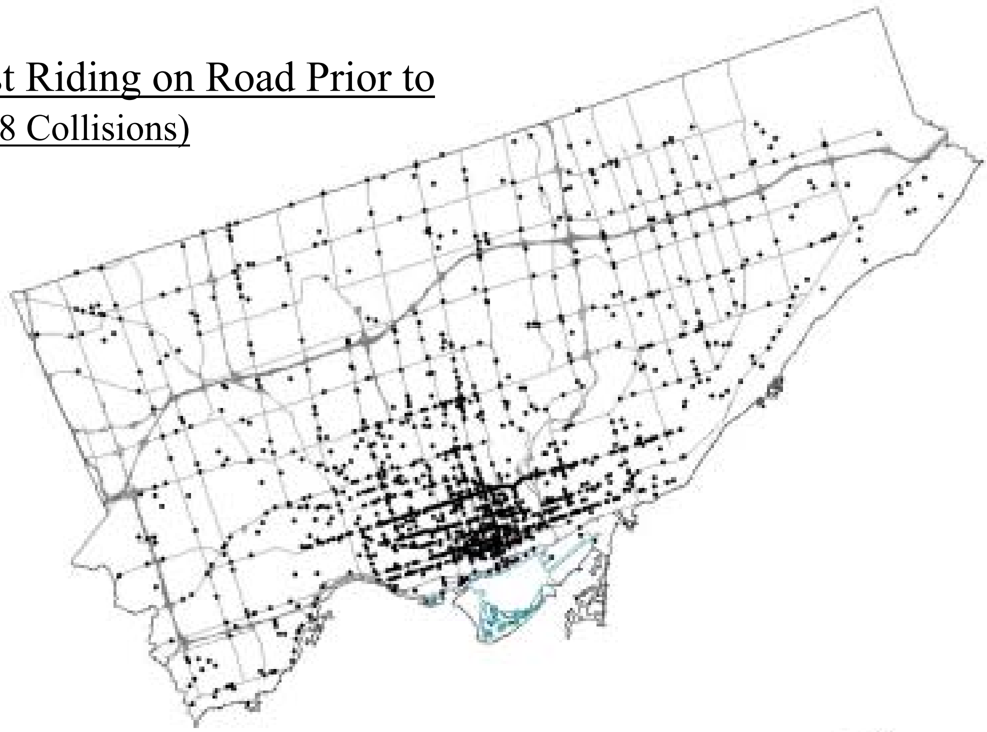


Fig. 3.12: Cyclist Riding on Sidewalk Prior to Collision
(710 Collisions)

Collisions in which the cyclists were riding on the roadway tended to result in slightly more severe injuries (and many more fatalities) than those in which the cyclists were riding on the sidewalk or within the crosswalk area (Fig. 3.13).

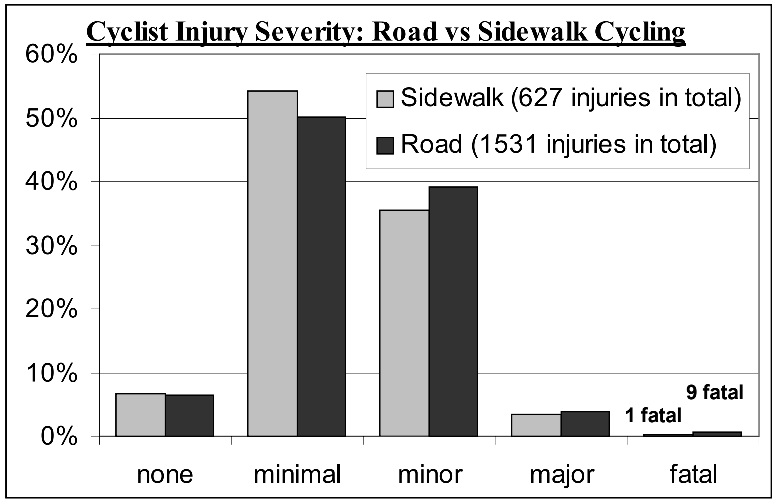


Fig. 3.13

Cycling in Darkness

Almost four hundred collisions occurred in darkness (15% of the total). Children under age fifteen were under-represented in night-time collisions, as might be expected. Cyclists between the ages of thirty-five and forty-five were more often involved, proportionally, than other age groups (see Figure 3.14). This could simply be a function of exposure, if cyclists in the latter age group ride at night more often than do other cyclists. There is some indirect evidence that this may be so: According to Decima survey data, almost fifty percent of the cyclists who indicated that they ride in winter months were within the thirty-five to forty-nine year age group. Winter bicycle-commuting often involves riding in the dark.

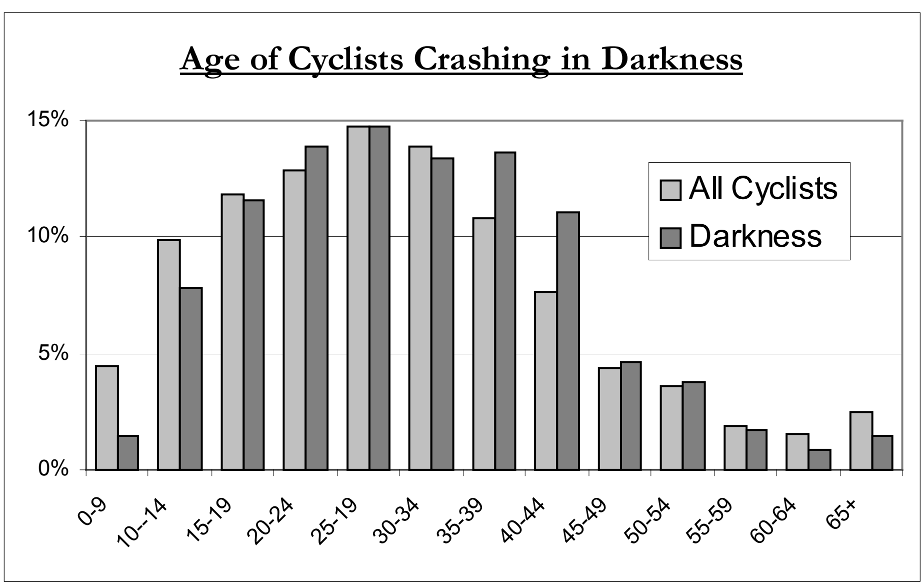


Figure 3.14

The following crash types occurred in darkness significantly more often than the norm, suggesting that darkness may have been a contributing factor in some cases:

Drive Out at Controlled Intersection	(18.3%)
Motorist Left Turn – Facing Cyclist	(20.2%)
Motorist Left Turn – In Front Of Cyclist	(33%)
Wrong Way Cyclist	(18.6%)
Drive Into or Out of On-Street Parking	(32%)

The geographic distribution of collisions that took place in darkness does not appear to differ from that of collisions that occurred in daylight.

Types of Motor Vehicles Involved

The type of motor vehicle involved was coded only for those collisions that occurred in 1998 (1237 in total, Table 3.1). Most were automobiles, with a few (38) large vehicles involved. Collisions involving trucks and buses apparently were more likely to result in major injuries and fatalities (Fig. 3.15). This is consistent with the Coroner's finding that large vehicles are over-represented in fatal collisions with cyclists.[28]

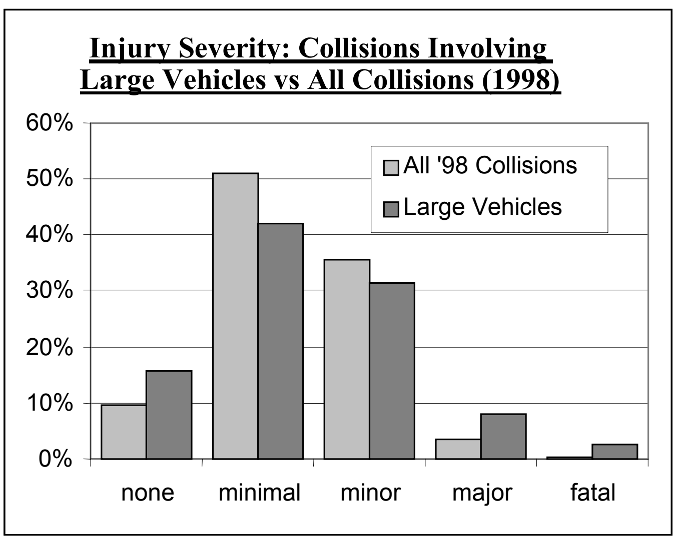


Figure 3.15

Table 3.1

Type of Vehicle	Number
Automobile	1014
Passenger van	79
Taxi	39
Pick-up truck	24
Delivery van	20
Municipal transit bus	17
Police vehicle	8
Truck – closed	7
Truck – tractor	6
Streetcar	4
Truck – dump	3
Motorcycle	2
Tow truck	2
School bus	2
Ambulance	2
Truck – open	1
Inter-city bus	1
Bus (other)	1
School van	1
Motor home	1
Off-road 3 wheels	1
Other	2

[28] Lucas, 1998

Frequencies of the Different Collision Types

The individual collision types are listed in table 3.2, in order of descending frequency. (The type-numbers refer to the order in which detailed findings are presented in Part II of this report.) The relative frequency of each type is also indicated, as a percentage of all collisions for which sufficient information was available to allow classification (2325 of 2572). The "other" category consists of incidents for which complete information was available, but which did not fit into any of the established types. The results were consistent for each of the two years studied, providing good assurance that these patterns are reliable and meaningful, not random.

Table 3.2

Crash Type	Frequency		
	Number of Cases	**%**	**Cumulative Percent**
1) Drive Out At Controlled Intersection	284	12.2%	12%
10) Motorist Overtaking	277	11.9	24
6) Motorist Opens Vehicle Door	276	11.9	36
8) Motorist Left Turn – Facing Cyclist	248	10.7	47
5) Motorist Right Turn (Not at Red Light)	224	9.6	56
4) Motorist Right Turn At Red Light	179	7.7	64
2) Drive Out From Lane or Driveway	179	7.7	72
12) Ride Out At Controlled Intersection	65	2.8	75
15) Wrong Way Cyclist	59	2.5	77
11) Ride Out At Mid-block	51	2.2	80
9) Motorist Left Turn – In Front Of Cyclist	48	2.1	82
13) Ride Out From Sidewalk	44	1.9	84
18) Cyclist Lost Control	44	1.9	85
16) Cyclist Left Turn In Front Of Motorist	41	1.8	87
7) Cyclist Strikes Stopped Vehicle	39	1.7	89
3) Motorist Reversing	37	1.6	90
20) Cyclist Overtaking	31	1.3	92
19) Cyclist Caught in Intersection	30	1.3	93
14) Ride Out From Lane or Driveway	29	1.3	94
21) Drive Into/Out of On-Street Parking	28	1.2	95
17) Cyclist Left Turn – Facing Traffic	11	0.5	96
22) Other (Not classified)	101	4.3	100
23) Unknown (Insufficient Information)	247		

Injury Severity

The most frequent types of collisions, identified in the previous section, clearly merit attention in the form of specific safety countermeasures. However, while a particular type of crash may be very common, it may not necessarily represent the most significant health risk to the local cycling population. Beyond the straightforward ranking of collision types by frequency, it is important to identify the types of collisions that cause the most serious injuries. From the standpoint of a municipal body trying to determine where to direct counter-measure resources, it may be more appropriate to focus on those types of collisions that result in the greatest number of fatalities and/or serious injuries each year. From the cyclist's perspective, it may be more important to know what types of collisions pose the greatest *risk* of serious injury, regardless of their frequency. Such information could be incorporated in cycling safety training courses, to highlight the kinds of situations that cyclists should be most careful to avoid.

In order to rank the different collision types this way, it is necessary to quantify injury severity somehow — perhaps the way insurance companies do, when determining accident compensation amounts. Of course, the question of what is an appropriate weight for each injury category cannot be answered definitively. In the MVA reports, injuries are described using the categories, "none," "minimal," "minor," "major," or "fatal" (see table 2.3). One might assign each of these a weight, representing the severity of each category relative to the others. To rate a given collision type, one would begin by multiplying the number of injuries in each category (within that type) by the appropriate weight. The sum of these products would provide a measure of both the number and severity of injuries resulting from collisions of that type. Dividing this sum by the number of collisions of that type would yield a relative measure of its 'average severity.'

For the purpose of this analysis, the "no injuries" category should be assigned a weight of zero. That is not to say such collisions are insignificant. Rather, it is likely that such incidents occur very frequently, even though few are reported to police.[29] In this study sample, therefore,

[29] Furthermore, some of these "property damage only" collisions appear to have been reported simply because they involved government vehicles (including transit buses) or damage to City property. In such cases, reporting to police is mandatory. Thus, the fact that such an incident was reported to police may not mean that it was a serious incident.

the number of collisions that involved no injuries probably does not reflect their actual prevalence. Collisions that *do* involve injuries are much more likely to be reported, and so our data can be expected to provide a good indication of the relative frequency of injuries of varying severity.

The collision types are listed again in order of decreasing frequency in Table 3.3, along with the distribution of injuries, so that the reader may evaluate the severity of the different types by any method.

Table 3.3

Collision Type	Injury Severity				
	No Injuries	**Minimal Injuries**	**Minor Injuries**	**Major Injuries**	**Fatal**
Drive Out At Controlled Intersection	15	159	85	8	0
Motorist Overtaking	20	137	96	7	4
Motorist Opens Vehicle Door	6	122	125	8	1
Motorist Left Turn – Facing Cyclist	13	91	116	11	0
Motorist Right Turn (Not at Red Light)	19	116	71	3	0
Motorist Right Turn At Red Light	7	95	59	4	0
Drive Out From Lane or Driveway	11	92	54	3	0
Ride Out At Controlled Intersection	4	27	21	3	2
Wrong Way Cyclist	1	36	16	2	0
Ride Out At Mid-block	4	22	19	4	1
Motorist Left Turn – In Front Of Cyclist	1	25	18	2	0
Ride Out From Sidewalk	3	22	13	5	0
Cyclist Lost Control	2	16	20	2	0
Cyclist Left Turn In Front Of Traffic	3	18	10	6	0
Cyclist Strikes Stopped Vehicle	4	17	12	1	0
Motorist Reversing	2	18	12	0	0
Cyclist Overtaking	2	10	15	0	0
Cyclist Caught in Intersection	1	19	9	0	0
Ride Out From Lane or Driveway	2	10	14	1	0
Drive Into/Out of On-Street Parking	0	16	10	0	0
Cyclist Left Turn – Facing Traffic	1	3	5	2	0
Other (Not classified)	10	33	31	9	2
Unknown (Insufficient Information)	20	80	46	4	0
Totals:	151	1184	877	85	10

Various weighting schemes were applied to the different injury categories, in an attempt to rank the collision types with respect to injury severity. When both frequency *and* injury severity are taken into account, we find little effect on the rank order of the most frequent types of collisions, except that “Drive-out at controlled intersection” drops from first to fourth. As more and more weight is given to the most severe injuries and fatalities, the “Motorist overtaking” category acquires higher priority. Only when the weight assigned to successive injury categories increases by a factor of ten or more do any of the less frequent collision types assume more importance. (“Ride out at controlled intersection” rises to third place and “Ride-out at mid-block rises to sixth.) We can therefore state with some confidence that the most frequent types of collisions result in the most significant impact on the well-being of the local cycling population. When allocating limited resources, these should be the primary focus of efforts to reduce cycling injuries. However, if the severity of injuries greatly outweighs the number of injured as a primary concern, priority should be given to the less frequent types of collisions mentioned above.

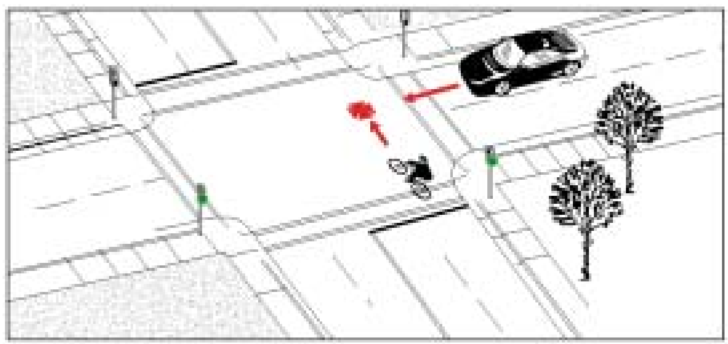
An attempt was also made to rank the collision types according to their ‘average severity,’ calculated by dividing the “score” for each collision type (described above) by its frequency. This number can be seen as a measure of the probability that a particular type of collision will result in serious injury. Cyclists might benefit from knowing what types of collisions should be especially avoided because of their high risk of injury. Once again, the results depended somewhat on the choice of weights assigned to the various injury classes. Several of the “cyclist error” collision types (“Cyclist left-turn…” and “Ride out…” types) appear[30] to be more likely to result in severe injuries than some of the more frequent “Drive-out” types. It is perhaps not surprising that crashes such as these, in which the cyclist crosses the path of motor vehicles moving ahead at normal speed tend to yield worse injuries than those in which the motorist is stopping, starting, or turning slowly. While educational approaches to reducing the more frequent types of collisions must necessarily focus on enabling cyclists to anticipate and avoid certain motorists’ errors, informed cyclists may be able to make choices about their own actions and avoid some of the less frequent but potentially more severe types.

[30] The small sample sizes make statements about these collision types less certain. More data would be required to perform this kind of analysis with more confidence.

3.3 Characteristics of Particular Collision Types

The most frequent collision types occurred in sufficient numbers to allow the reporting of statistical characteristics with a good degree of reliability. In addition, some of the less frequent types exhibited peculiarities that were pronounced enough to be statistically significant, despite the small sample sizes. Particular age groups, environmental conditions, and other factors were found to be over- or under-represented in some types of collisions, providing clues about the underlying safety problems. The following discussions summarise the key findings for the most frequent types of collisions, and findings on two less frequent types that yield valuable lessons.

Type 1: Drive Out At Controlled Intersection



The most frequent type of crash involved a motorist approaching or proceeding into a controlled intersection and colliding with a cyclist who was crossing the intersection in a perpendicular direction. Roughly half of the cyclists in this category were riding on the sidewalk and collided with the motor-vehicle within the crosswalk area. The majority (75%) of the drivers were facing stop signs, while 18% were at red lights[31] and 7% at pedestrian crossovers. Injuries typically were less severe than average, probably because the motor-vehicle speeds were quite low. Young cyclists, between the ages of 10 and 20 years of age, were highly over-represented in this type of collision. Darkness, rain, and wet road surfaces were also over-represented, suggesting that poor visibility and/or impaired braking may have been contributing factors.

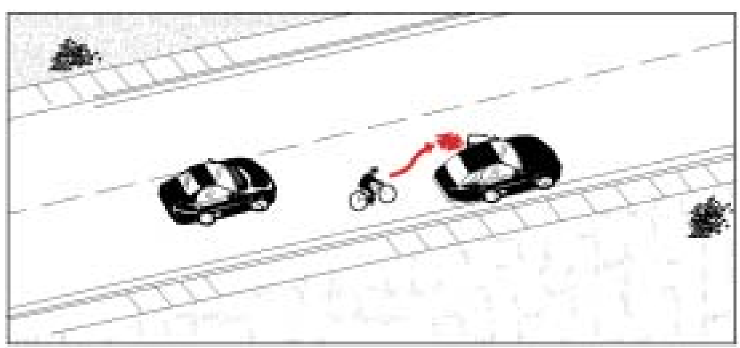
Over 30% of the collisions in which the cyclist was riding on the road took place in darkness, twice the average for all crashes (15%). On the other hand, only 12% of the crosswalk collisions took place during darkness. While darkness may have often made it difficult for

[31] Some of these drivers may have intended to turn right, but this could not be deduced from the MVARs.

motorists to detect cyclists riding on the road, other factors would appear to have contributed to most of the crosswalk collisions. Cyclists riding towards an intersection on the sidewalk, even at a moderate speed, can seem to appear quite suddenly and unexpectedly from outside the driver's field of view. This is especially problematic in situations where buildings abutting the sidewalk obstruct sight-lines, when drivers fail to stop before the stop line, and when cyclists ride onto the roadway without slowing down or stopping first.

These "sidewalk cyclists" clearly failed to stop and dismount at the intersection, as required by the Highway Traffic Act. Moreover, although young cyclists were over-represented, the majority (75%) of the 'sidewalk cyclists' in this type of crash were over the age of fourteen, and therefore likely to be riding adult size bicycles, in violation of a City by-law[32]. While cyclists in such cases may therefore be deemed at fault in law, it is probably not correct to suggest that sidewalk cycling was the sole 'cause' of these collisions. In many collisions of this type, it is quite likely that the motorist did not come to a complete stop before crossing the stop bar. While this HTA infraction is noted explicitly in only a few MVA reports, studies have shown that prior to making a right turn, many motorists "roll" past stop signs while looking mainly to their left for on-coming traffic.[33] The *combination* of these two factors (improper stopping by the motorist and sidewalk cycling) probably contributed to many of these collisions. (See also Types 2 and 4.)

Type 6: Motorist Opens Door In Cyclist's Path



Another very frequent type of crash involved a motorist opening a vehicle door into the path of a passing cyclist. Drivers in their thirties are significantly over-represented. Notably, darkness does not seem to increase the likelihood of this type of incident. In contrast, darkness

[32] Bicycles with wheels larger than 24 inches in diameter are not permitted on Toronto sidewalks.

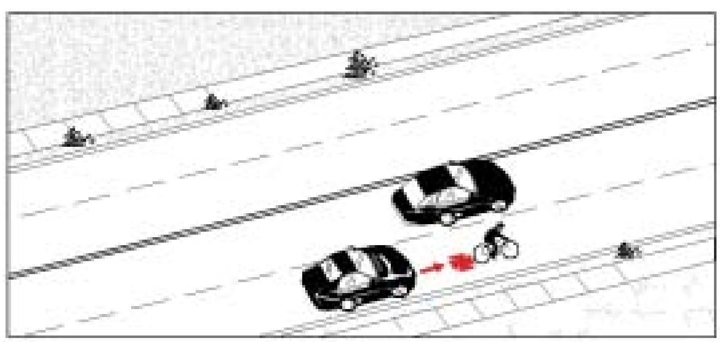
[33] Summala *et al*, 1996

was found to be a frequent factor in collisions in which the motorist was exiting on-street parking spot, which are very similar to these in configuration (see Type 21, below). This suggests that visibility is not always a critical factor, and that many motorists simply failed to ensure that opening their door would not endanger on-coming cyclists (as they are legally required).

Almost all cases occurred on arterial roads in central areas of the city, making "the Door Prize," as it has become known, the most frequently reported type of bicycle/motor-vehicle collision in central Toronto. In contrast to the previous type, the cyclists involved were typically adults between twenty and forty years of age. This age group can be expected to ride on the road, rather than the sidewalk, more often than children and the elderly, and therefore suffer greater exposure to the risk of this kind of collision. Since the injuries sustained were often more severe than average, this type of crash would appear to be a very serious concern for urban cyclists.

A portion (15%) of these crashes involved cyclists passing on the right of the vehicle. Many of these vehicles were taxis, sometimes discharging passengers in the second lane, where the curb lane was occupied by parked vehicles. Taxis accounted for 7.1% of the motor vehicles involved in this collision type, compared to 3.1% of all car/bike collisions, and 5% of the car/bike collisions that occurred in the central area.

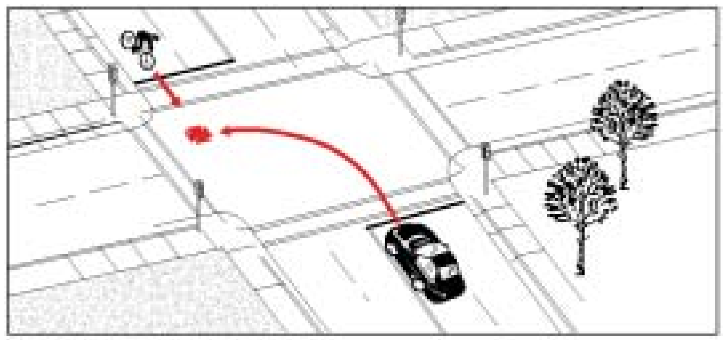
Type 10: Motorist Overtaking



Collisions involving motorists overtaking cyclists are among the top three most frequent collision types and, like the "Door Prize" (Type 6), they occur most often in the central area. These collisions also involved significantly more adult cyclists (age 25 to 40) than most other crash types. As with other types of crashes that occur only on roads, the over-representation of adults is probably a result of their higher exposure to this risk. Compared to "dooring" collisions, though, adults over age 36 were not as strongly over-represented.

In most cases, the injuries resulting from this type of collision were less severe than the average. On the other hand, four of the ten cyclist deaths in this two-year period resulted from motorists overtaking, indicating that this rather frequent type of collision can also be very dangerous. It would appear that most instances were minor impacts — 'glancing blows' that occurred when motorists attempted to pass cyclists — with the occasional disastrous result. Darkness and poor weather, which can affect visibility, were not frequent factors. Once again, taxis are over-represented, accounting for 7.6% of the motor vehicles involved in this crash type.

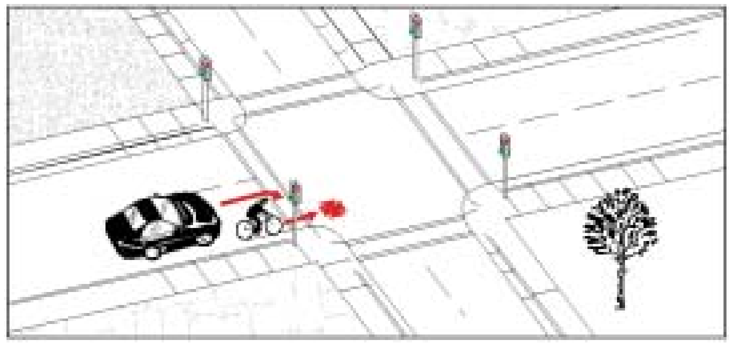
Type 8: Motorist Left Turn – Facing Cyclist



Collisions in which a motorist turned left across the path of an on-coming cyclist (who was approaching from the opposite direction) also involved more cyclists over twenty than the norm. Most occurred while the cyclist was riding on the road, with only 18% involving sidewalk cycling. Cyclists in their twenties are strongly over-represented, but older adults are not. In comparison with the "door-prize," which involves adult cyclists in a relatively wide range of ages, involvement seems to drop off even earlier (around age 30) than it does in the previous type (motorist overtaking). This might suggest that cyclists with more experience cycling (and driving) on busy roads can develop ways of anticipating and avoiding this type of collision.

Injuries in this category tended to be significantly more severe than average, which might be expected, since the relative speed of the two vehicles would often have been fairly high. Most of the collisions took place in the central area, at intersections controlled by traffic signals. Darkness was over-represented in this type of collision, suggesting that the driver's ability to detect the cyclist plays an important role. Drivers over age 60 were over-represented, but darkness was *not* a frequent factor in such collisions for this age group. This suggests that less acute vision and/or reflexes might have been more significant factors for these drivers.

Type 5: Motorist Right Turn

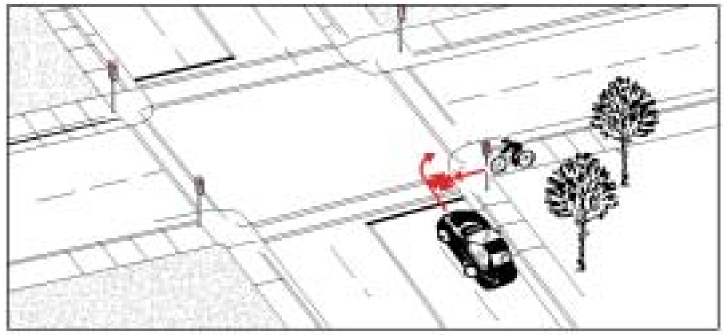


The cyclist age profile for collisions in which a motorist was making a simple right turn (not at a red light) revealed no unusually high involvement for any particular age group, although cyclists age fifteen to nineteen were slightly over-represented. Cyclists were riding on the sidewalk only slightly more often than the average (35%, compared to 31% overall). Half of the sidewalk riders were under age eighteen. Environmental conditions do not appear to have played a significant role. Injuries sustained by cyclists in these incidents were typically slight.

A few (3.6%) of the cyclists were noted to have been overtaking the motor vehicle (on the road) on the driver's right. Some cyclists are uncomfortable overtaking right-turning vehicles on the left, since it often requires swerving close to the path of through-vehicles in the adjacent lane. Even if they are aware that a motorist intends to turn, some cyclists attempt to pass on the right as the driver waits for pedestrians to cross.

Many of the motorists' and cyclists' statements that were available for this crash type expressed differing opinions as to who was passing whom. This relates to what is perhaps the main issue with this kind of incident: Drivers of motor vehicles usually do not have to think about sharing a lane safely with another vehicle. A motorist preparing for a right turn would have no reason to expect another driver to attempt to pass on the right, and might not feel there is any need to shoulder-check to the right. If a driver underestimates the speed of a cyclist, he or she may feel it is safe to pass the cyclist just before turning. Even if a driver has not overtaken, but is simply ahead of a cyclist, the cyclist can end up in a driver's "blind spot" as the driver slows in preparation for the turn. The driver may be unaware of the cyclist's presence, and the cyclist may not be able to see the driver's turn signal.

Type 4: Motorist Right Turn – At Red Light

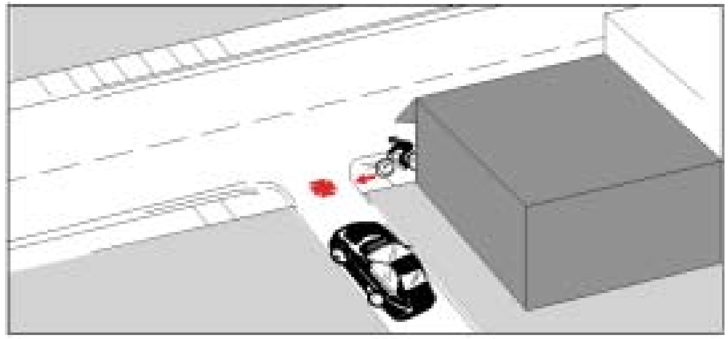


The characteristics of collisions involving motorists turning right at red lights are quite different from those of other kinds of motorist right-turn collisions. First, the two vehicles typically were travelling along perpendicular, rather than parallel paths (*i.e.,* the cyclist was proceeding on a green light or “walk” signal). In addition, while most (65%) of the cyclists in other right-turning motorist collisions were cycling on the road in the direction of traffic flow, in this type most (86%) of the cyclists were riding on the sidewalk just before the collision. (A further 3.4% were cycling on the wrong side of the road.) This represents the highest level of sidewalk cycling of any crash type.

Whereas no age group stood out in the previous type (Motorist Right Turn), cyclists age ten to twenty were strongly over-represented in this collision type, as were those over sixty. These age groups may be more likely to ride on the sidewalk than middle-aged adults. Also, the very young may not fully appreciate this kind of traffic hazard. Rainy weather appeared to play a role in some of these crashes, perhaps impairing visibility (especially for drivers) and/or braking ability (for cyclists). Three-quarters of “right-on-red” collisions occurred in the outer areas of the City, accounting for 13.7% of all outer-area collisions (compared to only 3.6% of the collisions in the central area.) This type of collision was much more likely to occur on roads with more than four lanes than were most other types.

The combination of sidewalk cycling and improper stopping by the motorist, as discussed above (see Type 1 – “Drive-Out at Controlled Intersection”), was probably a factor in many of these collisions, although the MVA reports provide little direct evidence of this. This kind of driving behaviour may be more common in outer areas, where drivers can expect to encounter fewer pedestrians (and cyclists) at intersections. Furthermore, where pedestrians are relatively infrequent and traffic speeds are quite high, cyclists may be more inclined to use the sidewalks.

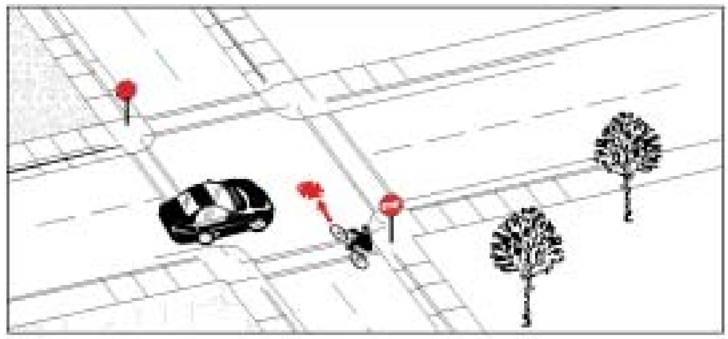
Type 2: Drive Out From Lane or Driveway



Of the cyclists who were struck by a vehicle emerging from a lane or a driveway, 81% were riding on the sidewalk at the time. Cyclists between the ages of ten and twenty were over-represented, and were even more likely to be cycling on the sidewalk (85%) than the older cyclists in this type of crash. Cyclists between the ages of twenty-five and forty, on the other hand, were much less frequently involved in this type of collision than in other types. Still, three out of four cyclists in that age group were riding on the sidewalk when they crashed. As with Type 1 (Drive Out at Controlled Intersection) and Type 4 (Right Turn at Red Light) collisions, the combination of sidewalk cycling and motorists not stopping before crossing the sidewalk seems to have contributed to a large proportion of these crashes.

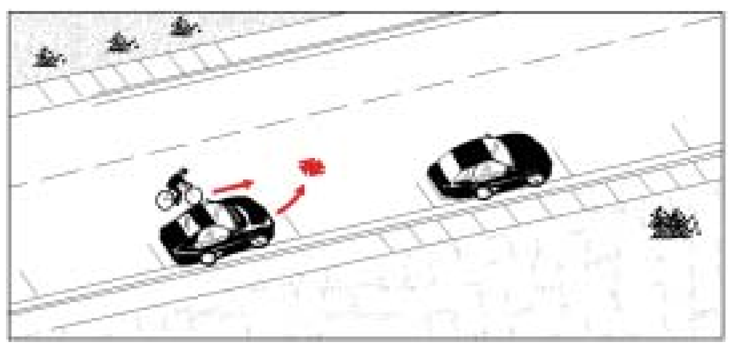
Most of these collisions occurred in outer areas of the city. This type of collision was much more likely to occur along roads with six lanes than were most other types, suggesting that the problem may be most acute at busy commercial driveways. Very few (3) cyclists involved in this kind of collision suffered any serious injuries, probably because the relative speed of the vehicles would have been quite low in most cases. Drivers age 40-55 and 70-80 were somewhat over-represented.

Type 12: Ride Out At Controlled Intersection



Just as "Drive Out at Controlled Intersection" was the most frequent type of collision defined by a motorist action, Ride-Out at Controlled Intersection was the most frequent type defined by a cyclist action. Although there were over four times as many is "drive out" as "ride out" collisions at controlled intersections, almost as many cyclists as motorists were found to have disobeyed traffic control (21 motorists and 18 cyclists). In both types, the majority of collisions occurred at intersections controlled by stop signs. Although there were only 65 cases, this type of collision resulted in 2 of the 10 cycling fatalities that occurred during this two-year period. Thus, while cyclists disobeying traffic controls were involved in relatively few collisions, some of them clearly suffered very serious consequences.

Type 21: Motorist Entering/Exiting On-Street Parking



While there were only twenty-eight collisions of this type, analysis of the data yielded a result that is significant in that it sheds light on a similar, much more frequent crash type. Collisions in this category fall into two groups, with rather different configurations: Collisions in which the motorist was *entering* an on-street parking space resemble "Motorist Right Turn" (Type 5) collisions, in which the cyclist is on the motorist's right. Collisions in which the motorist was *exiting* an on-street parking space are similar in some respects to "Motorist Left Turn in Front of Cyclist" (Type 9) collisions, where the cyclist is to the left of the motorist.

Unlike the first pair, a much larger-than-average portion of the other two types of collisions (Motorist Exiting Parking and Type 9) took place in darkness.[34] This contrasts with an important finding, discussed previously, regarding "Door Prize" collisions. For collisions in which a motorist opened the vehicle's door in a cyclist's path, darkness was *not* found to be a frequent factor, even though that configuration is very similar to the "Motorist Exiting On-Street Parking" collision.

In "Motorist Left Turn…" and "Motorist Exiting Parking" collisions, the motorist's intended manoeuvre involves crossing the path of on-coming vehicles. In such circumstances, the driver can be expected to scan for on-coming vehicles, and it is not surprising that darkness might play a role in making cyclists more difficult to detect. Conversely, in situations (such as the first pair of crash types mentioned above) where motorists typically would *not* expect to come into conflict with other moving vehicles and hence not feel a need to scan, we would not expect darkness to play any significant role in contributing to collisions. This suggests that, in "dooring" incidents, where darkness was not found to be a significant factor, the key problem may be that some drivers do not feel a need to look in their mirror for on-coming traffic before opening their vehicle door. While a headlight can offer a cyclist an advantage in situations where motorists are looking in their direction, it will not reduce the risk of being struck by a car door if drivers fail to scan for cyclists. These are important messages for both drivers and cyclists.

[34] Despite the small number of cases, this finding is statistically significant.

Chapter 4: Conclusions

In the previous chapter, results of the data analysis were discussed in terms of the entire data set, and also with reference to certain types of collisions. In Part II of this report, which follows this chapter, the statistical characteristics of each collision type are presented in detail. In order for the reader to digest these pieces of information, it will be helpful to try to synthesise the many separate findings. The implications of some key findings are discussed here, and the problems they seem to highlight are related to appropriate countermeasures. Finally, some recommendations are offered, regarding priorities for responding to the various issues identified. The success of this study will ultimately depend upon the extent to which the information it provides can be translated into actions that increase safety for cyclists.

4.1: Discussion of Key Findings

In this type of study, findings emerge in the form of deviations from the statistical norm, when the characteristics of a particular sub-set of the data differ from those of the larger sample. Such findings do not tell us directly ‘what happened,’ or what should be done about it. Instead they provide clues about the kinds of problems that may have contributed to the occurrence of the collisions. A few collision types seem to exhibit similar characteristics, suggesting common underlying problems. In trying to understand the relationships between crash configurations and their statistical characteristics, the reader may interpret the study’s numerous findings according to their knowledge, experience and areas of expertise. To facilitate this process, the findings are discussed here in the context of what we understand about cycling and driving behaviour in Toronto’s urban environment.

Age-Related Findings

The findings pertaining to the age of the cyclists and drivers involved in different kinds of collisions are important for several reasons. In addition to telling us about “what is happening to whom," they often point out underlying behavioural factors that could play a role in the collisions. Results indicating that an age group is disproportionately involved in a particular kind of collision suggest that factors related to characteristics peculiar to that group probably play a role. While such factors often apply to other age groups as well, and other factors may also be involved, these findings help us to identify factors that are likely to be most significant, which can lead to ideas for countermeasures.

Some of these age-related findings are clearly linked to exposure. For instance, the under-representation of cyclists under age fifteen in 'dooring' collisions is probably a result of their reluctance to cycle on downtown arterial roads (where such collisions tend to take place). The high involvement of young cyclists in sidewalk-related collisions is probably due largely to the fact that children are more likely to ride on sidewalks — as they are allowed and often encouraged to do. Their less-developed judgement, bicycle handling skills, and awareness of traffic hazards may have played a role as well. The number of very young children injured by reversing motorists seems surprisingly high, until we note that many of these collisions took place on residential driveways. While their small size makes children more difficult for motorists to detect when reversing, and lack of awareness of this kind of hazard may have played a role, exposure is likely the main factor accounting for their over-representation.

Some age-related findings suggest we focus on features other than exposure. For example, elderly drivers (over sixty) are over-represented in collisions in which they turned left across the paths of on-coming cyclists, yet it is highly unlikely that elderly drivers make left turns more often than other drivers. It is much more likely that this finding is a function of aspects of this age group that might affect their driving ability, such as less-acute vision or reflexes. Of course, not every driver involved in such a collision is elderly, but this finding implies that similar problems might also affect other drivers. Indeed, we find that darkness was a frequent factor in such collisions involving drivers *under* sixty. The key issue seems to be that left-turning motorists sometimes have difficulty detecting on-coming cyclists. Anything that might increase drivers' ability to detect on-coming cyclists before turning across their path should help reduce collisions of this type.

By providing clues about possible contributing factors, age-related findings can thus highlight a wide range of problems. They can also be very useful in the development and delivery of safety messages tailored to specific audiences. For example, a driver-focused safety message about ‘dooring’ might be most effective if it is designed to appeal to the “thirty-something” demographic. School programs should focus on issues most relevant to young cyclists, such as the hazards associated with cycling on the sidewalk. Cyclist-training courses, which are offered at various levels, can deliver detailed information about the problems faced most often by cyclists in certain age groups or with particular travel patterns. Driver training courses can also inform drivers about specific problems to watch out for.

Motorists’ Detection of Cyclists

Darkness is not a factor in most collisions, since most cycling activity takes place in daylight. However, the disproportionate involvement of darkness in some collision types can highlight more fundamental problems. There are at least four stages in the “detection” of a cyclist: the motorist’s expectation of encountering other vehicles (specifically bicycles), the effort taken to look for them, the actual detection of a moving object, and the recognition of that object as a cyclist travelling along a potentially conflicting path. Darkness, poor visibility, and inconspicuous appearance can hinder the last two stages of this process.

For the types of collisions in which a motorist’s intended manoeuvre involves the possibility of crossing the path of on-coming traffic (motorist left-turn, drive-out at controlled intersection, exiting an on-street parking spot), darkness was found to be over-represented. In such situations, drivers typically scan in the direction they would expect on-coming vehicles. Any difficulty in detecting and recognising cyclists could be aggravated by darkness or poor visibility. While this would explain the over-representation of darkness in these kinds of collisions, it is very likely that the motorists’ ability to detect and recognise cyclists was also a factor during daylight. Anything that might increase cyclists’ visibility would help prevent collisions of these types.

This contrasts with situations in which motorists would not expect to come into conflict with *motorised* traffic (motorist right-turn, right on red, entering on-street parking, opening a car-door, etc.). It should not be surprising that darkness was not found to be a frequent factor in situations like these, where drivers may not feel a need to scan for potentially conflicting vehicles. Counter-measures to collisions like these should focus primarily on increasing drivers' awareness of the need to watch for cyclists. Infrastructure enhancements (prohibiting right-turns at red lights, installing bicycle lanes next to on-street parking) also may reduce the potential for some of these conflicts at particular locations. In many cases, cyclists can avoid putting themselves in positions where drivers may not anticipate conflicting traffic.

Drivers who *expect* to encounter cyclists are able to detect and recognise them more readily, so increasing drivers' awareness of cyclists has great potential to reduce collisions. The fact that many cyclists do not take steps to make themselves more visible at night suggests that they may not be fully aware of how inconspicuous they can be to drivers. Their small size and the absence of a full-sized pair of headlights make bicycles more difficult to see than other vehicles, especially for drivers accustomed to looking primarily for motor vehicles. When cyclists mix with heavy traffic in darkness, they become even more difficult to spot among the larger vehicles and bright headlights. Although the law requires the use of lights when cycling in dark conditions, most bicycles sold in Canada are not equipped with lights as standard equipment. High quality light systems are expensive and easily stolen, while inexpensive light systems can be unreliable. Reflectors provide little benefit in some of the collision configurations discussed above, since the motorist's headlights would not be aimed directly at the cyclist.

Increasing cyclists' conspicuity can be achieved in several ways. Bicycle lanes can provide a consistent and predictable space for cyclists, making them somewhat easier to detect. Some cities use special markings and/or coloured pavement to highlight conflict zones and to remind drivers to look out for cyclists. On roads without bike lanes, the CAN-BIKE program teaches that cyclists can make themselves more visible by their position on the road. Often, the cyclist can increase the likelihood of early detection by riding further out from the curb. Bright clothing can help, especially in situations where the cyclist's lateral motion across the driver's field of view is slight (as when a cyclist approaches a driver head-on or from behind) or is within the driver's peripheral zone. A loud horn may also be useful in some circumstances. In general, cyclists should never assume that motorists are aware of their presence, and should cycle defensively, especially in conditions of darkness and poor visibility.

Sidewalk Cycling

One of this study's more surprising findings is the degree to which sidewalk cycling is involved in Toronto's car/bike collisions. While some types of collisions never involve sidewalk cycling ("Motorist Overtaking…" and "Dooring" incidents, for example), of those that can occur while the cyclist is riding on the road *or* the sidewalk, over half involved sidewalk cycling.

Sidewalk cycling presents a complex problem, putting cyclists in potential conflict with both pedestrians and motorists. Before considering measures to prevent these types of collisions it is important to understand who is involved, where these collisions occur and what crash types are common. Young cyclists are over represented in sidewalk cycling crashes. This is to be expected, since children are encouraged to ride on the sidewalk until they are old enough and have acquired the necessary skills and experience to ride safely on the road. Bicycles with wheels 24 inches in diameter or smaller (typically ridden by young cyclists) are allowed on sidewalks in Toronto.

In addition to young cyclists who are legally using the sidewalk, many adults ride on the sidewalk, for a variety of reasons. For some, the sidewalk is simply a convenient way around an obstacle, such as a heavily congested stretch of a narrow road. Furthermore, there are many locations in Toronto where even experienced cyclists may feel unsafe, or at least very uncomfortable, on the road. Some view the sidewalks as a safer alternative. The road environment in Toronto's suburban areas can be especially hostile to cyclists, where high-speed arterial roads with heavy traffic are sometimes the only practical cycling routes. With very little pedestrian traffic, sidewalks on many of these streets can be appealing to cyclists. This would explain the finding that sidewalk-cycling collisions are more prevalent in the city's outer areas.

Sidewalks are intended to provide a safe facility for pedestrians to use, separate from vehicular traffic. Unfortunately, just as some drivers appear to underestimate the amount of space a cyclist may need to feel safe on the road, some cyclists apparently do not appreciate the threat they pose to pedestrians. The Motor Vehicle Accident Report form does not capture bicycle-pedestrian collisions, so this study is not able to shed any light on the relative frequency of such incidents. While most complaints about sidewalk cyclists originate in central areas of the city, where pedestrian traffic is heavy, few bicycle/motor-vehicle collisions involving sidewalk cycling are reported in these areas. Nevertheless, this study's findings suggest that many cyclists do not appreciate the significant risks they themselves face when riding on the sidewalk.

Sidewalk-cycling collisions can be separated into two classes: those in which motorists would not expect anyone to cross their path (ride out from sidewalk at intersection, mid-block, lane or driveway) and those in which cross-traffic can be expected, where the motorist would be prepared to stop (drive out at controlled intersection, right turn on red, and those involving regular right- and left-turns). Collisions in the first group are primarily the result of cyclist's actions, and must be addressed primarily through methods of improving the skills, judgement, and awareness of cyclists. Collisions in the second group may also be reduced by these methods, but are also amenable to measures aimed at improving drivers' awareness of cyclists, as well as improvements to geometric and operational aspects of intersections.

Many of the sidewalk-cycling collisions occurred when a cyclist crossed a lane or a driveway as a motorist drove out, or crossed an intersection within the crosswalk area (which is prohibited under the Ontario Highway Traffic Act) as a motorist approached the intersection. A cyclist riding on the sidewalk, even at a moderate speed, can enter the field of view of a motorist approaching an intersection (or exiting a lane or driveway) much more suddenly than would a pedestrian. On suburban arterial roads with few pedestrians, cyclists can comfortably travel at relatively high speed on the sidewalk. High motor vehicle speeds and plentiful commercial and residential driveways increase the potential for collisions.

The sidewalk cyclists involved in Type 1 collisions (Drive out at controlled intersection) may have had the expectation that approaching drivers would to come to a stop before entering the crosswalk area (as required by the Highway Traffic Act). Those involved in Type 2 collisions may have expected drivers exiting lanes and driveways to stop before crossing the sidewalk (as required by local by-laws). However, studies have shown that drivers often "roll" through intersections, especially when preparing to turn right, while looking mainly to their left for on-coming traffic[35] (as do many cyclists). Even if a driver does come to a complete stop before proceeding, cyclists riding across the road within the crosswalk area (in violation of the H.T.A.) may enter the conflict zone too quickly for the driver to avoid.

[35] Summala *et al*, 1996

For a police officer investigating the scene of such a collision, circumstantial evidence is generally sufficient to indicate that the cyclist was riding on the sidewalk. Ascertaining the motorist's actions, however, may depend on statements from the parties involved and any witnesses. Similarly, sidewalk cycling is something that is unmistakably indicated by the MVA report diagrams, but only a few MVA reports noted explicitly that the driver did not stop properly. Still, it seems likely that these kinds of collision would have been far less frequent had all the motorists stopped properly, and had all the cyclists stopped or slowed to a walking pace before entering the roadway. Altering these kinds of driving and cycling habits should be the focus of enforcement and education campaigns.

It is impossible to say whether fewer collisions would have occurred overall if all the cyclists had been riding on the roadway. A study of Toronto commuter cyclists suggests that cyclists who frequently use sidewalks tend to have higher crash rates, even on roadways, than cyclists who always ride on the road.[36] Simply advising (or forcing) these cyclists to use the roads could result in more on-road collisions, which tend to yield more serious injuries (see Fig. 3.13). Enforcement will never eliminate sidewalk cycling as long as cyclists feel unsafe using the road. An effective long term strategy must be based on creating a safer and more comfortable road environment for cyclists, and helping motorists and cyclists understand how to share the road more safely.

Regional Differences in Collision Patterns

The combination of problems described above (sidewalk cycling and improper stopping) seems to have played a role in roughly 20% of all collisions, and was most common in the following crash types: Drive Out at Controlled Intersection, Drive Out from Lane or Driveway, and Right Turn at Red Light. These kinds of collisions were more likely to occur in suburban areas of the city, and tended to involve young cyclists. Several other types, including Motorist Overtaking and 'Dooring' collisions (both of which only affect cyclists riding on the road), were more likely to occur in the central area, and tended to involve adult cyclists. When developing educational messages as counter-measures to these types of collisions, it may be most effective

[36] Doherty, Aultman-Hall and Swaynos, 2000

to address different messages towards adult, commuter cyclists downtown, and to school age children in the outer areas. Drivers also need to be aware of the different safety issues in these different areas. Area-specific traffic enforcement strategies and different kinds of infrastructure treatments should also be considered in these very different urban environments.

Severity of Different Collision Types

Ranking the different types of collisions using a combination of frequency and injury severity suggests that the crash types causing the most harm (that is, the largest number of more-severe injuries and fatalities) tend to involve mainly adult cyclists riding on arterial roads, and are most common in the city-centre. These include Motorist Overtaking, ‘Dooring,’ and Motorist Left-Turn Facing Cyclist crash types. Drive Out at Controlled Intersection is also very frequent, and tends to be nearly as harmful, but occurs more evenly across the city. This information should be used to guide enforcement and public education strategies, as well as infrastructure improvement programs.

A few other crash types, while less frequent, tend to result in severe injuries when they do occur. These include the Cyclist Left Turn types, and some of the Ride Out types. Since these are collisions in which the cyclist’s actions are the primary cause, there is real potential for cyclists to take steps to avoid them. Cyclist training courses should provide information on these issues, as well as addressing ways that cyclists can anticipate and avoid the more frequent dangers mentioned above.

4.2: Potential Countermeasures

Three important types of countermeasures are available to address the many factors that can contribute to collisions: “bike-friendly” infrastructure and policy enhancements; education and promotion; and police enforcement. Each approach is effective in addressing particular kinds of problems, and each has its limitations. To achieve the best results in increasing cycling safety and promoting the use of bicycles, all three must be used in combination. Each method is discussed below, with reference to some of the issues identified in this study.

Infrastructure Improvements

One of the key components of the Toronto Bike Plan is a 1,000-kilometre bikeway network, which is to be implemented over the next decade. The network will include various types of facilities and spot improvements to make travel by bicycle easier and safer. The impact of bicycle lanes and paths on overall safety is the subject of debate, but it is clear that the cities with the highest levels of bicycle use and the lowest injury rates are those that have provided plenty of “bicycle-friendly” infrastructure. Apart from the inevitable problems that can be expected when two very different modes of transportation must share traffic lanes that are often wide enough for only one of them, it is difficult to link the collision data to specific infrastructure deficiencies. However, as discussed in the previous chapter, this study has identified a few locations that deserve attention. It has also provided information that may help to determine appropriate treatments. Further analysis is expected to highlight additional “hot-spots.”

Improvements such as bike lanes and wide curb lanes could reduce the number of “Motorist Overtaking” and “Dooring” collisions, by encouraging drivers to give cyclists more space. It is generally easier for motorists and cyclists to share the road when separate lanes are clearly defined. Bike lanes and bike paths do not eliminate interactions between cyclists and motorists at intersections, where many other kinds of collisions occur. However, the presence of bicycle lanes can serve to remind motorists to be alert for cyclists, and they can also channel cyclists into a more predictable and visible position on the road. For cyclists not comfortable mixing with traffic, they provide a better alternative than the sidewalk, and thus may reduce the incidence of sidewalk cycling and its associated problems. Where separated bike paths run parallel to the roadway, careful attention must be paid to intersection design, to avoid similar kinds of problems. Implementing left turn signal phases, prohibiting right turns on red lights, or adding separate traffic signals for bikes, also can eliminate several kinds of conflict.

Infrastructure improvements in the central area, where much of the city’s cycling activity takes place, can be expected to benefit a large number of cyclists, pedestrians, and motorists. Although Toronto’s roads were not designed for bicycles, this is changing gradually, especially with the roll-out of the Bike Plan. Still, it is a real challenge to provide dedicated bicycle facilities in a densely built city. Along many of the arterial roads most heavily used by cyclists, there is not enough space within the right-of-way to provide separate bicycle facilities without taking space away from other uses. Even if there was community support for eliminating the on-street parking in some areas, the presence of streetcar tracks limits the potential for re-distributing lane space on many key downtown routes.

In general, therefore, a combination of safety countermeasures must be employed. The new Official Plan advocates re-allocating space for the more vulnerable road users. New design approaches must be tested, and implemented where feasible. Infrastructure enhancements must be accompanied by programs to improve the skills and awareness of drivers and cyclists, and to target enforcement where it can be most effective in reducing collisions and injuries.

Education and Public Awareness

In European countries with high levels of bicycle use, such as Germany, Denmark, and the Netherlands, most parents are able to pass on their own cycling knowledge and experience to their children, and schools provide rigorous instruction in road safety. In contrast, many North American cyclists did not have cycling parents to learn from, and learned little about cycling in school. While nearly everyone 'knows how' to ride a bike, relatively few cyclists really understand the extent to which they can reduce the danger by improving their awareness of traffic hazards, and by taking simple measures to avoid risks. Furthermore, while most European drivers also cycle, and frequently interact with cyclists when driving, many North American drivers rarely encounter cyclists on the road, and have little or no experience cycling in traffic.

The first step in preventing collisions is knowing how and why they usually happen. With this information, cyclists and drivers are better able to anticipate the actions and errors that can lead to collisions, and take steps to avoid them. There are many methods by which the knowledge gained by this kind of study can be delivered effectively. Public awareness campaigns are able to target specific audiences, and can focus on specific issues. Driver and cyclist training courses can provide more detailed and comprehensive information, and can improve both skills and awareness.

Specialised training can be particularly beneficial to cyclists, since riding a bicycle safely in mixed traffic demands certain skills that are not critical to safe driving. The cyclist must not only choose (as must the motorist) which lane to use, but they must also decide which portion of the lane to occupy. While motorists can be fairly certain that other drivers will not attempt to drive beside them in the same lane, cyclists must be prepared to share their lane with other vehicles. If the cyclist feels the lane is not wide enough to share safely, he or she can try to prevent motorists from 'squeezing past' by positioning themselves in a way that forces overtaking motorists to change lanes — called "taking the lane." On the other hand, a cyclist may decide to overtake a slower-moving motor vehicle on the left or the right, and must anticipate the motorist's intentions in order to pick the safer alternative. At the same time, cyclists must be constantly aware of road surface conditions that do not cause problems for motorists, such as streetcar tracks, pot-holes, sewer grates, and debris. While keeping an eye out for all these potential hazards, cyclists can never assume that the motorists around them have detected their presence, or that they will react to their presence predictably. The skills required to deal with these factors and ride safely in traffic are usually acquired gradually, with increasing cycling (and driving) experience, but many of them can also be taught. For these reasons it is important to identify education and training issues appropriate for cyclists of various age, experience, and skill levels.

Many of the issues discussed above are poorly understood by non-cyclists, and so there is also potential for much improvement in the way motorists interact with cyclists on the road. For example, the issue of lane-sharing needs to be more uniformly understood, especially as it applies to overtaking and right-turning motorists. Driver training courses and the Province's Drivers Manual could deliver this kind of information. Greater awareness of these issues could also help police officers — many of whom have little cycling experience — in making more thorough, balanced assessments of collisions involving cyclists.

Enforcement of Traffic Regulations

Enforcement of traffic laws, by itself, has limited potential to achieve lasting results. An enforcement 'crack-down' with significant resources applied can produce short-term changes in behaviour, but is generally not sustainable. Enforcement can be more effective when it complements educational strategies, and focuses on the kinds of behaviour that contribute most frequently to collisions and injuries. In this regard, the findings of this study should help police develop effective traffic-enforcement campaigns. For example, while there may be a perception that many cyclists recklessly disobey stop-signs and traffic signals, the collision data indicates that less than 3% of collisions involve a cyclist failing to stop at a controlled intersection. Enforcement campaigns targeting cyclists rolling through stop-signs 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 linked to collisions can be expected to yield better results, in terms of improving safety, than campaigns that simply target infractions that are easy to enforce. For instance, the importance of using bicycle lights at night should be communicated through well-advertised promotion and enforcement campaigns.

While rolling stops by cyclists *on the roadway* appear to have contributed to very few collisions, the same cannot be said for cyclists using the sidewalk. Riding quickly along the sidewalk not only increases the risk of collision at intersections, it can also threaten the safety and comfort of pedestrians. Some police officers are reluctant to ticket cyclists for simply being on the sidewalk, perhaps because they feel that cyclists are better off on the sidewalk than on a busy road. To be effective in reducing collisions and injuries, any enforcement campaigns aimed at sidewalk cycling should focus on cyclists riding into pedestrian crosswalks, and on behaviour that can frighten and endanger pedestrians. Targeting motorists who roll through intersections is also likely to achieve more significant results in terms of improving safety, and would benefit both cyclists and pedestrians.

The limitations of enforcement are apparent when one considers that the most easily enforced and frequently ticketed cycling offences (rolling through a stop sign, not having a bell) rarely result in collisions. On the other hand, some of the driving infractions that frequently result in collisions and serious injuries (unsafe passing, opening a door without checking for traffic, failing to yield the right-of-way) are difficult to enforce unless a collision actually occurs. This would suggest that these offences should be treated very seriously when they are implicated in collisions, so that drivers become more aware of the potentially serious consequences.

4.3: Next Steps

The primary purpose of this study is to analyse bicycle-motor vehicle collisions in Toronto in order to better understand who they're happening to, where they are happening, and what actions and behaviours lead to collisions. This study also raised many questions about the interactions between cyclists, motorists, and the road environment. Further analysis of the data may answer some of these questions, while others will require more information, from a variety of sources.

The most important question still to be answered is what can we do to prevent bicycle-motor vehicle collisions. It is not the purpose of this report to lay out an exhaustive counter-measures program. However, having identified some of the key issues that emerge from the collision data, and some of the potential countermeasures that may be used to address them, it is possible at this point to make some suggestions regarding next steps for action. Specific countermeasures will be developed and implemented in consultation with the Toronto Cycling Committee and in co-operation with the City departments and agencies which share responsibility for road safety.

Developing, Implementing and Evaluating Specific Countermeasures

The most complex and potentially most rewarding task ahead will be to develop specific counter-measures for preventing collisions. Countermeasures will include a combination of infrastructure enhancements, education and enforcement. Different collision types will require different countermeasure approaches. For example, 'dooring' collisions occur primarily on narrow downtown arterial streets with busy commercial activity and high-turnover curb-side parking. Many of these routes also support streetcar tracks, and some sections have fairly narrow sidewalks. Making infrastructure changes is very challenging in this environment. However, given that these collisions are concentrated in a relatively compact area, there may be other creative ways to make drivers and cyclists more aware of the problem.

There are too many collision types to tackle all at once. In order to allocate resources effectively, a process needs to be established, involving transportation and planning staff, the

Toronto Police Service and the Cycling Committee, to identify priorities and to develop a countermeasure strategy. Priorities can be set based on factors such as the following:

- which crash types are most frequent and result in the most severe injuries;
- which crash types are most preventable by countermeasures; and
- which measures will be most sustainable over time.

Making the Information Available

Perhaps the most urgent task is to make the findings of this study available, both internally and to a wider audience. It is important that staff and consultants responsible for the design of transportation facilities are aware of any collision data that may affect their design decisions. Professionals involved in investigating collisions and responding to bicycle crash victims (such as Police officers, legal and insurance personnel) should have knowledge of Toronto's bicycle crash data. Many other groups, including those promoting cycling, those working to improve road safety and to reduce injuries in general, and cyclists themselves, could benefit from the information contained in this report. Finding effective ways to deliver this information to those who can make use of it will involve several tasks, from making it available in hard copy, posting it on the City's web-site, and making group presentations.

Some of the study's findings have already been incorporated into the City's CAN-BIKE training materials, to ensure that Toronto cyclists are learning about Toronto-specific issues. Going further, information for parents, on the kinds of collisions that happen to young cyclists and simple steps for preventing them, would be very helpful. Other audience-specific safety information can be targeted to adult cyclists, professional drivers, and the general driving public.

The database compiled for this study contains a wealth of information that can be extracted through specific queries, and it will continue to provide information about bicycle/motor-vehicle collisions as new questions are posed. For example, examination of collisions that occurred on or near a bike lane may illuminate safety issues peculiar to these facilities, which could influence design. This exercise might also provide evidence about the effectiveness of bicycle lanes in increasing safety. Another analytical approach will be to sort the data not by crash type, but by variables such as roadway classification, with a view to identifying problems associated with certain types of roads, or other variables. Individuals and organisations interested in specific aspects of road safety may have suggestions for such approaches, and should be encouraged to formulate specific research questions.

Identifying High Collision Locations/Corridors

A key aspect of determining countermeasure priorities — especially potential infrastructure treatments — will be the identification of collision “hot-spots.” As mentioned earlier in the report, the study succeeded in identifying a few such concentrations, and it is quite possible that others will show up when more collision records are mapped. Geographic analysis can be done quite quickly, and can be used to isolate clusters of collisions, which can then be examined in further detail. One goal would be to identify potential sites for geometric analysis and/or conflict studies, with the hope of finding ways to address location-specific problems.

Routine coding of bicycle/motor-vehicle collisions by typology

Transportation Services staff currently review all motor-vehicle collision reports involving pedestrians and cyclists, to verify the accuracy of the data. A simplified coding process based on the knowledge gained through this study could be included as part of the verification process, allowing collision type frequency data to be collected routinely. High-quality data on car/bike collisions would then be available for ongoing analysis, in order to monitor trends in cycling collisions. However, it should be noted that part of this exercise will be to determine whether collecting and analysing additional data adds value to the development and evaluation of specific collision countermeasures, and that there is merit in collecting additional data.

Investigating other sources of bicycle crash data

As noted elsewhere in this report, many bicycle crashes are not reported to police, and so are not captured by this type of study. It is important to gain as comprehensive an understanding of local cycling safety issues as possible, in order to effectively address the most significant problems. To complement the current study, hospital and ambulance records of cycling-related injuries could be examined. This would provide information on the kind of injuries sustained in incidents that are not reported to police, including collisions between cyclists and pedestrians, and single-bicycle crashes. It would allow us to confirm whether motor-vehicle collisions do in fact represent the most significant safety hazard for Toronto cyclists, as we currently believe. Hospital records likely will not tell us much about how and where such incidents happened, though.

A survey of cyclists could also shed light on collision reporting rates, and on the proportion of all bicycle crashes and injuries that result from interactions with motor-vehicles. Collecting exposure data as well as crash histories would allow the calculation of crash rates, at least on a rudimentary level. A survey might also provide valuable personal insights into the causes of some crashes, perhaps including the role of surface conditions or other treatable aspects of the City's cycling facilities. Other mechanisms should be developed to facilitate the collection of information, from cyclists, on hazardous locations.

The collision data can tell us where collisions are most frequent, but by itself it does not provide any indication as to whether these locations are particularly hazardous, or simply heavily used by cyclists. Although we have a good general understanding of the routes that are important to Toronto cyclists, detailed bicycle traffic counts are vital to providing a more accurate assessment of the safety of these routes. Along with on-going analysis of collision patterns, the collection of comprehensive bicycle volume data will also provide a basis for evaluating the effectiveness of programs to enhance the safety and popularity of bicycle use.

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Part II: Detailed Analysis Results

Summaries of Findings by Collision-Type

Each type of collision was analysed separately, and the results of those analyses are presented in detail here. Age data is presented graphically, using histograms that compare the distribution of age groups involved in each particular crash type with the age distribution of all the cyclists in the study. (In cases where a low number of collisions limits the analysis, the number of age groups in the histograms has been reduced by using ten-year increments instead of five. In general, the statistical significance of any trends that appear to emerge from samples of fewer than fifty cases may be questionable.) A similar graphical procedure was used to characterise the distribution of injury severity for each type of crash. Weather and light conditions are also graphed whenever they appear to depart from the ‘norm.’ Other factors that may have been significant are noted in tables.

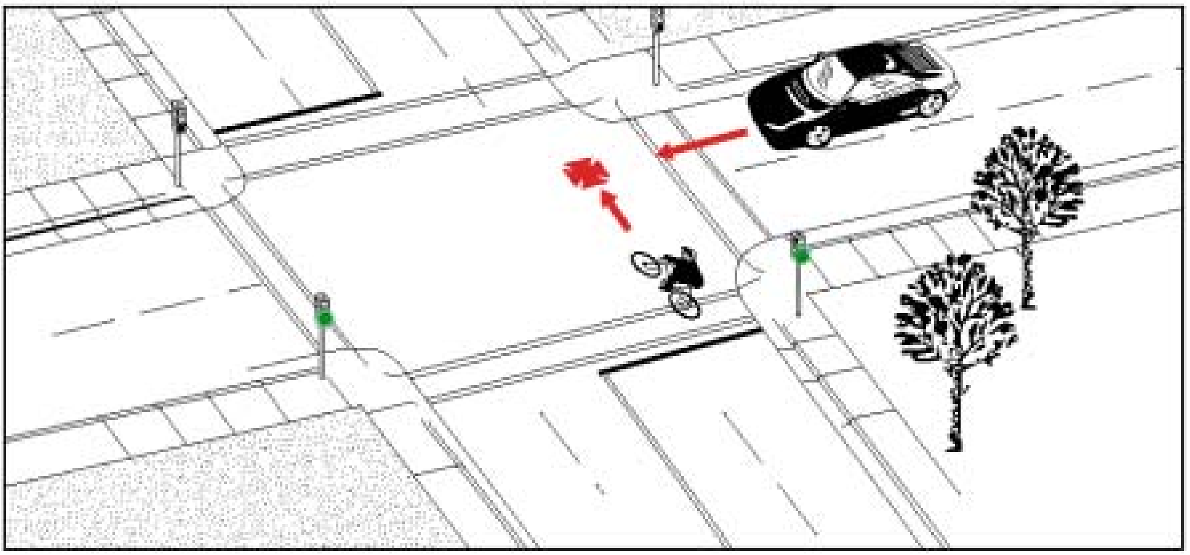
These summaries provide detailed information about each type of collision, and can be used to compare the characteristics of different types of collisions. They illustrate some of the features referred to in the previous discussions, and can provide a basis for investigating hypotheses about cycling safety. For each collision type, diagrams illustrate the typical physical configuration, and maps depict the geographical distribution of collision incidents.

Type 1:

Drive Out At Controlled Intersection

Frequency: 284 cases; 12.2% of all collisions

Severity: 3% resulted in major injuries
No fatalities



Description: This type of collision occurred as a motorist was starting or stopping at a controlled intersection, and collided with a cyclist who had the right-of-way or was crossing at a crosswalk.

Traffic Control:

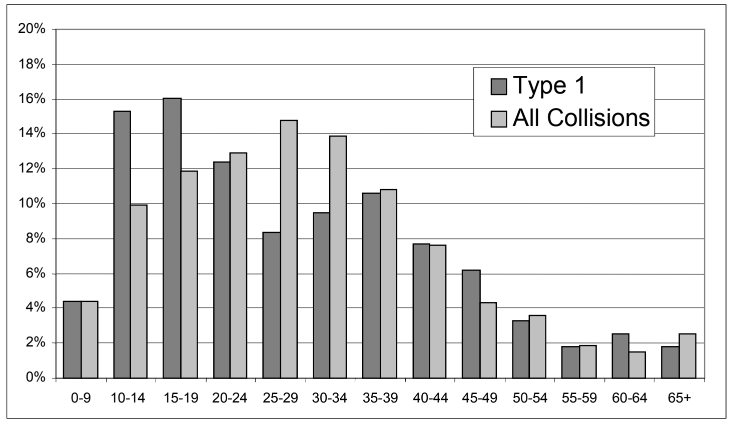
Stop Sign	75%
Traffic Signal	18%
Ped. Cross-Over	6.5%

Summary: In comparison to all collisions, this type tended to involve more young cyclists (ages 10 to 19). Resulting injuries were generally less severe than average.

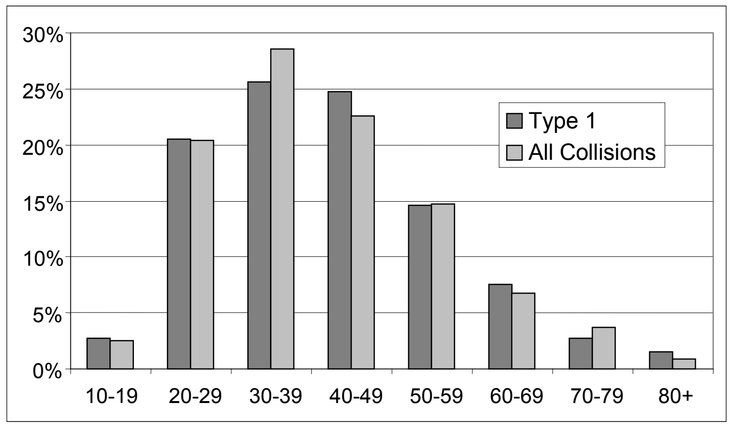
Other Significant Factors:	Type 1	All Collisions
Cyclist riding on sidewalk/crosswalk	51.1%	30.6%
Darkness	18.3%	14.9%
Rainy weather	10.9%	5.9%
Wet road surface	13.6%	7.9%
Motorist disobeying traffic control	7.4%	1.6%
Sight lines obstructed	4.2%	3.1%

Type 1: Drive-Out at Controlled Intersection

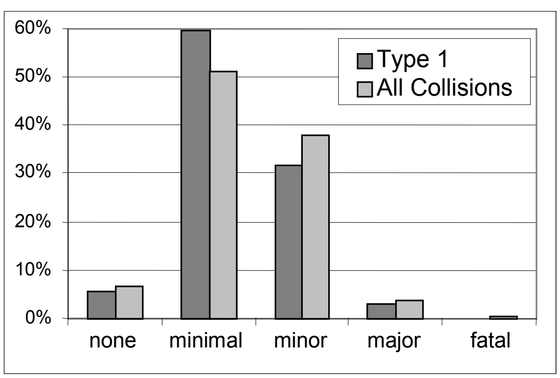
Cyclist's Age



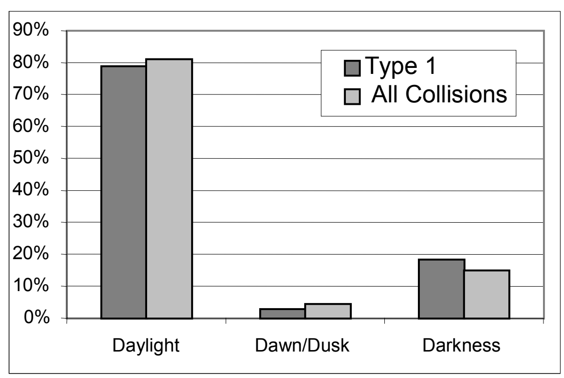
Driver's Age



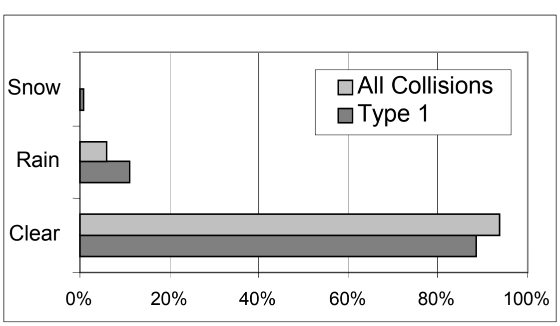
Cyclist's Injuries



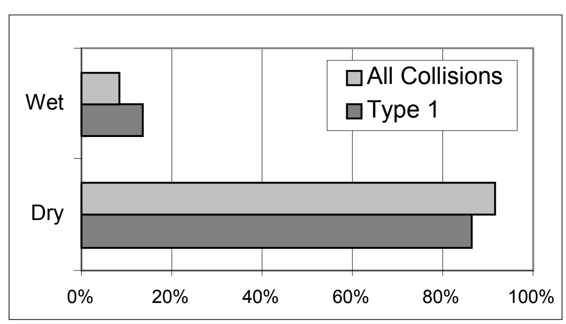
Light Conditions



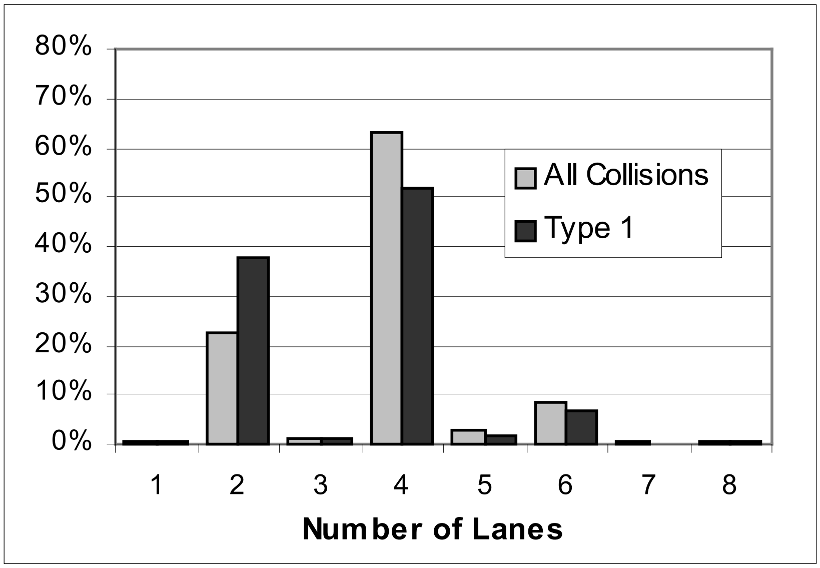
Weather Conditions



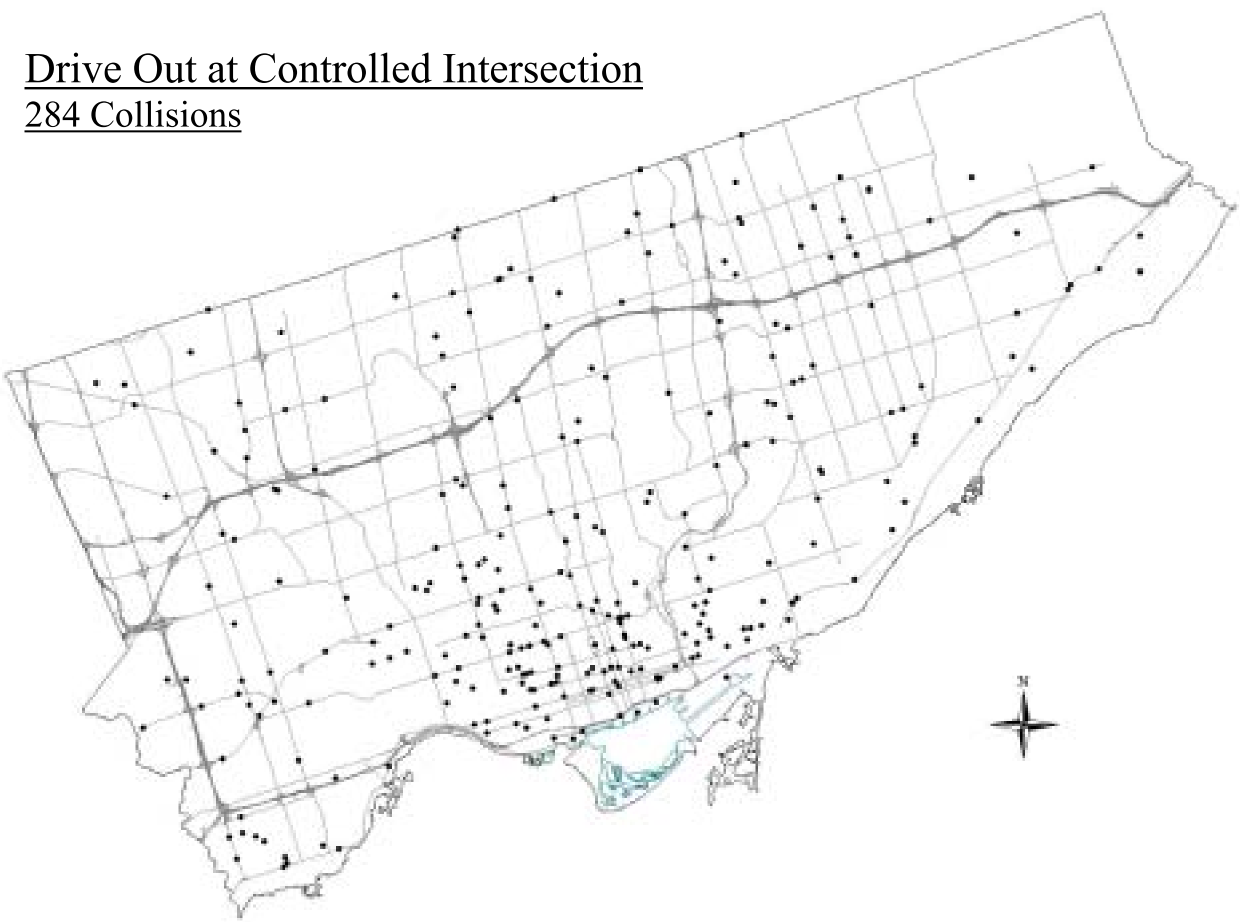
Road Surface Conditions



Number of Lanes



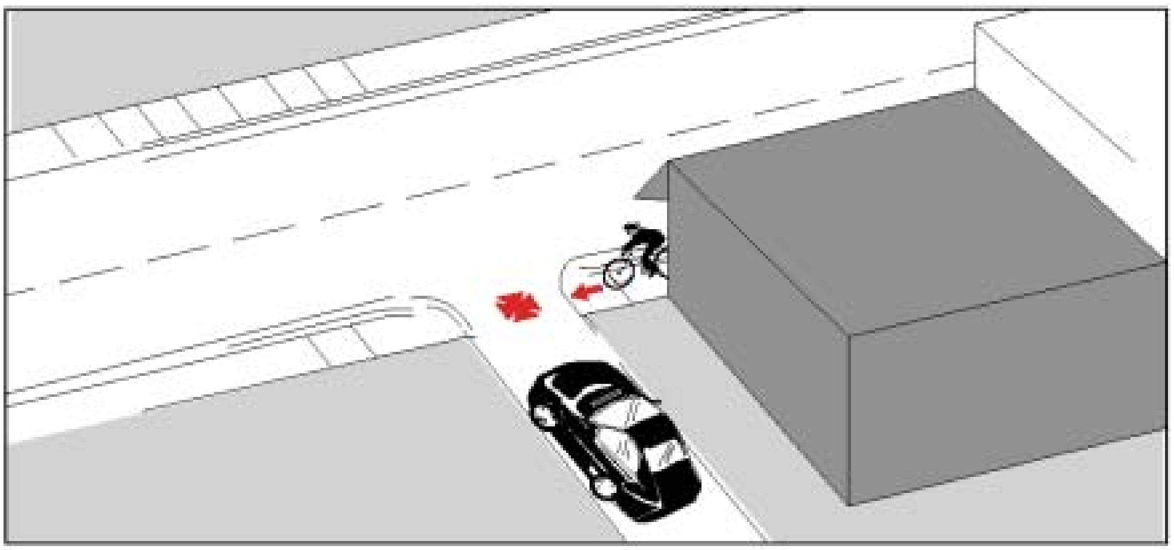
Drive Out at Controlled Intersection
284 Collisions



Type 2:

Drive Out From Lane or Driveway

Frequency:	179 cases; 7.7% of all collisions
Severity:	2% resulted in major injuries No fatalities



Description: The motorist was emerging onto the roadway from a private or commercial driveway, or a lane. While the motorist may have been initiating a turn, this could not be determined conclusively from the MVA report.

Summary: In comparison to all collisions, this type tended to involve more young cyclists (ages 10 to 19). Resulting injuries were generally less severe than average. Drivers age 40-55 and 70-80 were over-represented.

Environmental Conditions:

Daylight	90%
Clear Weather	95%
Dry Road Surface	95%

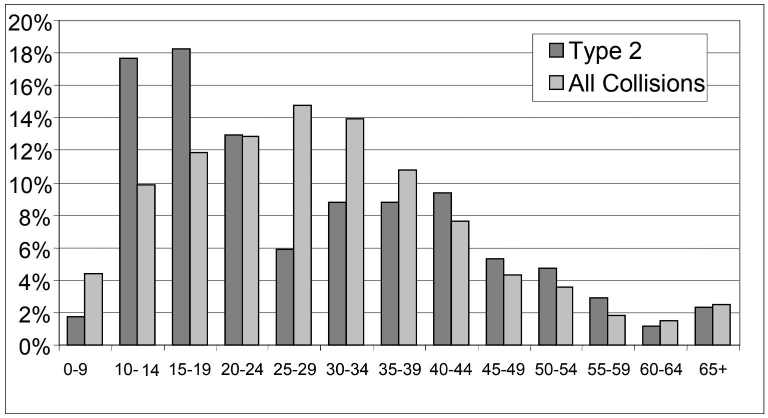
Poor weather and light conditions were not frequent factors in this type of collision.

Geographic Distribution:
No central concentration, *i.e.*, relatively more frequent in outer areas of the City.

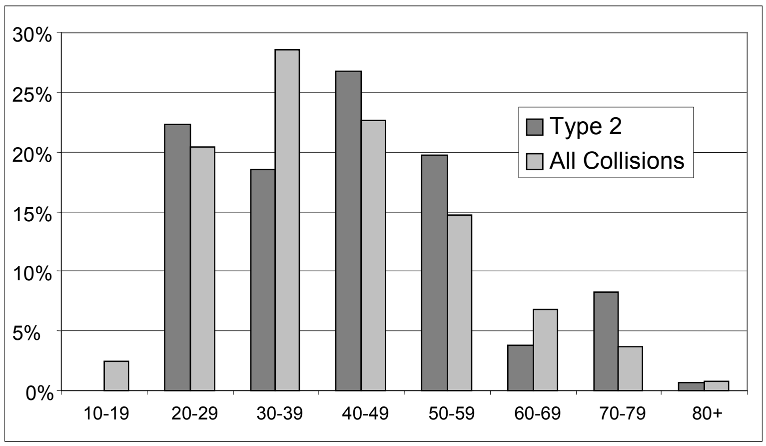
Other Significant Factors:	**Type 2**	**All Collisions**
Cyclist riding on sidewalk	81%	30.6%
Child cyclist	6.1%	5.7%
Sight lines obstructed	4.5%	3.1%

Type 2: Drive-Out from Lane or Driveway

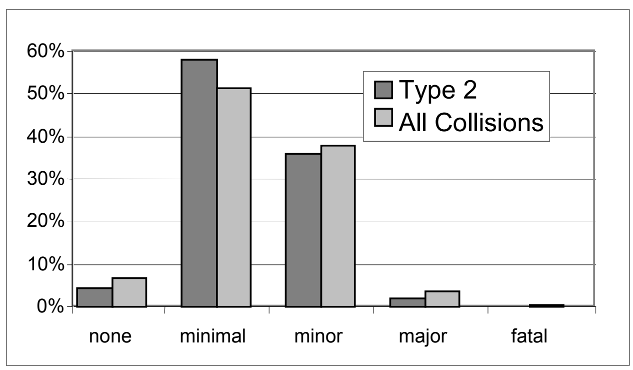
Cyclist's Age



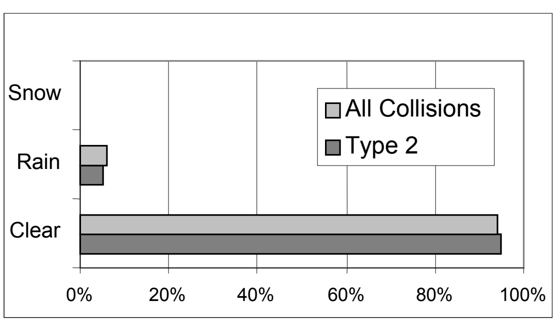
Driver's Age



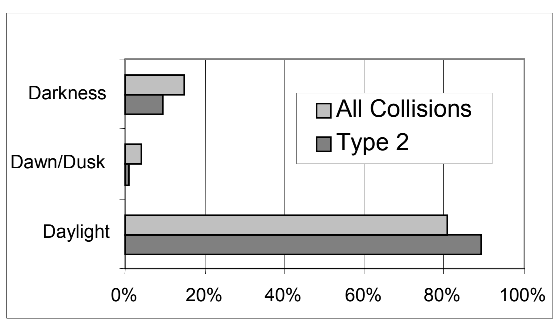
Cyclist's Injuries



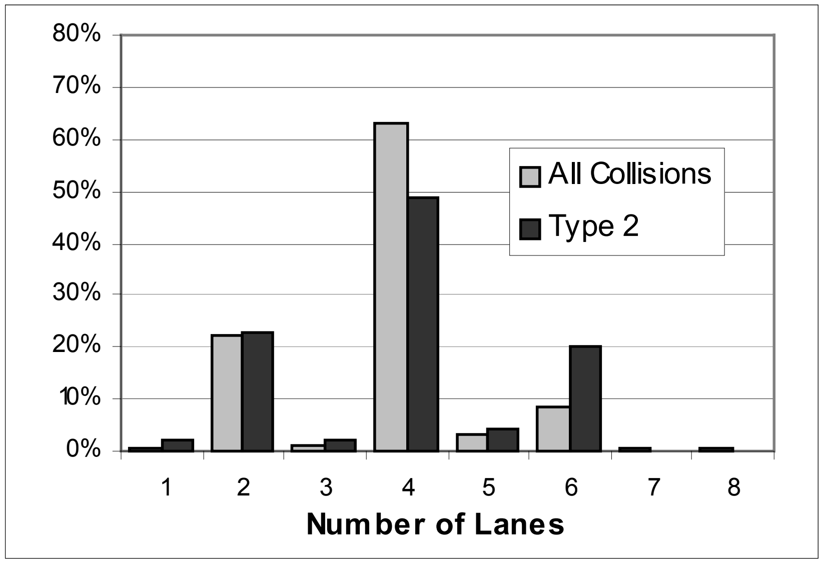
Weather Conditions



Light Conditions

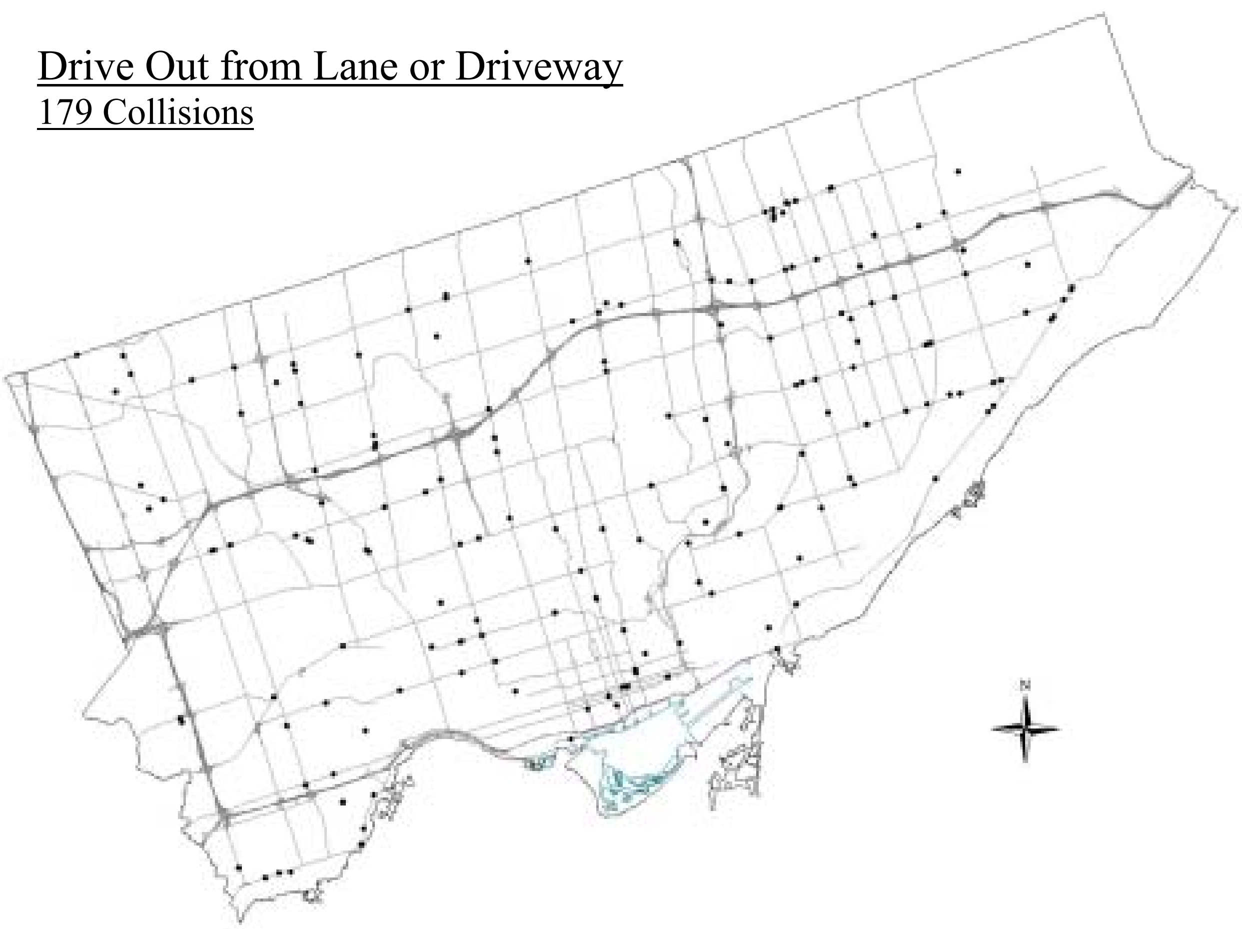


Number of Lanes



Drive Out from Lane or Driveway

179 Collisions

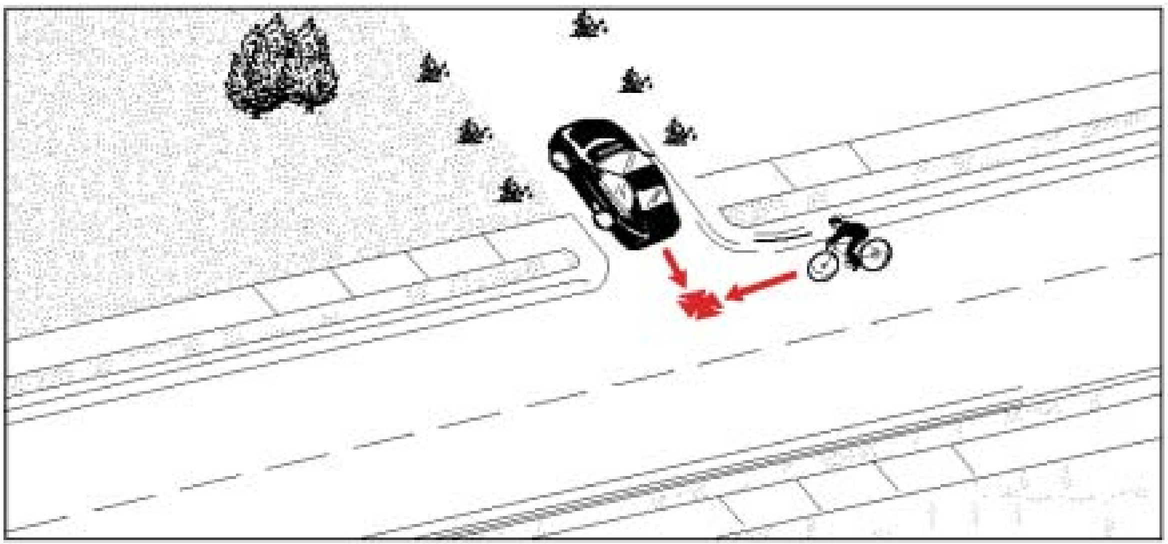


Type 3:

Motorist Reversing

Frequency: 37 cases; 1.6% of all collisions

Severity: No major injuries or fatalities



Description: The motorist was backing up, often on a private driveway (crossing a sidewalk) or in a parking lot.

Summary: Cyclists under 15 seem to be more frequently involved in this type of collision, as do those over 65. Resulting injuries were generally less severe than the overall average. Drivers age 50-60 were apparently over-represented.

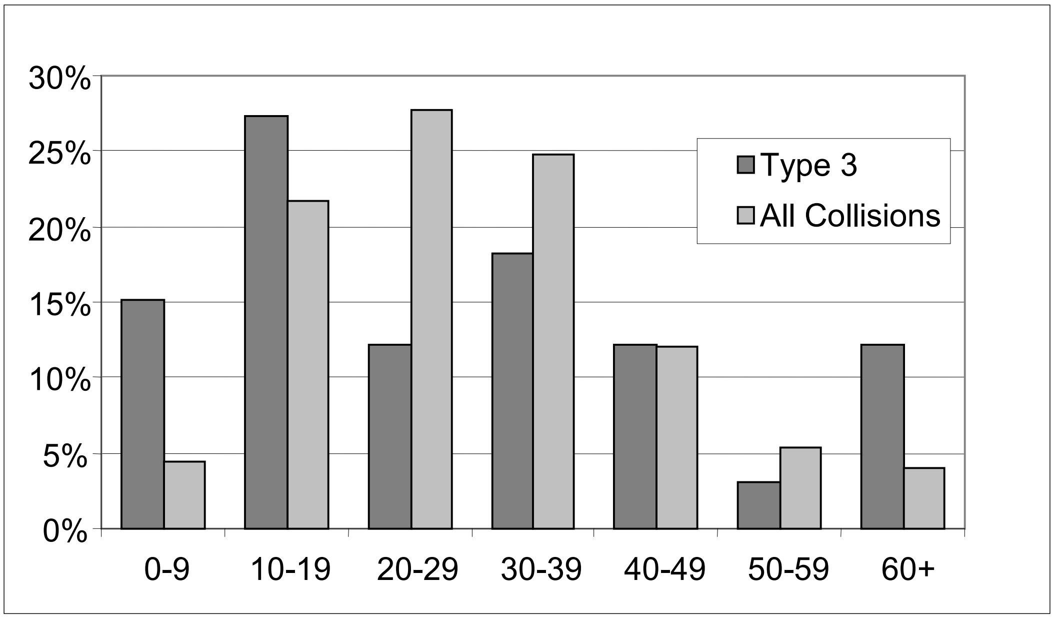
Environmental Conditions: Clear weather, all known cases. Three occurred in darkness.

Note: The small number of cases limits the confidence of some statements about this type of crash.

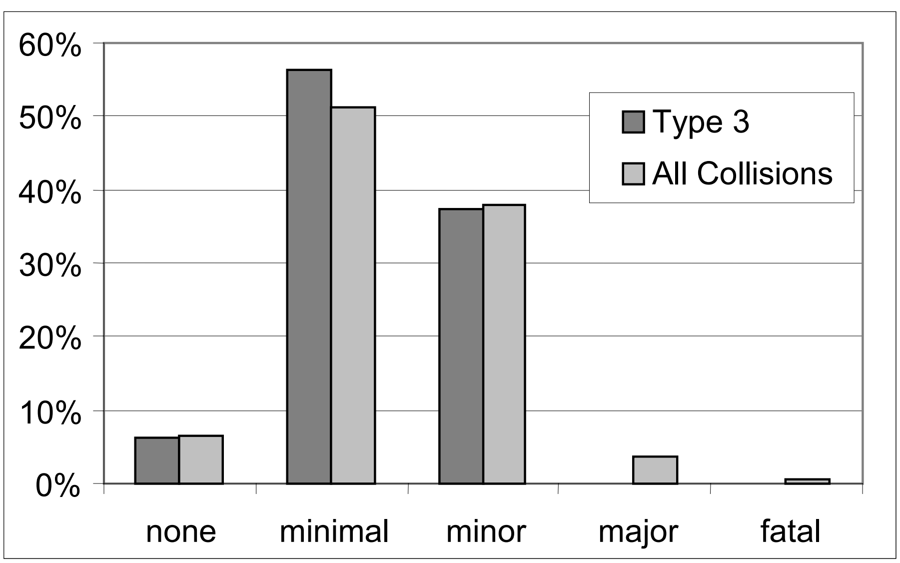
Other Significant Factors:	Type 3	All Collisions
Cyclist riding on sidewalk	45.9% (17 cases)	30.6%
Child cyclist	15.2% (5 cases)	5.7%
Sight lines obstructed	5.4% (2 cases)	3.1%

Type 3: Motorist Reversing

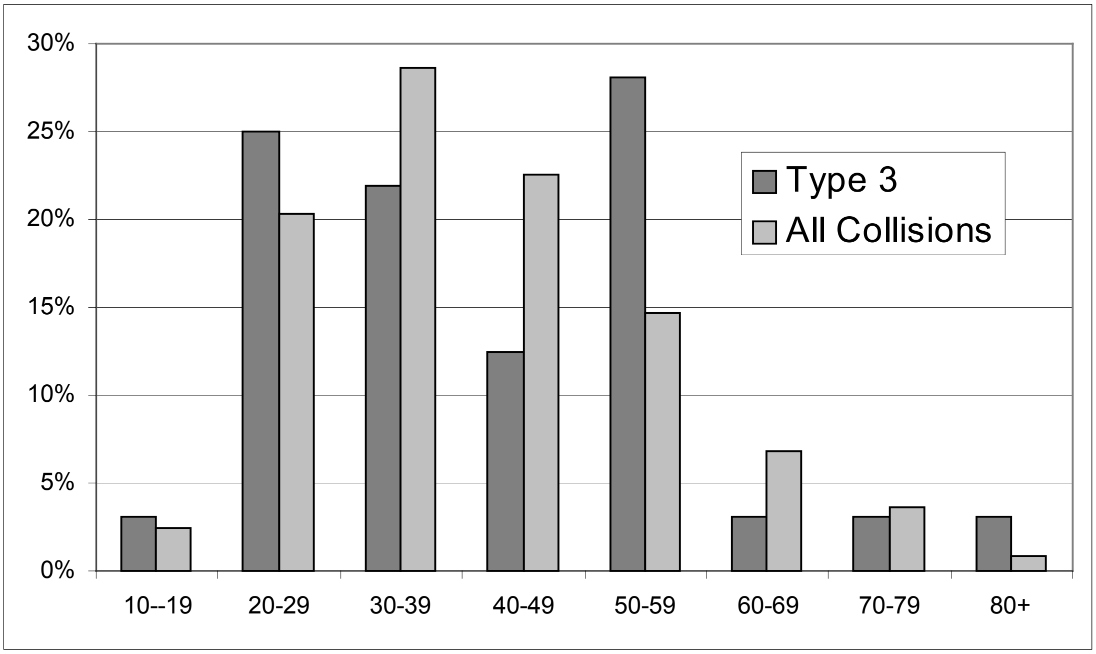
Cyclist's Age



Cyclist's Injuries



Driver's Age

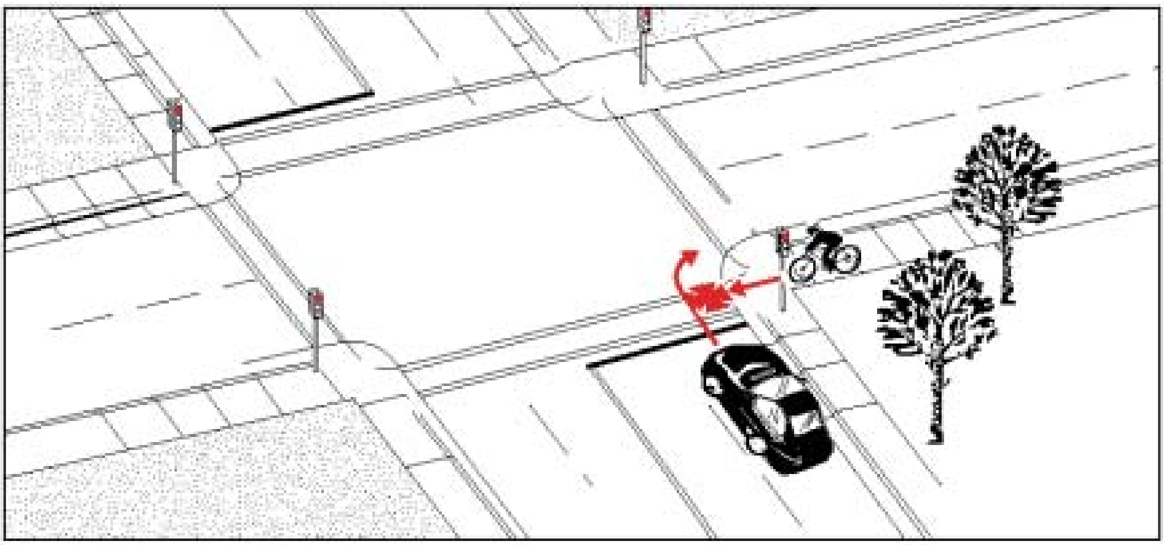


Motorist Reversing
37 Collisions

Type 4:

Frequency:	179 cases; 7.7% of all collisions
Severity:	2.5% resulted in major injuries No fatalities

Motorist Right Turn at Red Light



Description: The motorist was executing a right turn at a red light. The cyclist was most often crossing the road from the motorist's right, within the crosswalk. Cyclists were riding on the road, in the direction of traffic, in only 11% of these collisions, compared to 71% overall.

Summary: In comparison to all crashes, this type tended to involve more young cyclists (ages 11 to 20) and seniors (over age 57). Resulting injuries were generally less severe than average, probably because motor vehicle speeds were typically low.

Environmental Conditions:
Wet roads and rainy weather were significantly over-represented in this crash type. Reduced visibility may have been a problem, especially for motorists (foggy windows). Reduced braking ability could have been a problem, especially for cyclists.

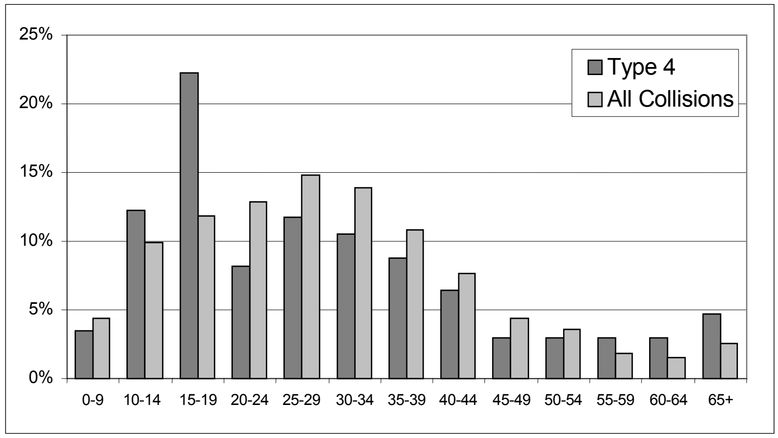
Darkness was not a frequent factor.

Geographic Distribution:
Very slight central concentration, *i.e.*, relatively more frequent in outer areas.

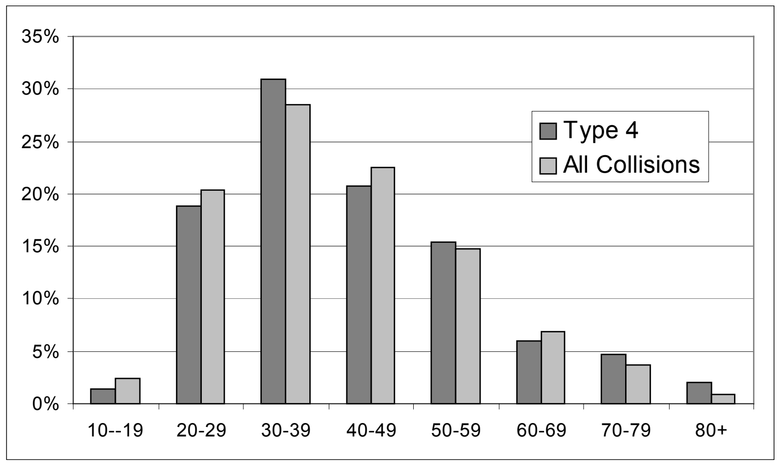
Other Significant Factors:	Type 4	All Collisions
Cyclist riding on sidewalk/crosswalk	86%	30.6%
Wet road surface	13.2%	7.9%
Rainy weather	8%	5.9%
Cyclist on road, riding against traffic	3.4%	1.8%

Type 4: Motorist Right Turn at Red Light

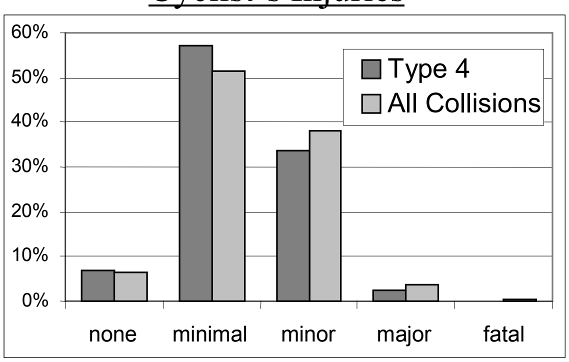
Cyclist's Age



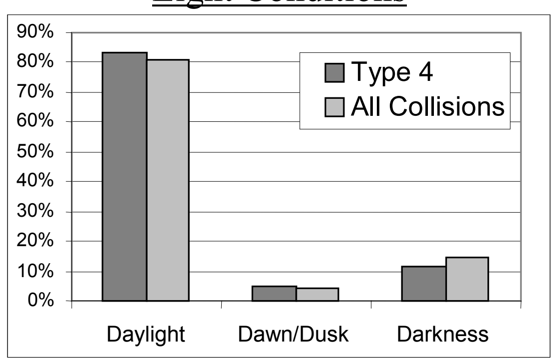
Driver's Age



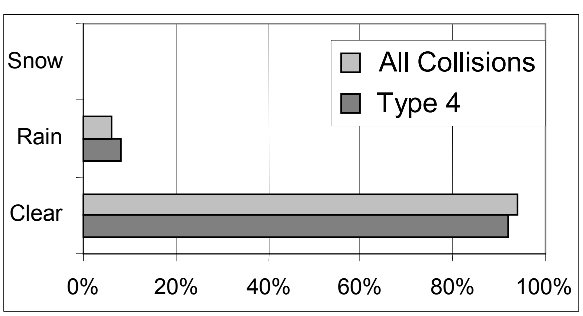
Cyclist's Injuries



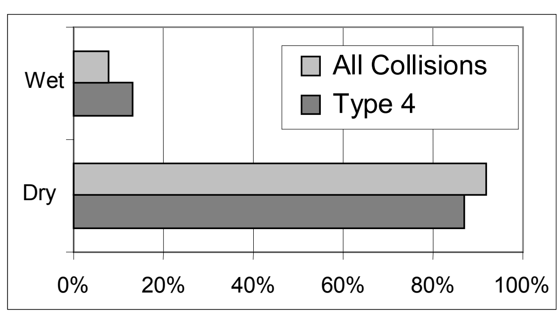
Light Conditions



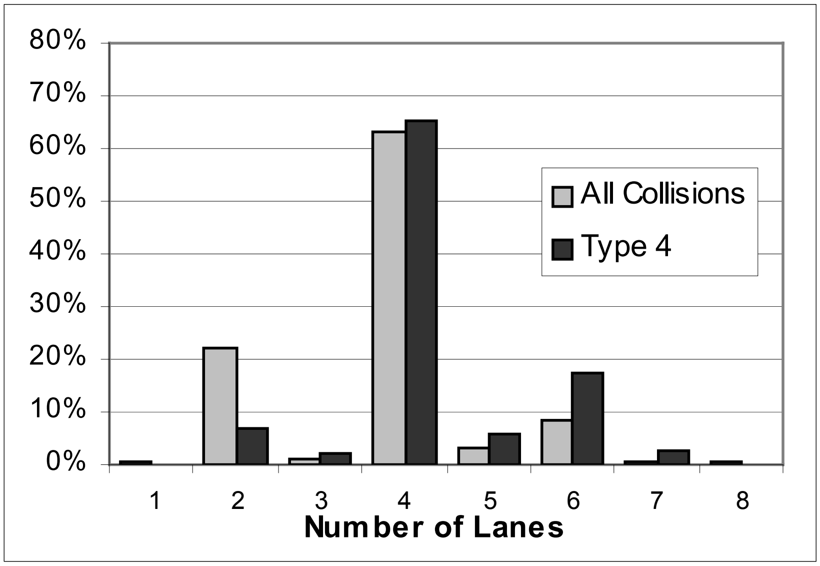
Weather Conditions



Road Surface Conditions

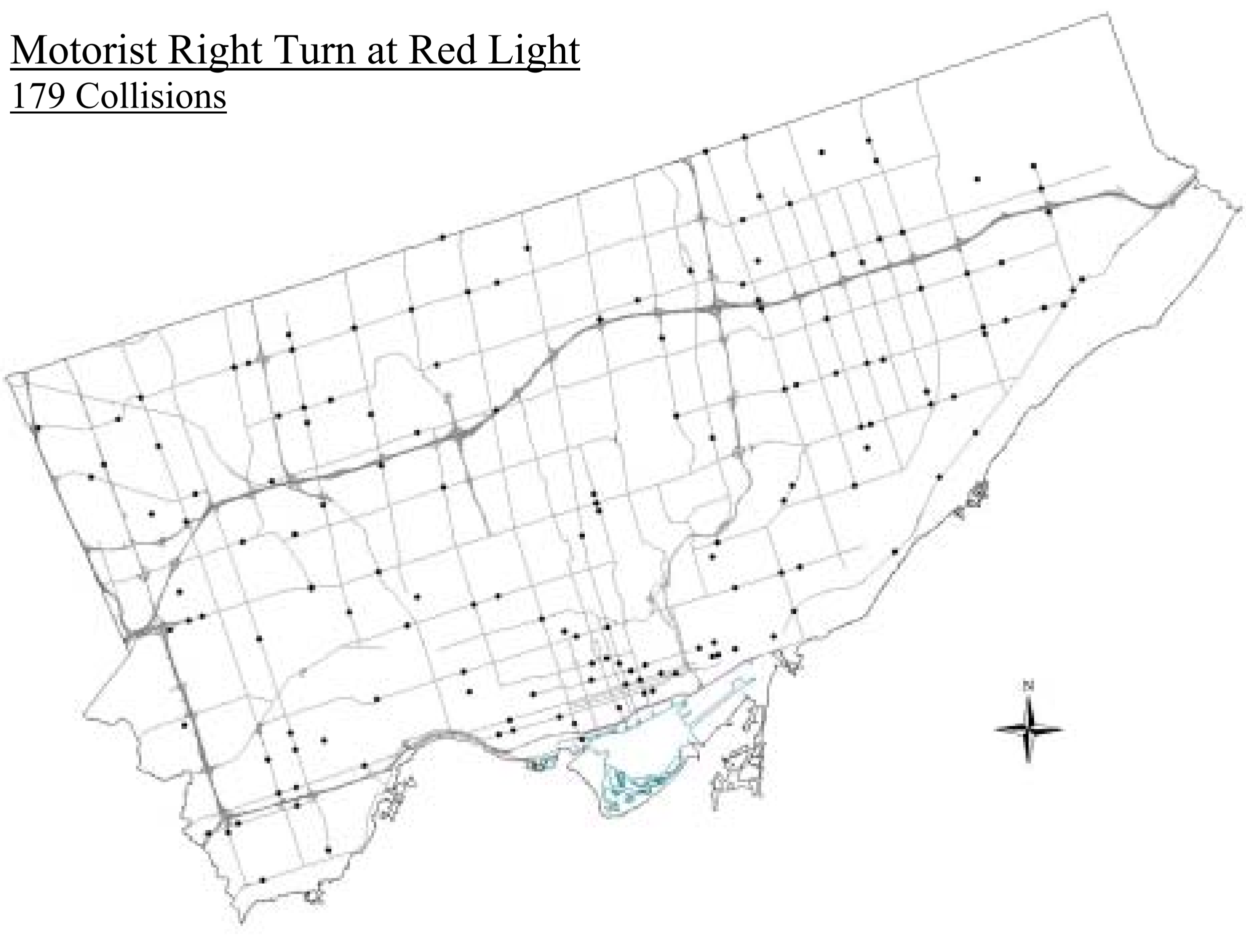


Number of Lanes



Motorist Right Turn at Red Light

179 Collisions

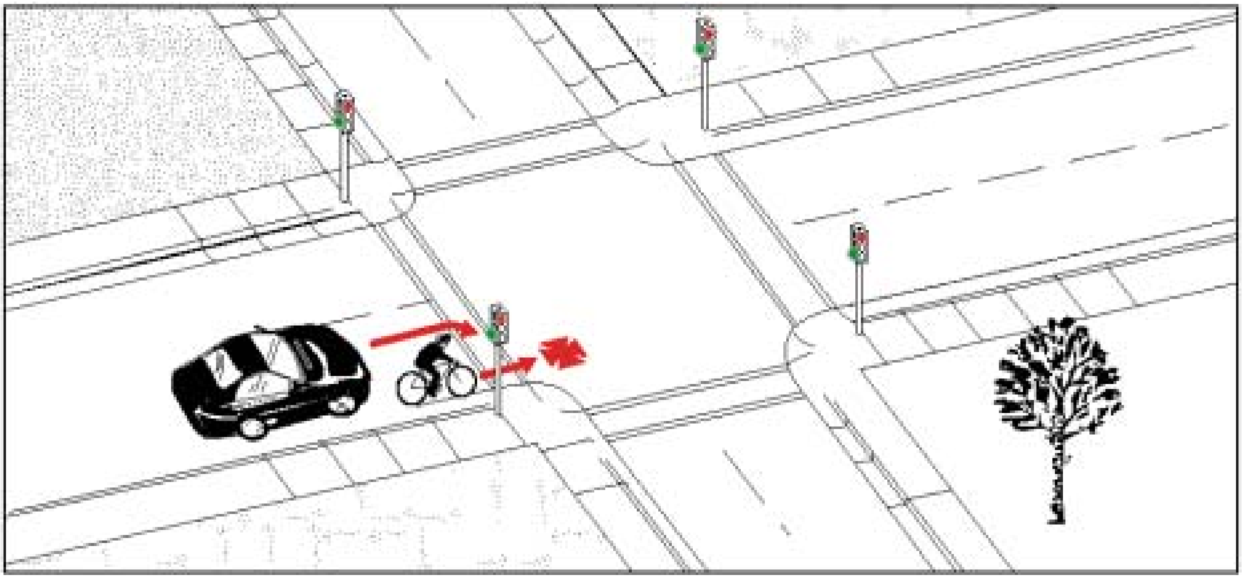


Type 5:

Motorist Right Turn - Other

Frequency: 224 cases; 9.6% of all collisions

Severity: 1.4% resulted in major injuries
No fatalities



Description: The motorist was making a right turn. The cyclist was usually riding in the same direction on the road, but in over a third of cases the cyclist was on the sidewalk, entering the crosswalk.

Summary: This type of crash tended to involve slightly more young cyclists (ages 15 to 19) than all crashes combined. Resulting injuries were generally much less severe than average. Drivers in their thirties seem to be under-represented.

Traffic Control:

No Control	47%
Traffic Signal	39%
Stop Sign	12%
Ped. Cross-Over	1%

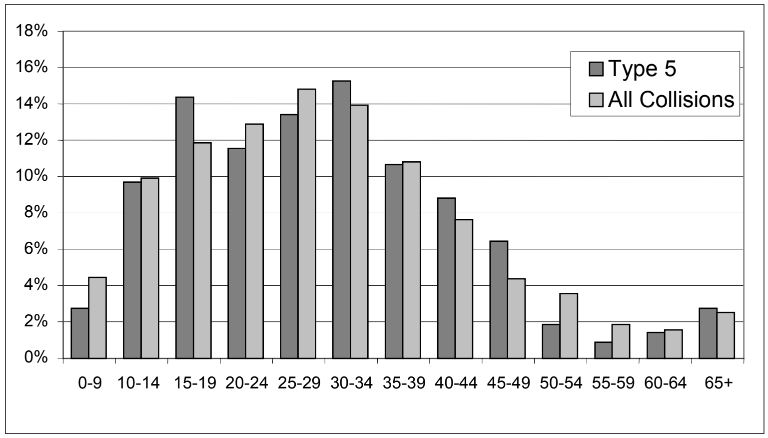
Environmental Conditions:
Not a frequent factor.

Geographic Distribution:
More frequent in central areas.

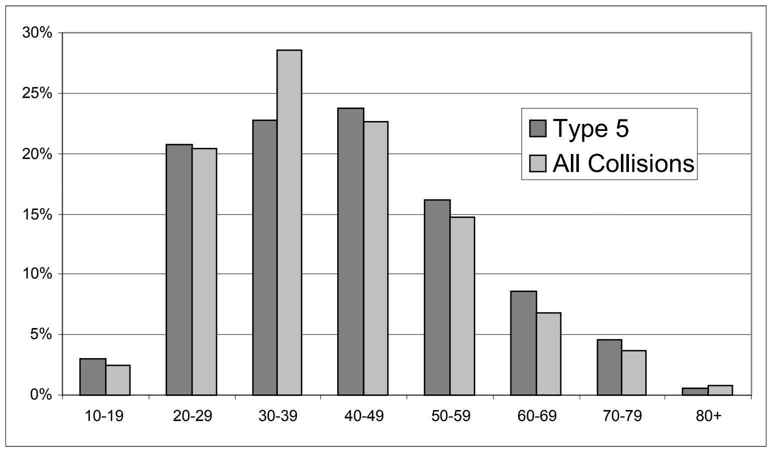
Other Significant Factors:	Type 5	All Collisions
Cyclist riding within crosswalk	35%	30.6%
Cyclist overtaking on the right	3.6%	2.5%

Type 5: Motorist Right Turn - Other

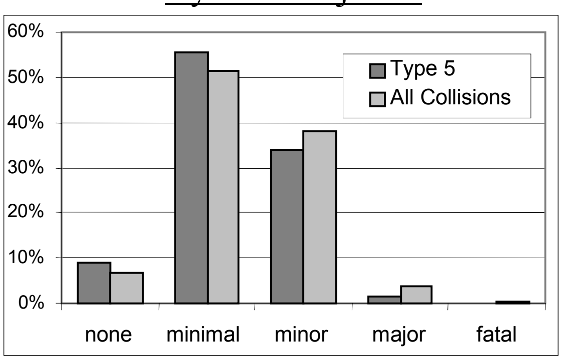
Cyclist's Age



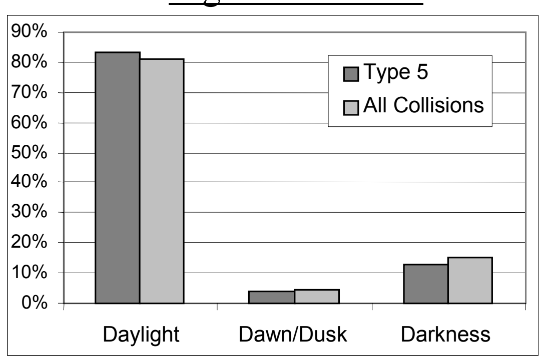
Driver's Age



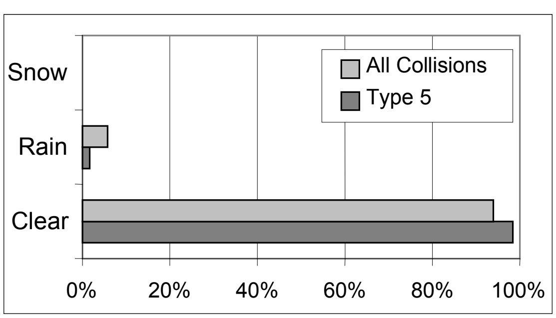
Cyclist's Injuries



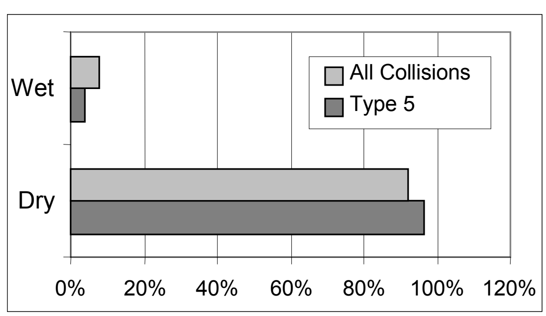
Light Conditions



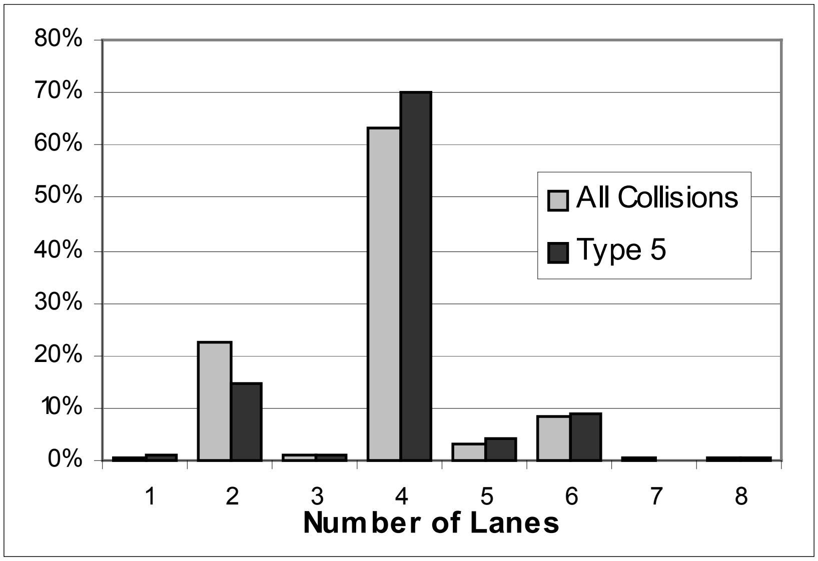
Weather Conditions



Road Surface Conditions

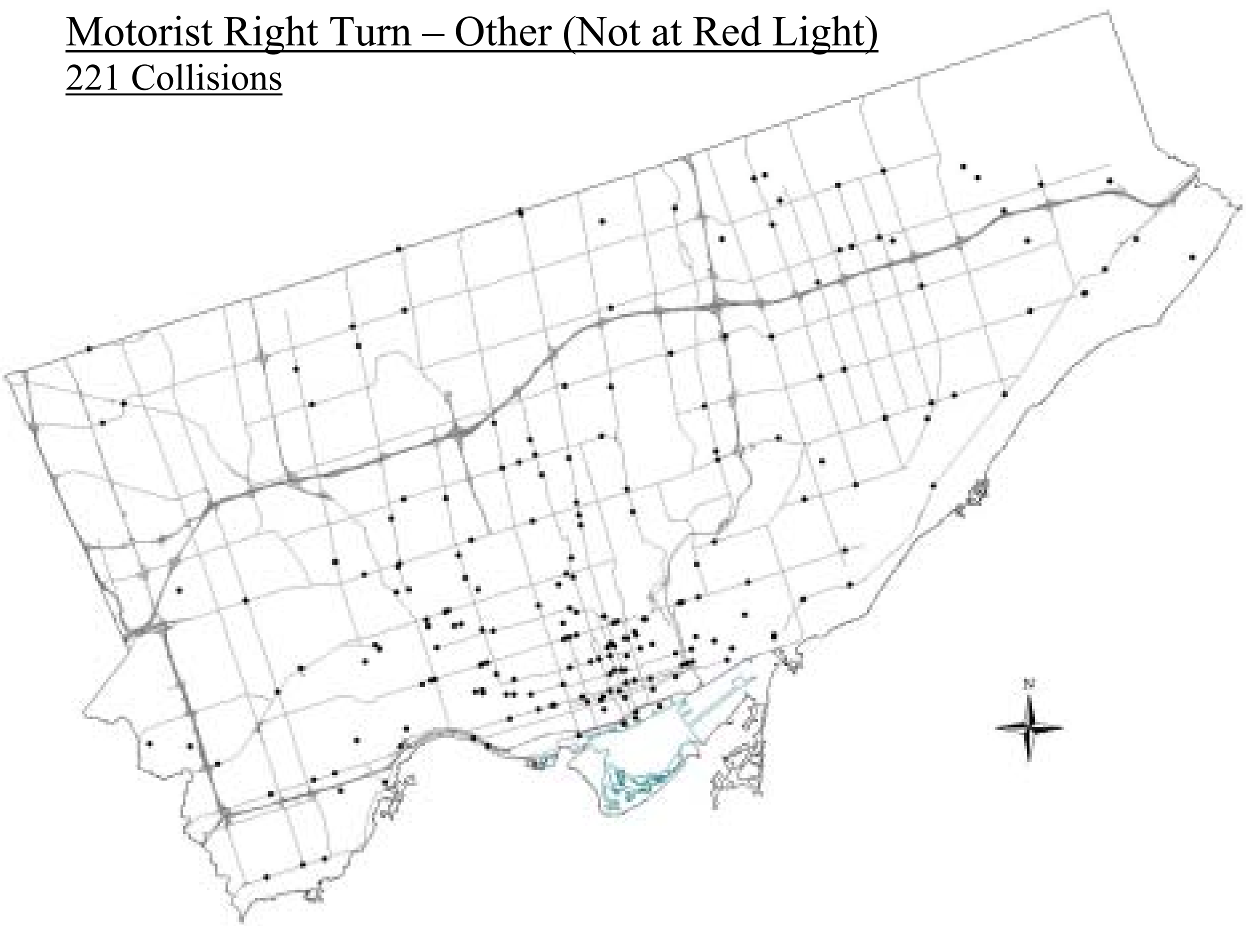


Number of Lanes



Motorist Right Turn – Other (Not at Red Light)

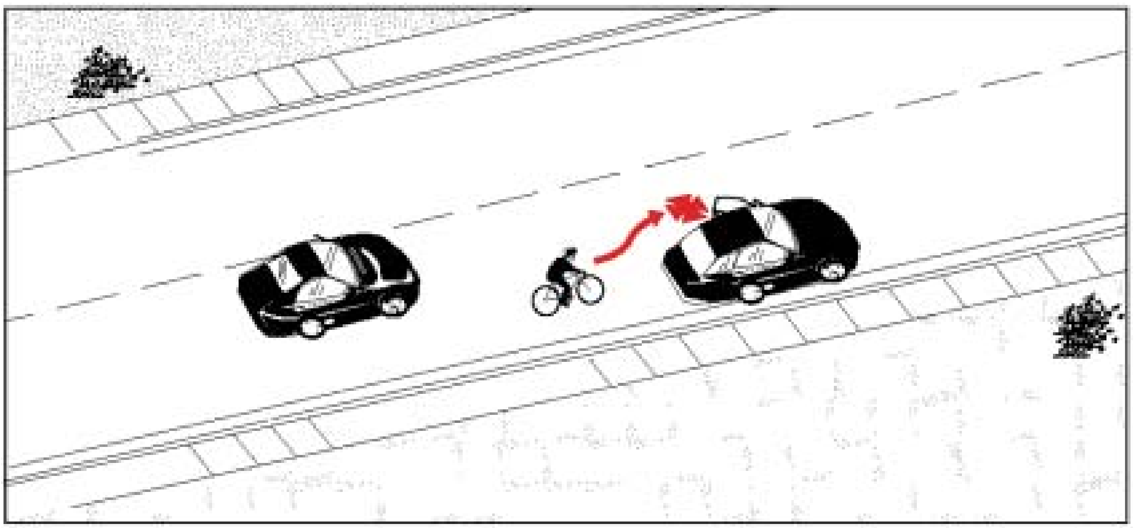
221 Collisions



Type 6:

Frequency:	276 cases; 11.9% of all collisions
Severity:	3.1% resulted in major injuries 1 fatality

Motorist Opens Door in Path of Cyclist



Description: In this type of crash, the cyclist was riding alongside a stopped vehicle when the driver or passenger opened a vehicle door into the cyclist's path.

Summary: Most of the cyclists involved in this type of collision were adults between 20 and 40 years of age. Resulting injuries were somewhat more severe than average. Light and weather conditions not appear to have been frequent contributing factors. Drivers in their thirties are over-represented.

Configuration :

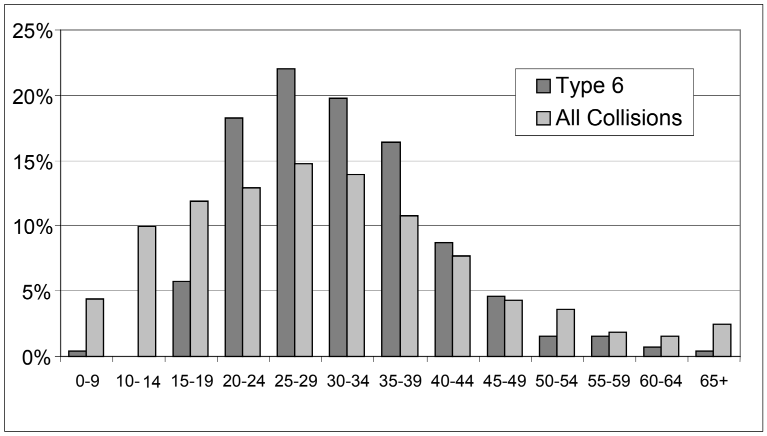
Motorist in Curb Lane,
Cyclist Passing on Left: 77%
Motorist in Curb Lane,
Cyclist Passing on Right: 15%
Motorist in Centre Lane,
Cyclist Passing on Right: 8%

Geographic Distribution:
Almost exclusively concentrated in central areas of the City.

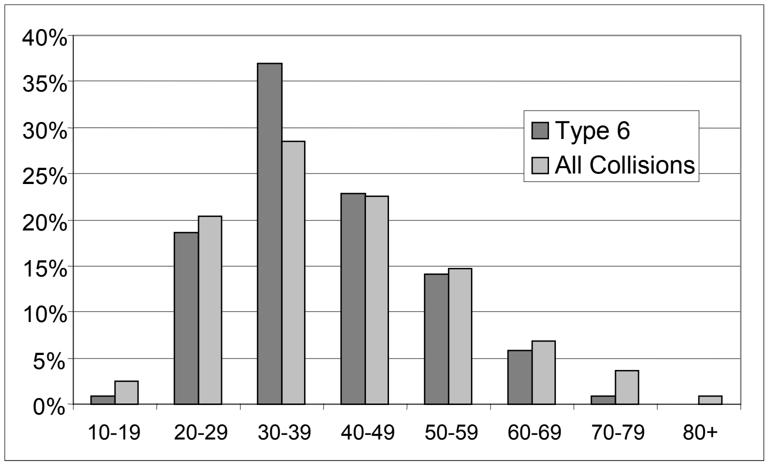
Other Significant Factors:	Type 6	All Collisions
Cyclist passing on the right	15.6%	2.5%
Motorist discharging passenger in centre lane	7.6%	1.0%
Taxi	7.1%	3.1%

Type 6: Motorist Opens Door in Cyclist's Path

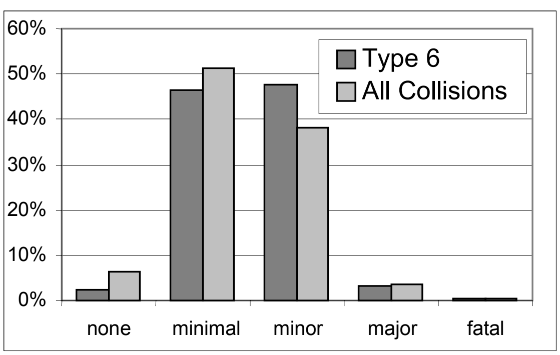
Cyclist's Age



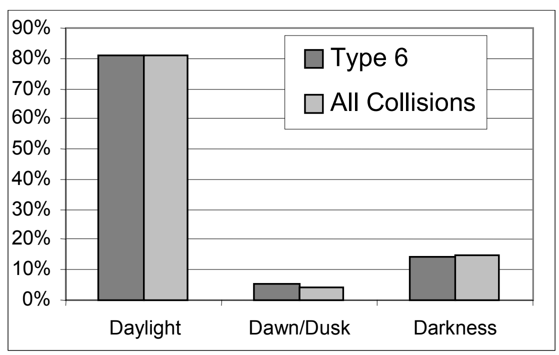
Driver's Age



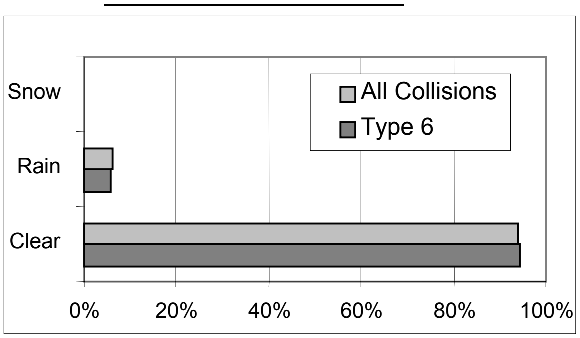
Cyclist's Injuries



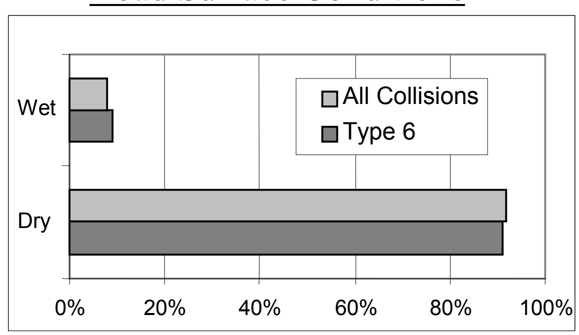
Light Conditions



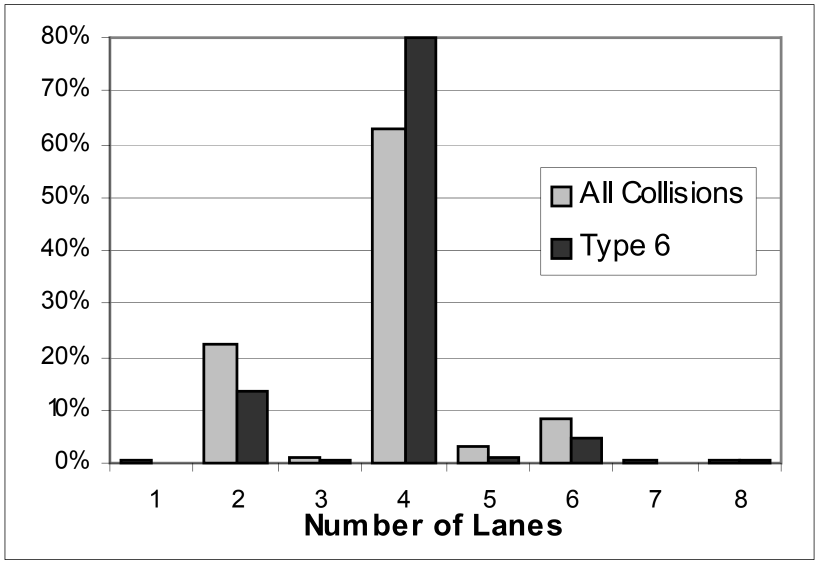
Weather Conditions



Road Surface Conditions



Number of Lanes



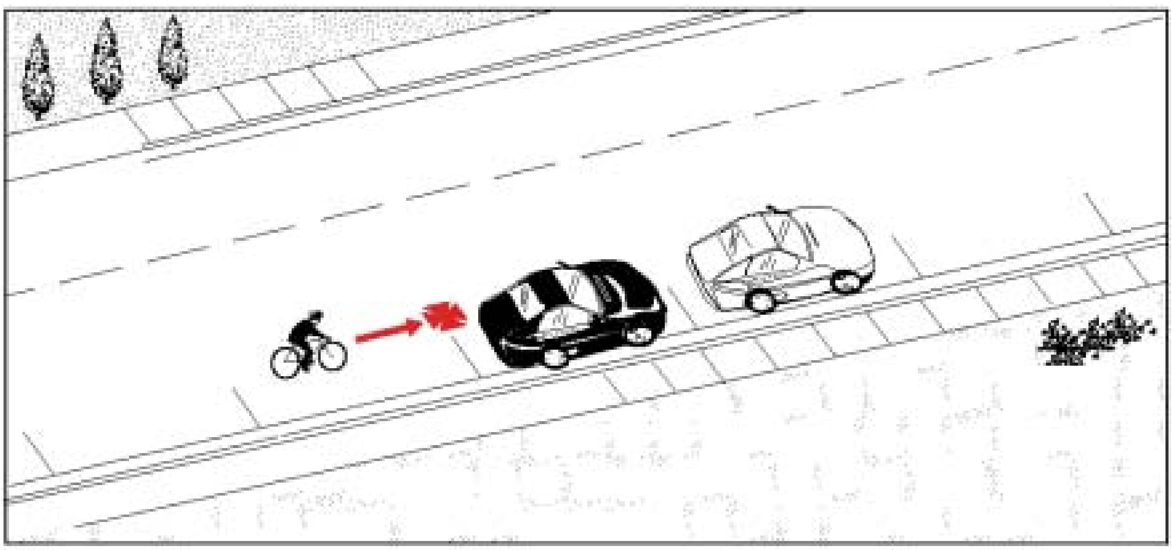
Motorist Opens Door in Cyclist's Path
275 Collisions

Type 7:

Cyclist Strikes Stopped Vehicle

Frequency: 39 cases; 1.7% of all collisions

Severity: 1 major injury (3% of cases)
No fatalities



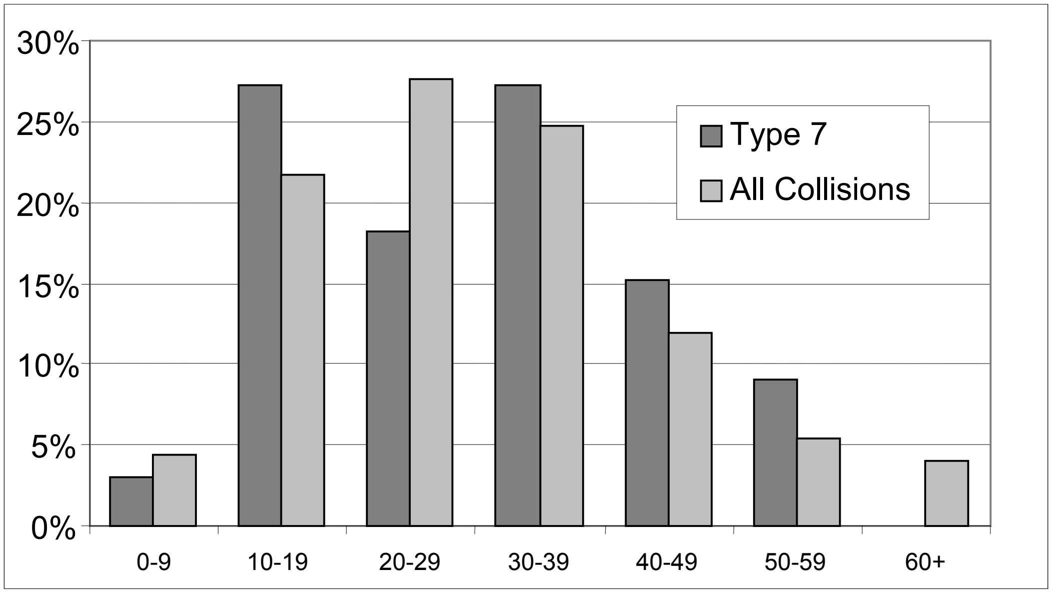
Description: The cyclist crashed into a motor vehicle that was parked or stopped.

Summary: In comparison to all crashes, this type seems to involve more young cyclists (ages 15 to 19). Several of these crashes resulted in no injuries to the cyclist.

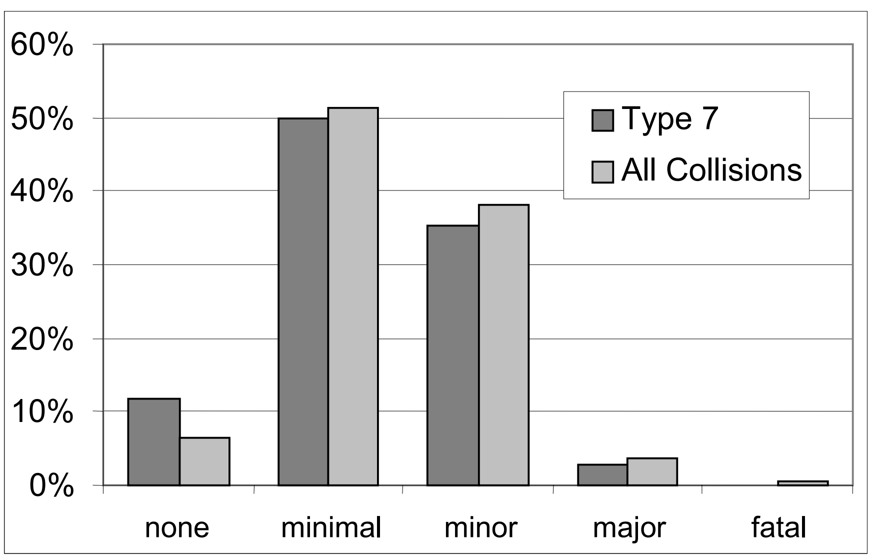
Note: The small number of cases may reduce the confidence of some statements about this type of crash.

Type 7: Cyclist Strikes Stopped Vehicle

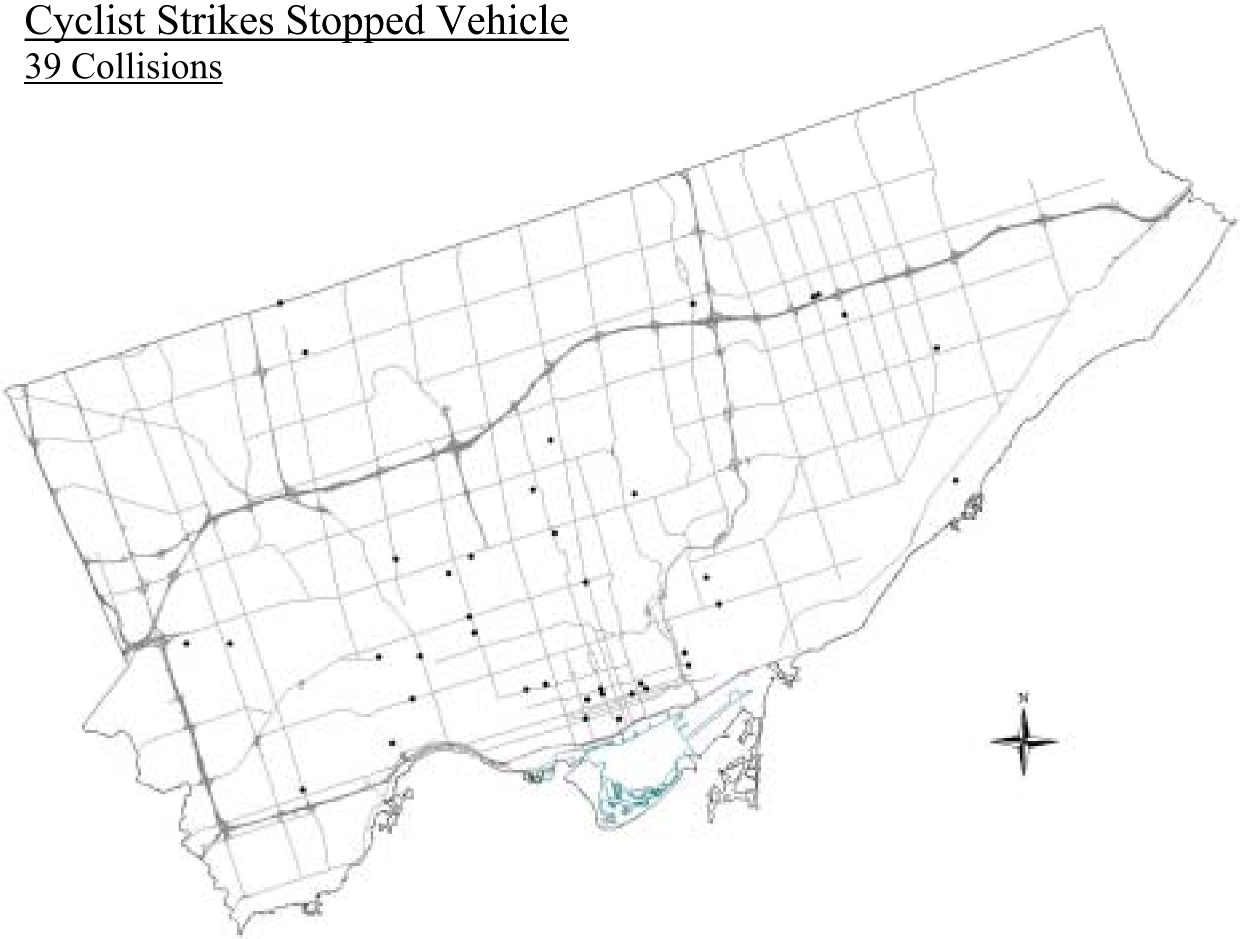
Cyclist's Age



Cyclist's Injuries



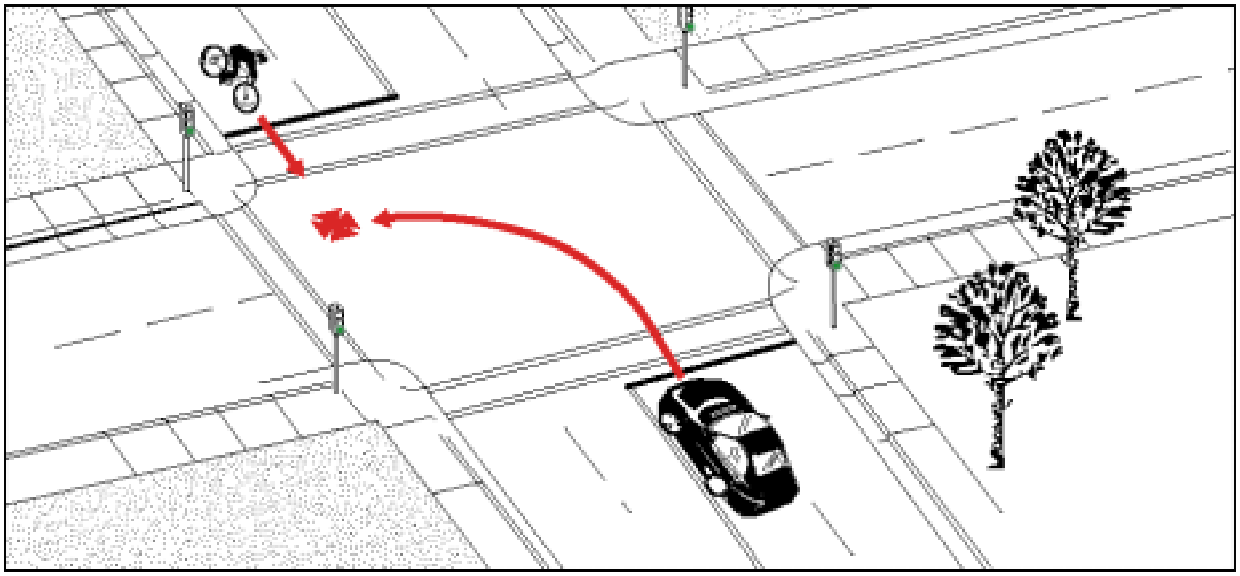
Cyclist Strikes Stopped Vehicle
39 Collisions



Type 8:

Motorist Left Turn - Facing Cyclist

Frequency:	248 cases; 10.7% of all collisions
Severity:	4.8% resulted in major injuries No fatalities



Description: The motorist made a left turn in front of a cyclist approaching from the opposite direction. Only 18% of the cyclists were riding on the sidewalk prior to the collision.

Summary: In comparison to all crashes, this type tended to involve more young adults (ages 20 to 30). Resulting injuries were often significantly more severe than average. Drivers over age 60 were over-represented.

Traffic Control:

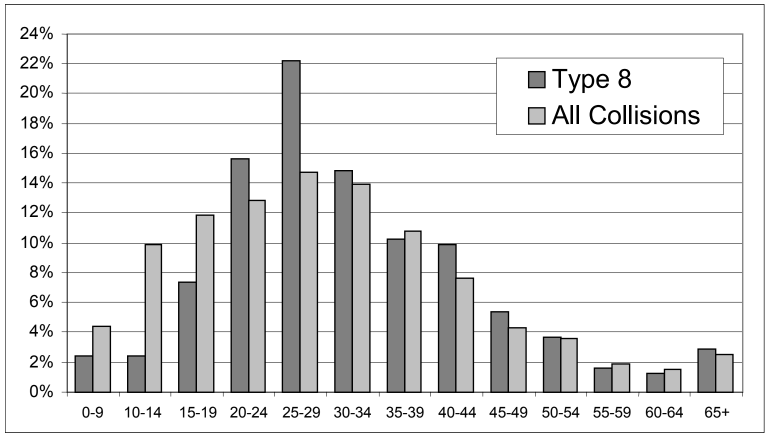
Traffic Signal	41.5%
No Control	39%
Stop Sign	18.5%
Ped. Cross-Over	1%

Geographic Distribution:
More frequent in central areas.

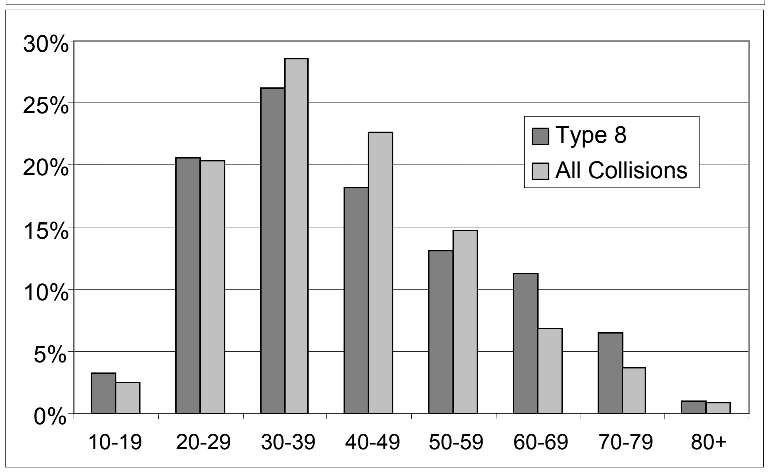
Other Significant Factors:	**Type 8**	**All Collisions**
Darkness	20.2%	14.9%
Sight lines obstructed	7.7%	3.1%
Motorist disobeyed traffic control	2%	1.6%

Type 8: Motorist Left Turn – Facing Cyclist

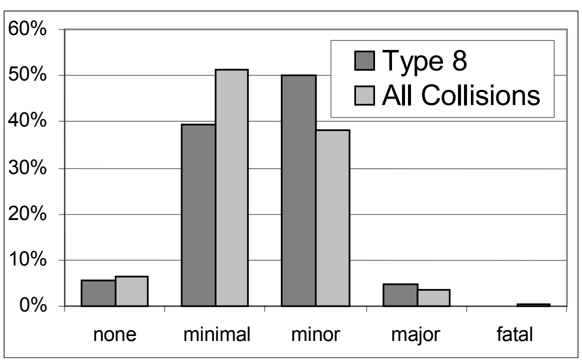
Cyclist's Age



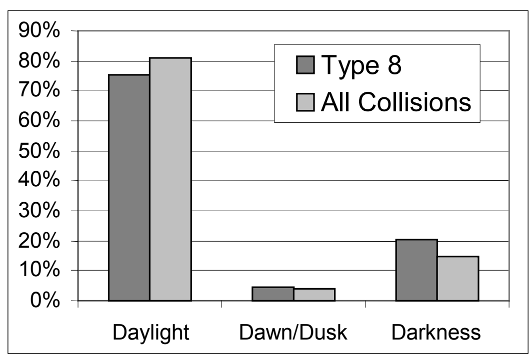
Driver's Age



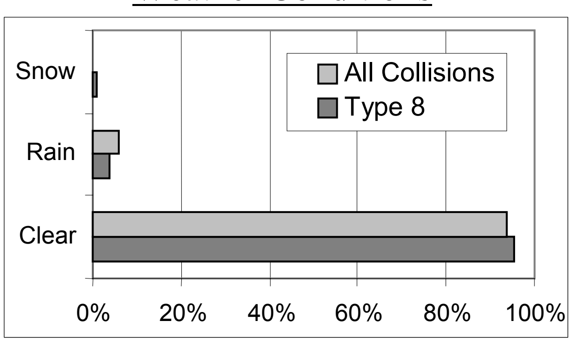
Cyclist's Injuries



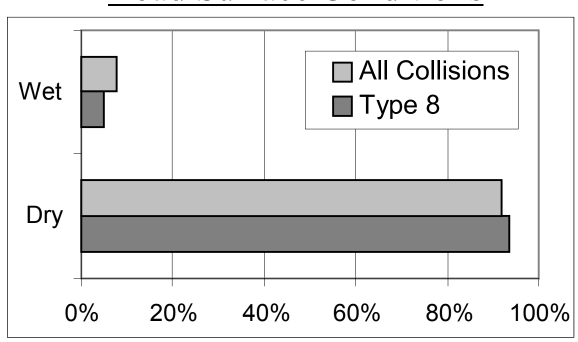
Light Conditions



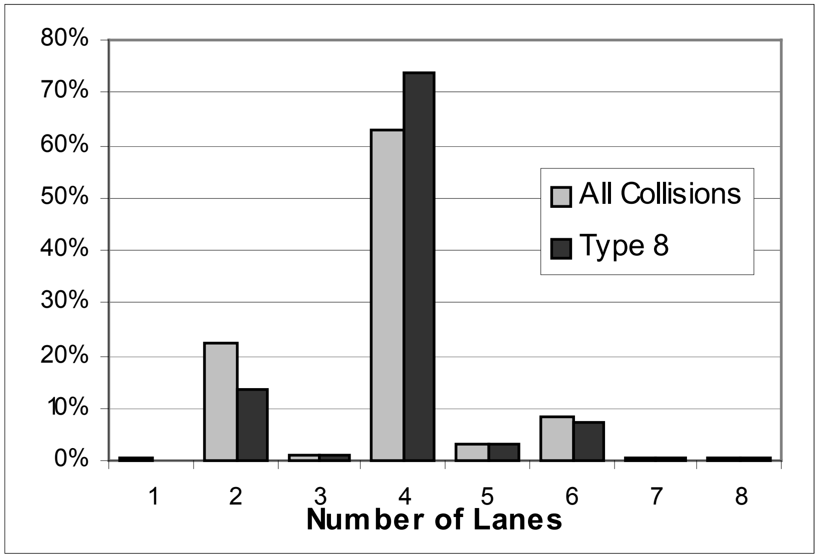
Weather Conditions



Road Surface Conditions

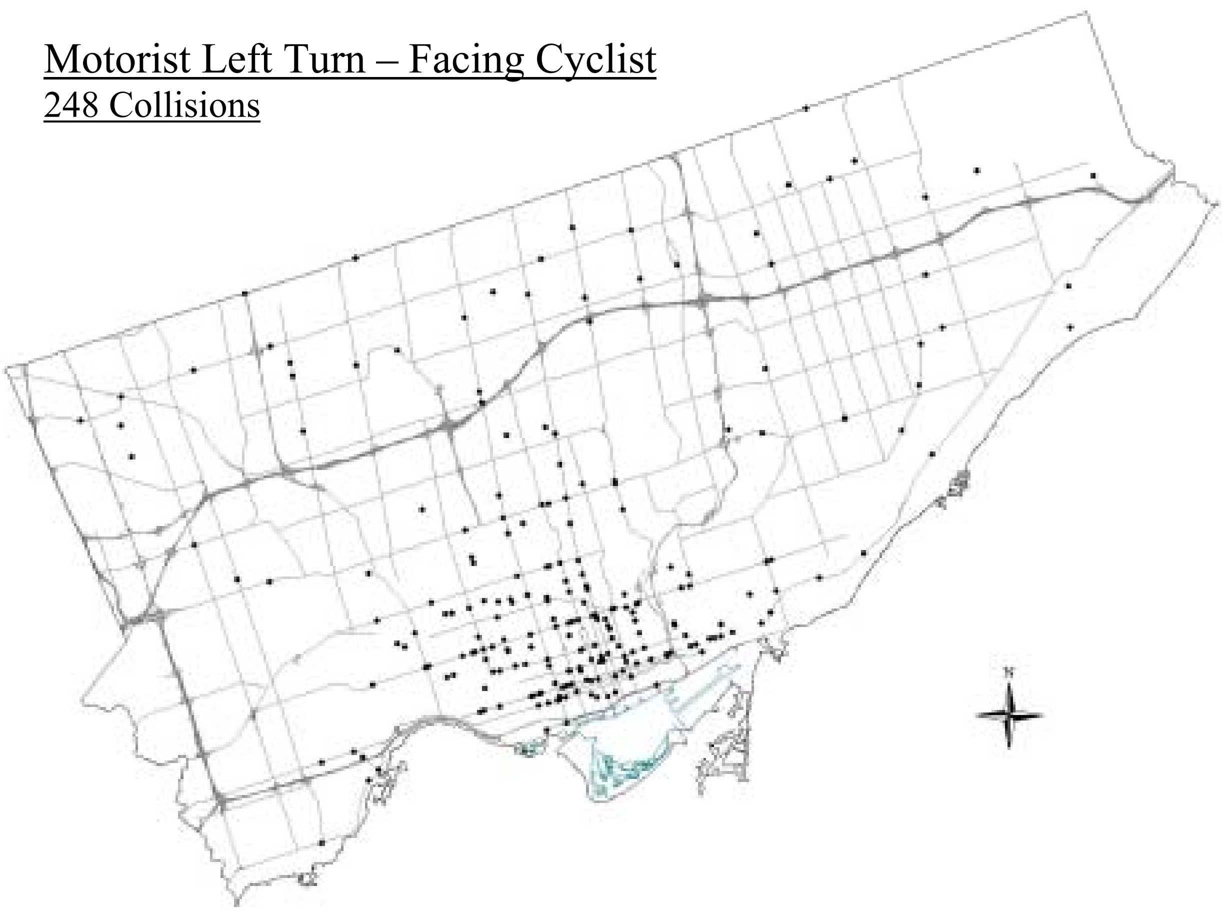


Number of Lanes



Motorist Left Turn – Facing Cyclist

248 Collisions

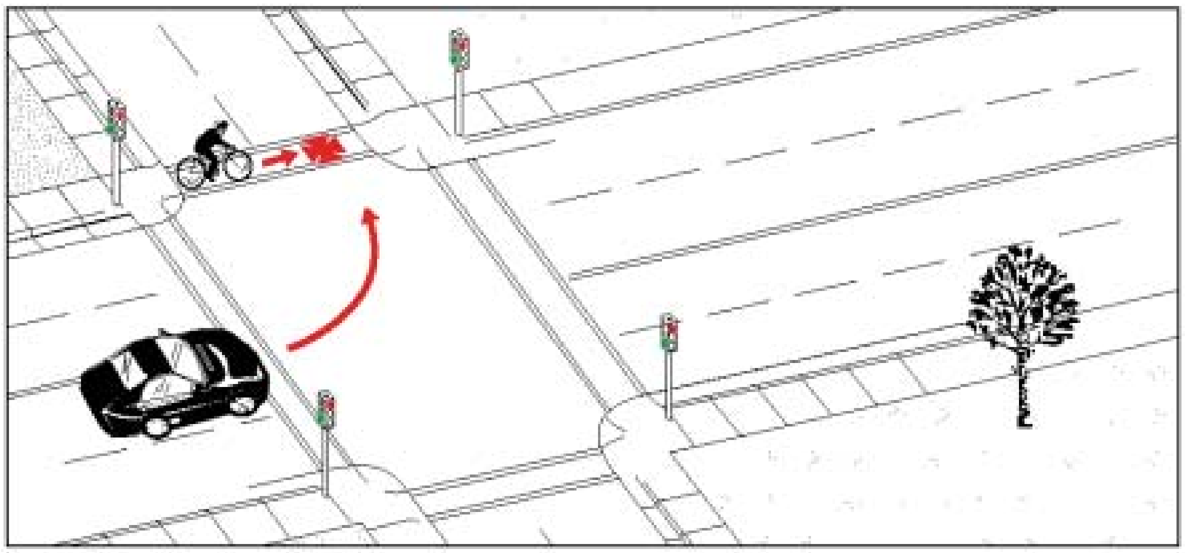


Type 9:

Motorist Left Turn - In Front of Cyclist

Frequency: 48 cases; 2.1% of all collisions

Severity: 2 major injuries (4.3%)
No fatalities



Description: The motorist made a left turn or merged left in front of a cyclist who was traveling in the same direction.

Summary: This crash type seems to involve more youths (age 10 to 15), and slightly more young adult cyclists than average. Injuries were more severe than average, with only one case resulting in no injuries. Drivers in their twenties were over-represented.

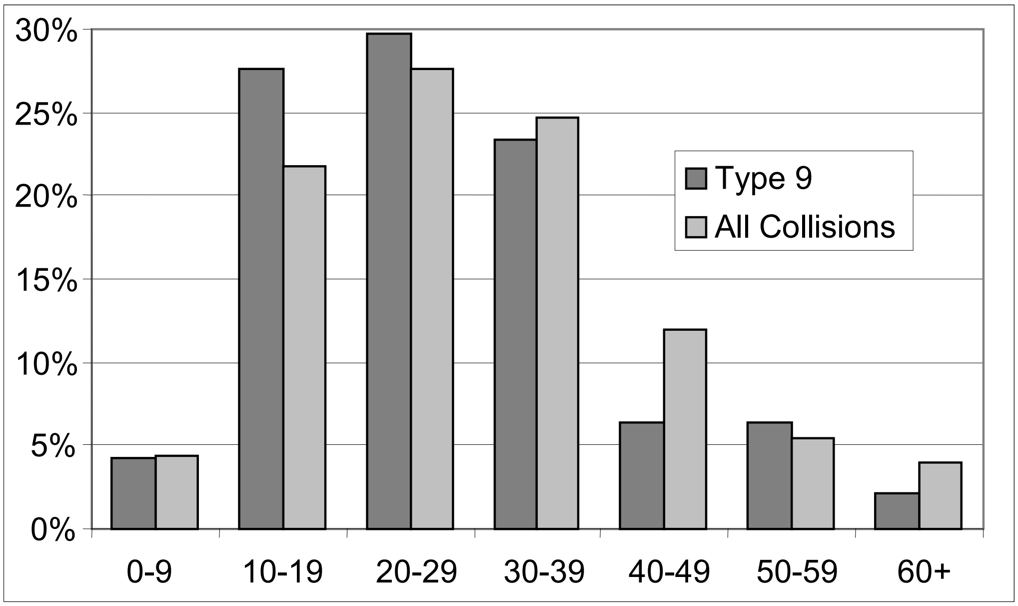
Environmental Conditions:
One in three cases took place in darkness. Wet or snowy road conditions appear to be slightly more frequent for this crash type, but this could be a spurious result, due to the small number of cases.

Note: The small number of cases may reduce the confidence of some statements about this type of crash.

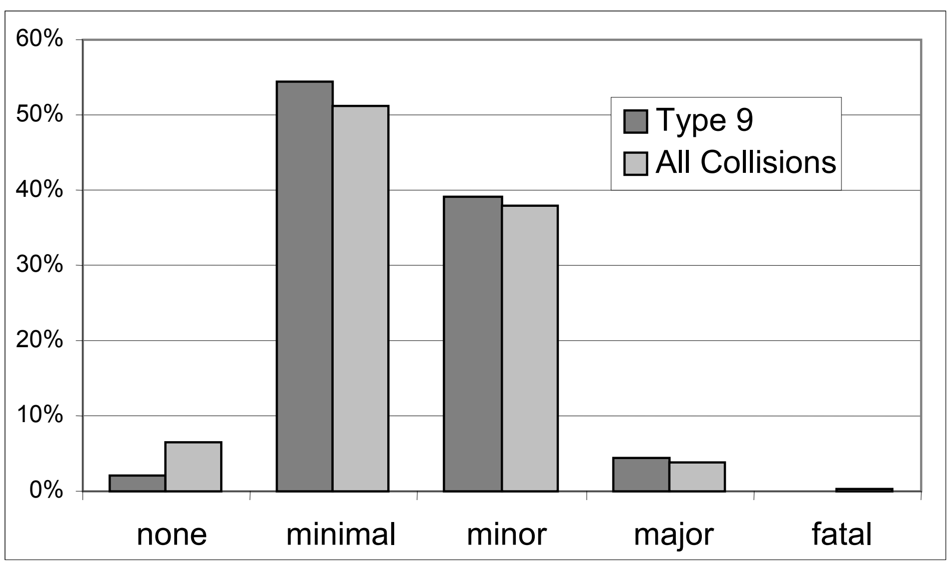
Other Significant Factors:	Type 9	All Collisions
Cyclist riding within crosswalk	48%	30.6%
Darkness	33%	15%
Child cyclist	8.3%	5.7%
Cyclist on wrong side of road	4.2% (2 cases)	1.8%
Motorist unsafe lane change	4.2% (2 cases)	2.9%

Type 9: Motorist Left Turn – In Front of Cyclist

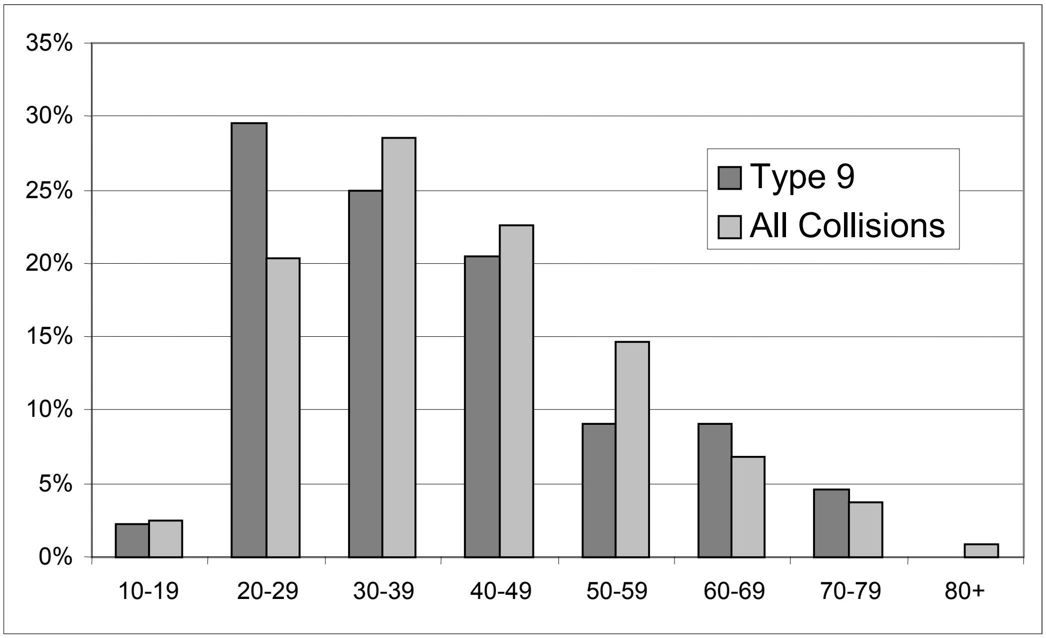
Cyclist's Age



Cyclist's Injuries



Driver's Age

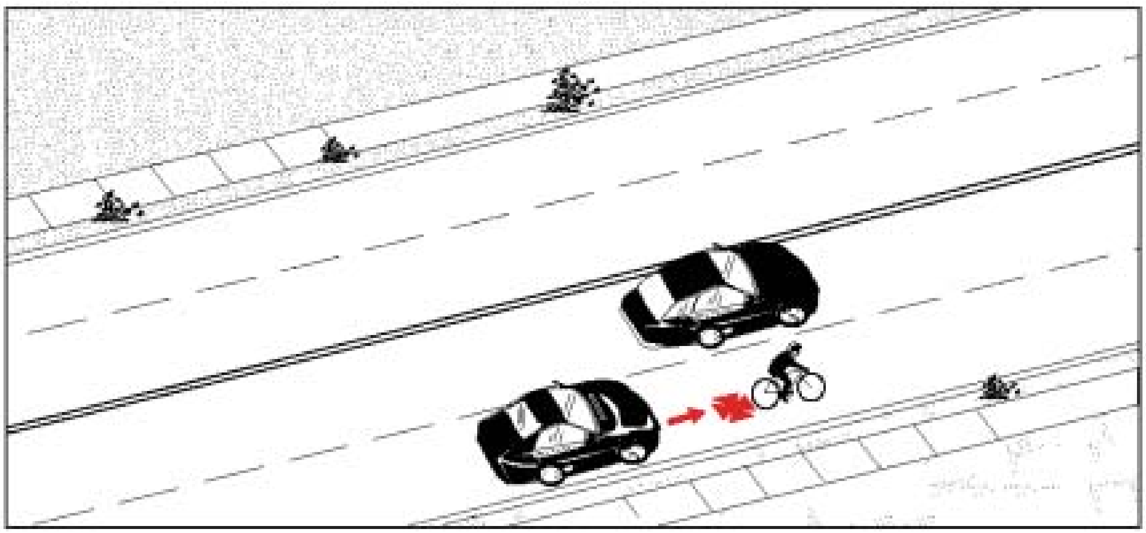


Motorist Left Turn – In Front of Cyclist
48 Collisions

Type 10:

Motorist Overtaking Cyclist

Frequency:	277 cases; 11.9% of all collisions
Severity:	2.7% resulted in major injuries 4 fatalities (out of 10 overall)



Description: Both parties were traveling the same direction. The motorist either brushed by or rear-ended the cyclist.

Summary: In comparison to collisions of all types, this type tended to involve more adult cyclists (age 23 to 37). Resulting injuries were more likely to be either minimal or fatal, with fewer 'in-between' injuries than other types of collisions.

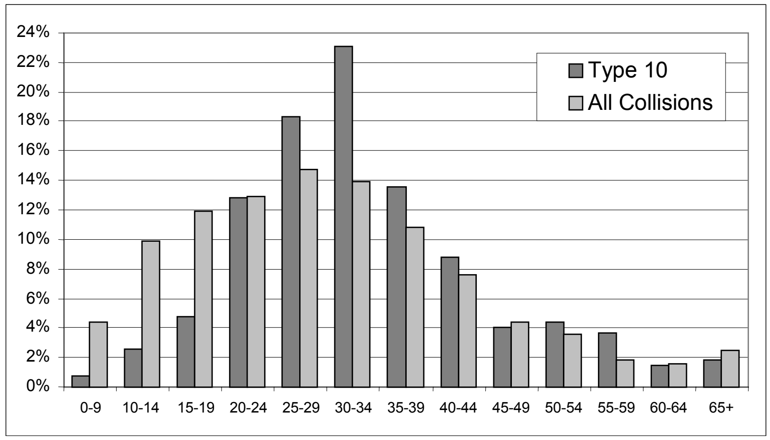
Environmental Conditions:
Light and weather conditions do not appear to have been significant factors in this type of crash.

Geographic Distribution:
Much more frequent in central areas.

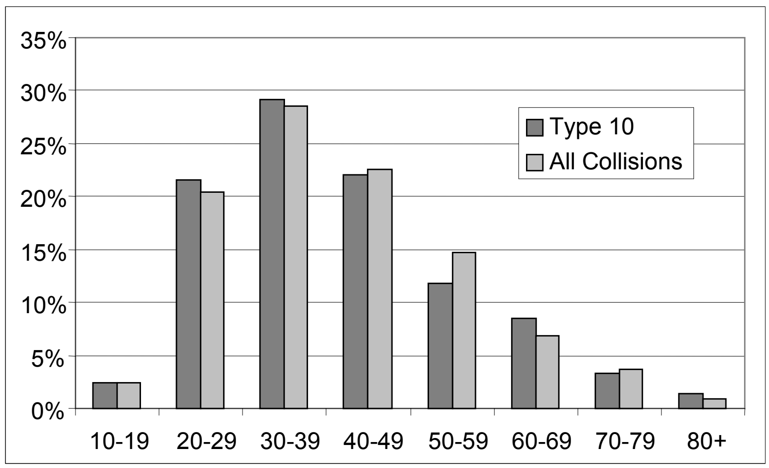
Other Significant Factors:	Type 10	All Collisions
Motorist unsafe/improper lane-change	16%	2.9%
Motorist misjudged passing space	13.4%	1.6%
Cyclist's path obstructed	4.0	0.7%
Vehicular assault (6 of 16 cases overall)	2.2%	0.7%
Taxi	7.6%	3.1%

Type 10: Motorist Overtaking Cyclist

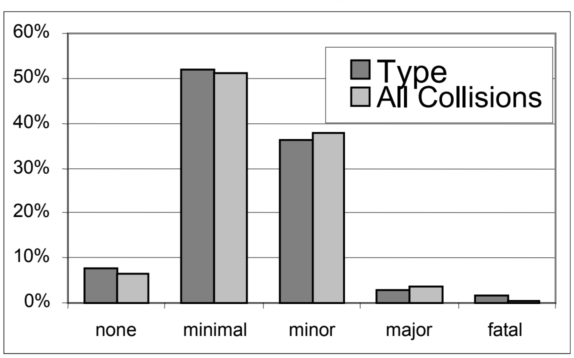
Cyclist's Age



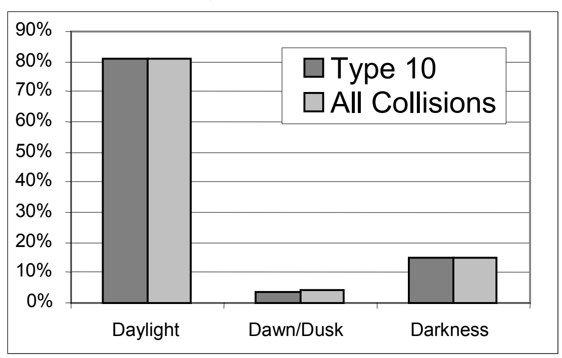
Driver's Age



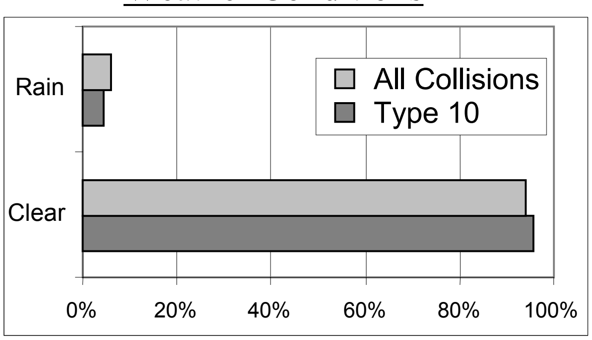
Cyclist's Injuries



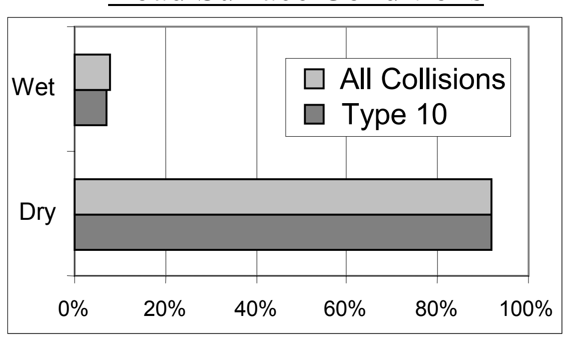
Light Conditions



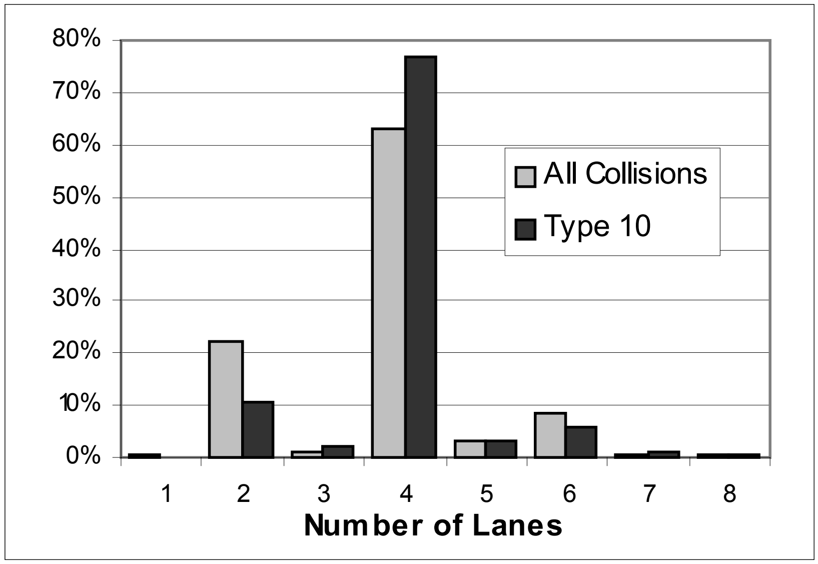
Weather Conditions



Road Surface Conditions



Number of Lanes



Motorist Overtaking Cyclist

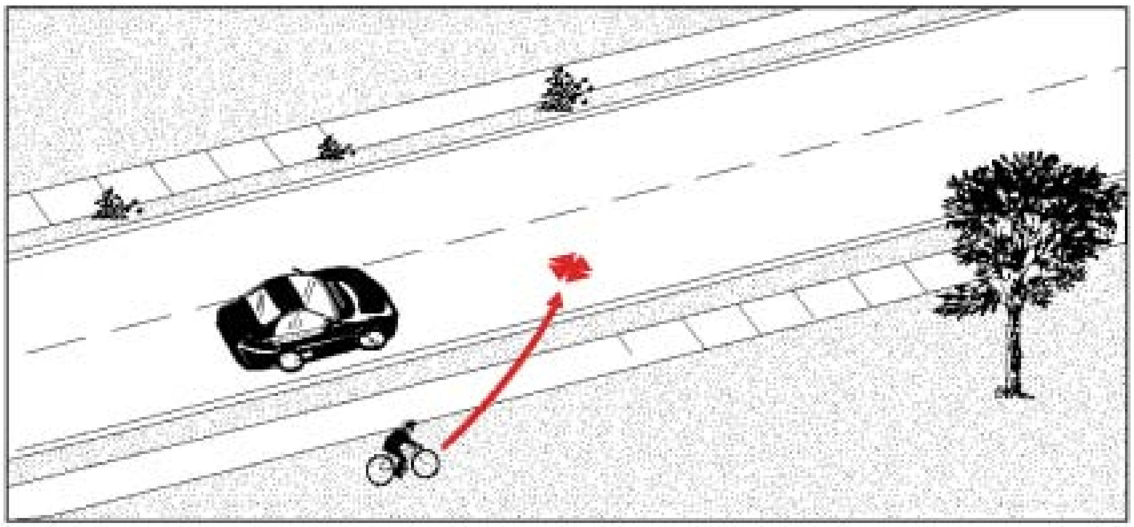
278 Collisions

Type 11:

Ride Out At Mid-Block

Frequency: 51 cases; 2.2% of all collisions

Severity: 8% resulted in major injuries
1 fatality



Description: The cyclist entered the roadway from the sidewalk, not at an intersection.

Summary: In comparison to all crashes, this type tended to involve more young cyclists (under 15). Resulting injuries were generally more severe than average. Drivers in their thirties seem to be over-represented.

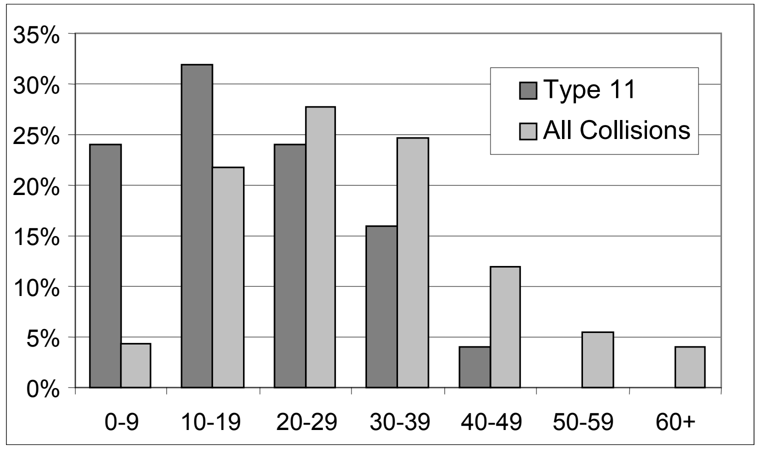
Environmental Conditions: Poor visibility or road conditions were not significant factors in these crashes.

Note: The small number of cases may limit the confidence of some statements about this type of crash.

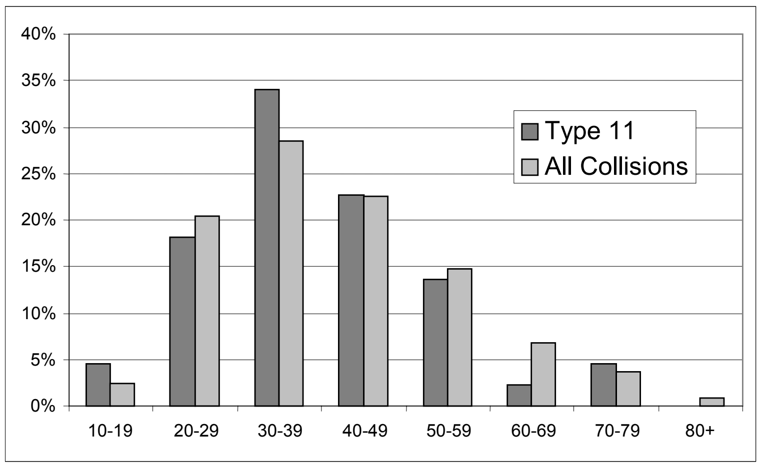
Other Significant Factors:	Type 11	All Collisions
Child cyclist	31.4%	5.7%
Sight lines obstructed	5.9%	3.1%

Type 11: Ride Out at Mid-Block

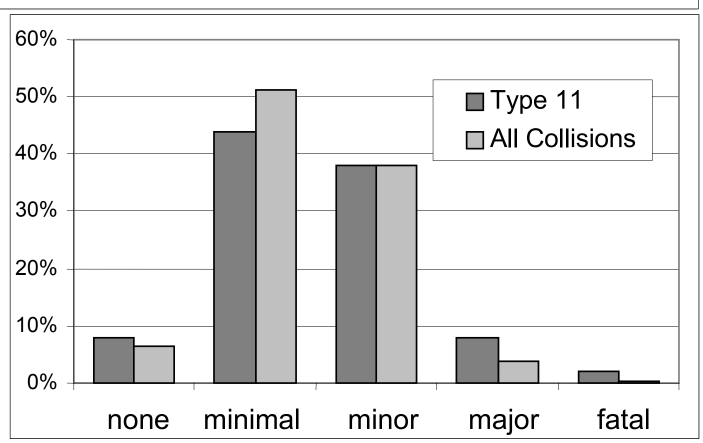
Cyclist's Age



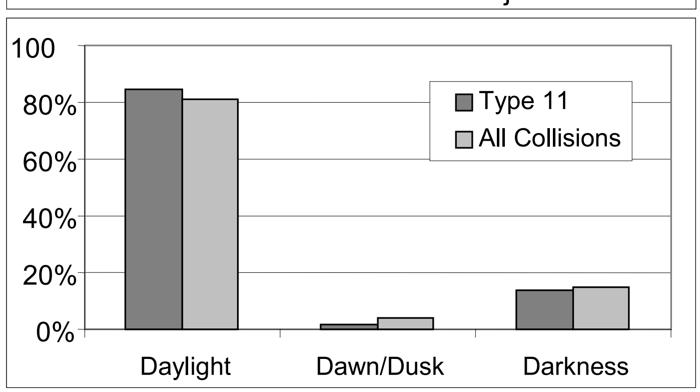
Driver's Age



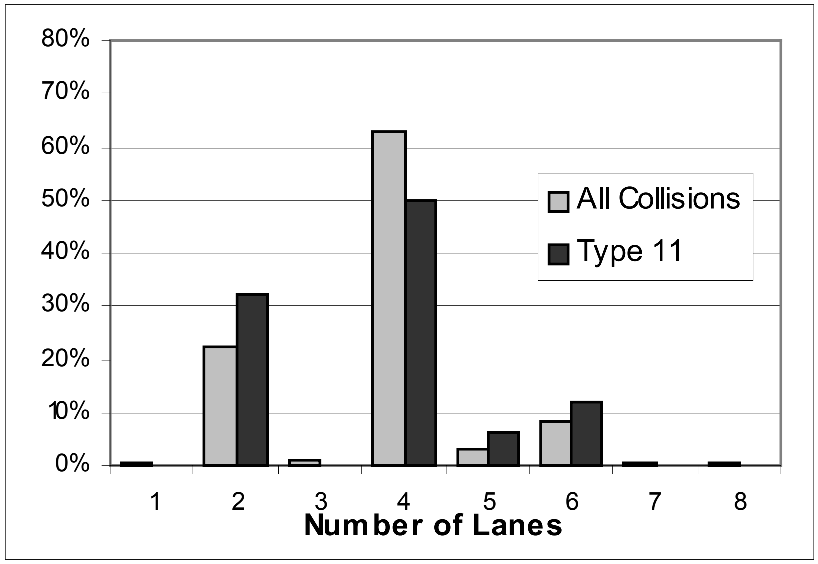
Cyclist's Injuries



Light Conditions

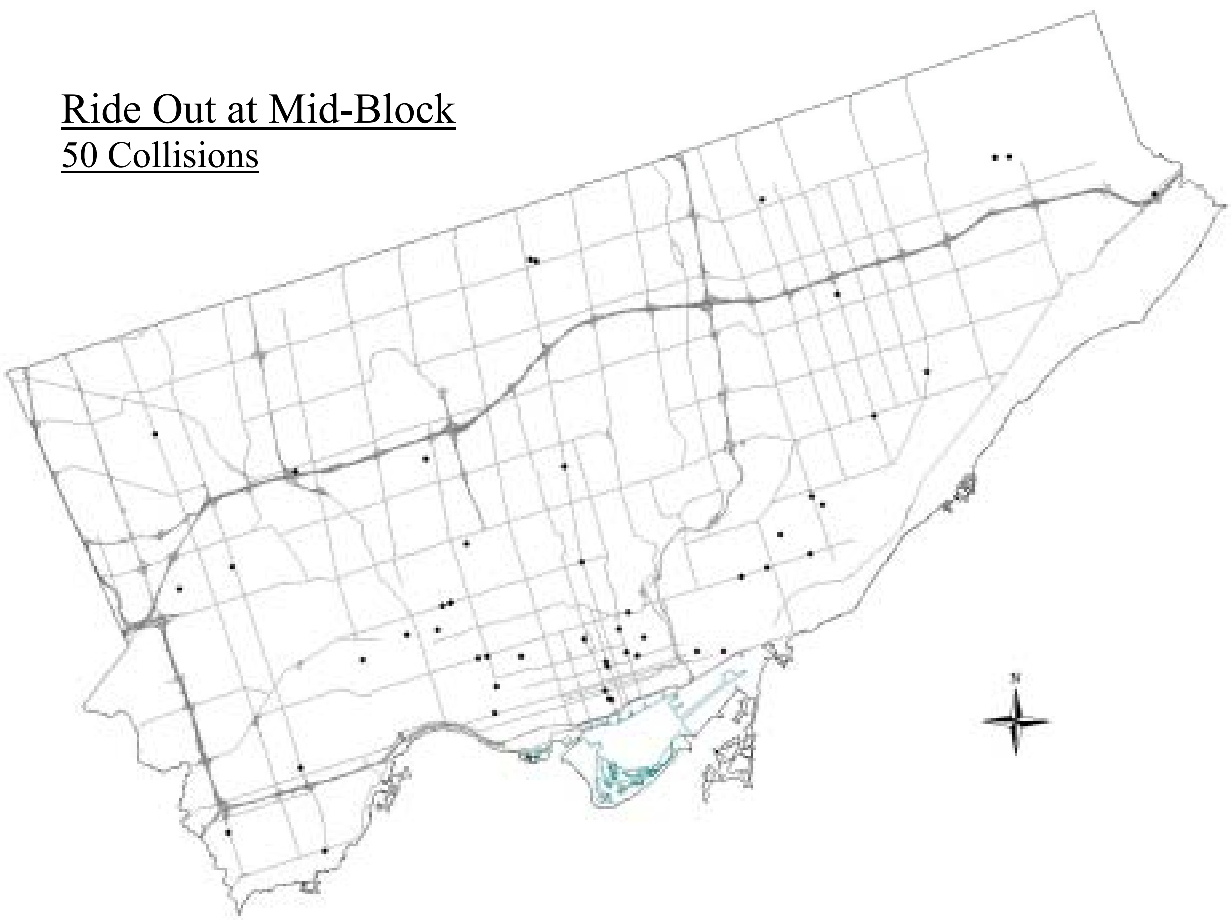


Number of Lanes



Ride Out at Mid-Block

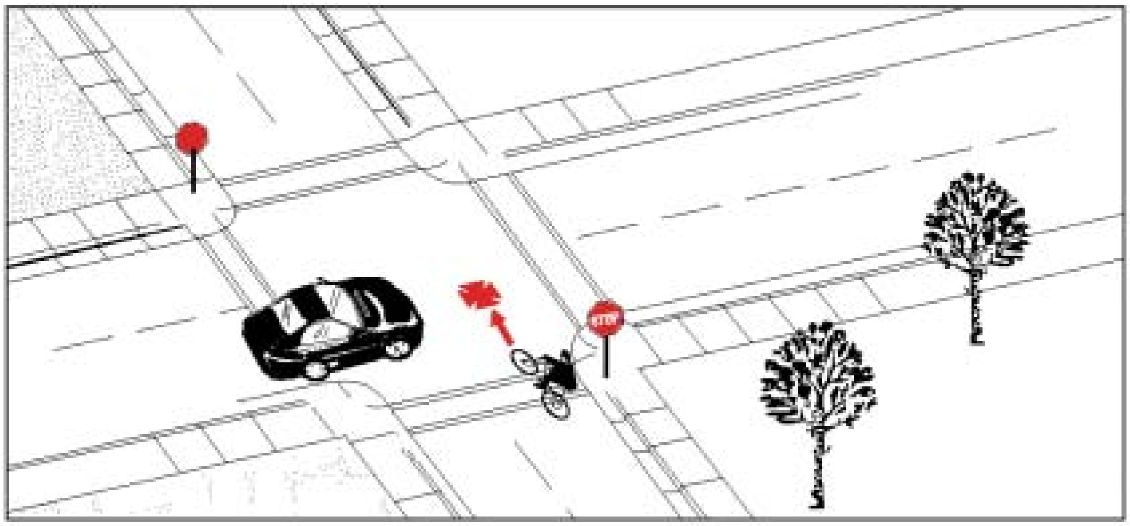
50 Collisions



Type 12:

Ride Out At Controlled Intersection

Frequency:	65 cases; 2.8% of all collisions
Severity:	3 major injuries (5.3%) 2 fatalities (2.5%)



Description: The cyclist failed to stop, or proceeded into the intersection before it was safe, and collided with a motor vehicle.

Summary: Children under 15 were more frequently involved in this type of collision, as well as adults over 65. Injuries were only slightly more severe than average, but there were two fatalities, out of only 65 cases. Drivers in their forties appear to be under-represented.

Traffic Control:

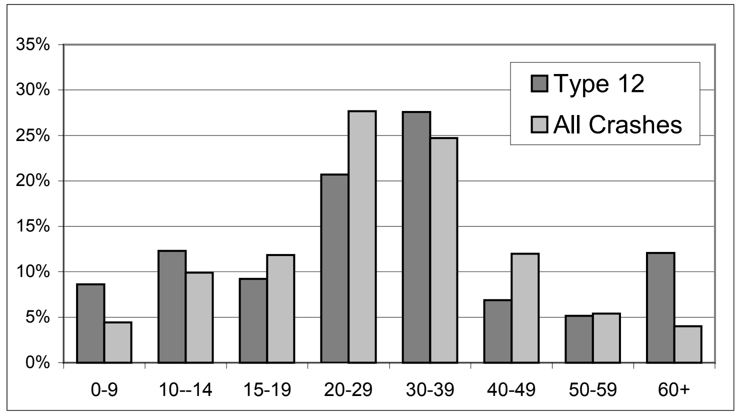
Stop Sign	62%
Traffic Signal	34%
Ped. Cross-Over	3%

Geographic Distribution:
More frequent in central areas.

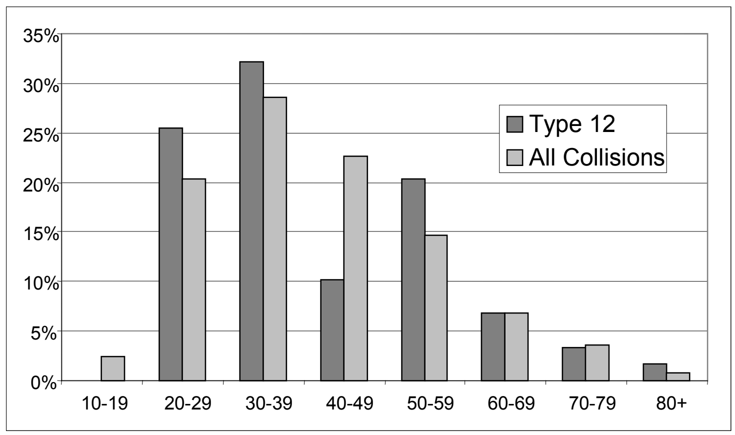
Other Significant Factors:	Type 12	All Collisions
Cyclist disobeyed traffic control	25%	1.9%
Darkness	16.4%	14.9%
Child cyclist	12.3%	5.7%

Type 12: Ride Out at Controlled Intersection

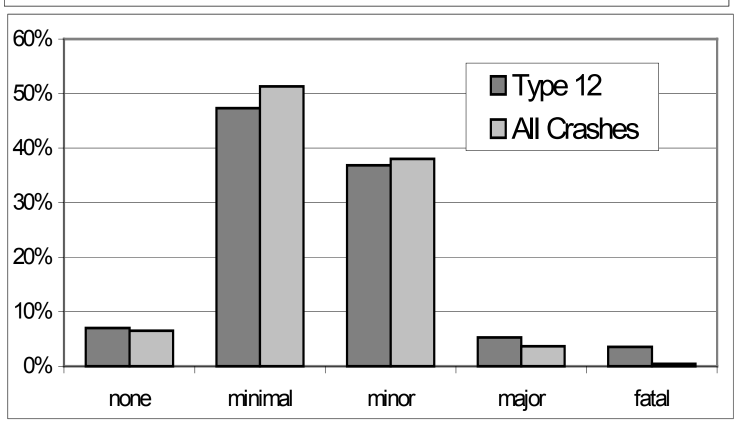
Cyclist's Age



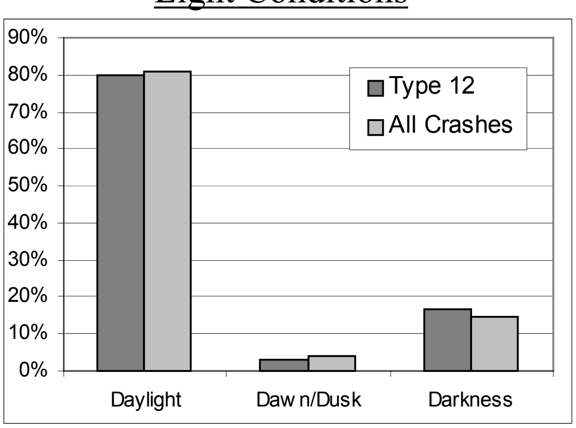
Driver's Age



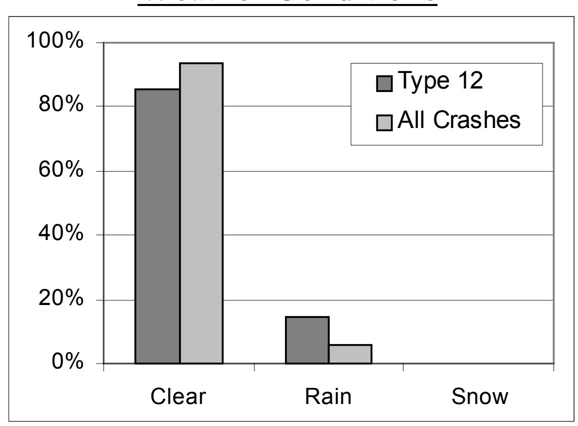
Cyclist's Injuries



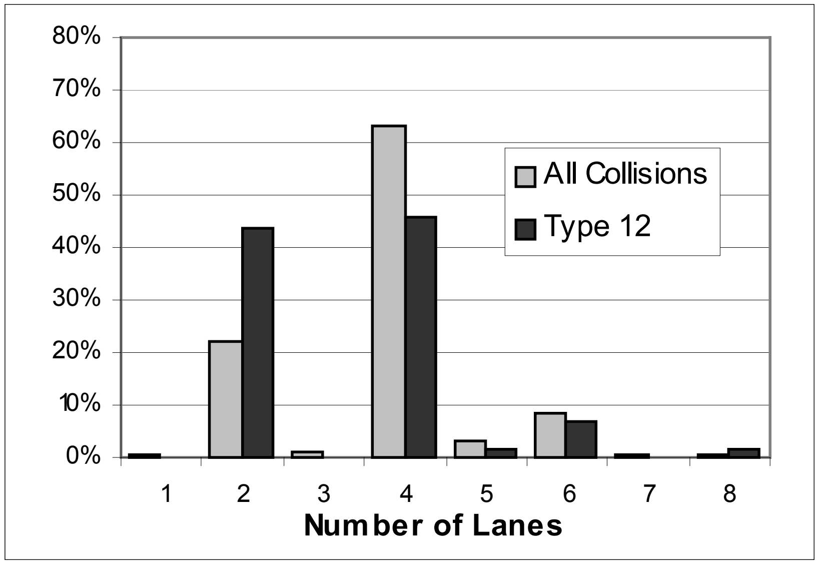
Light Conditions



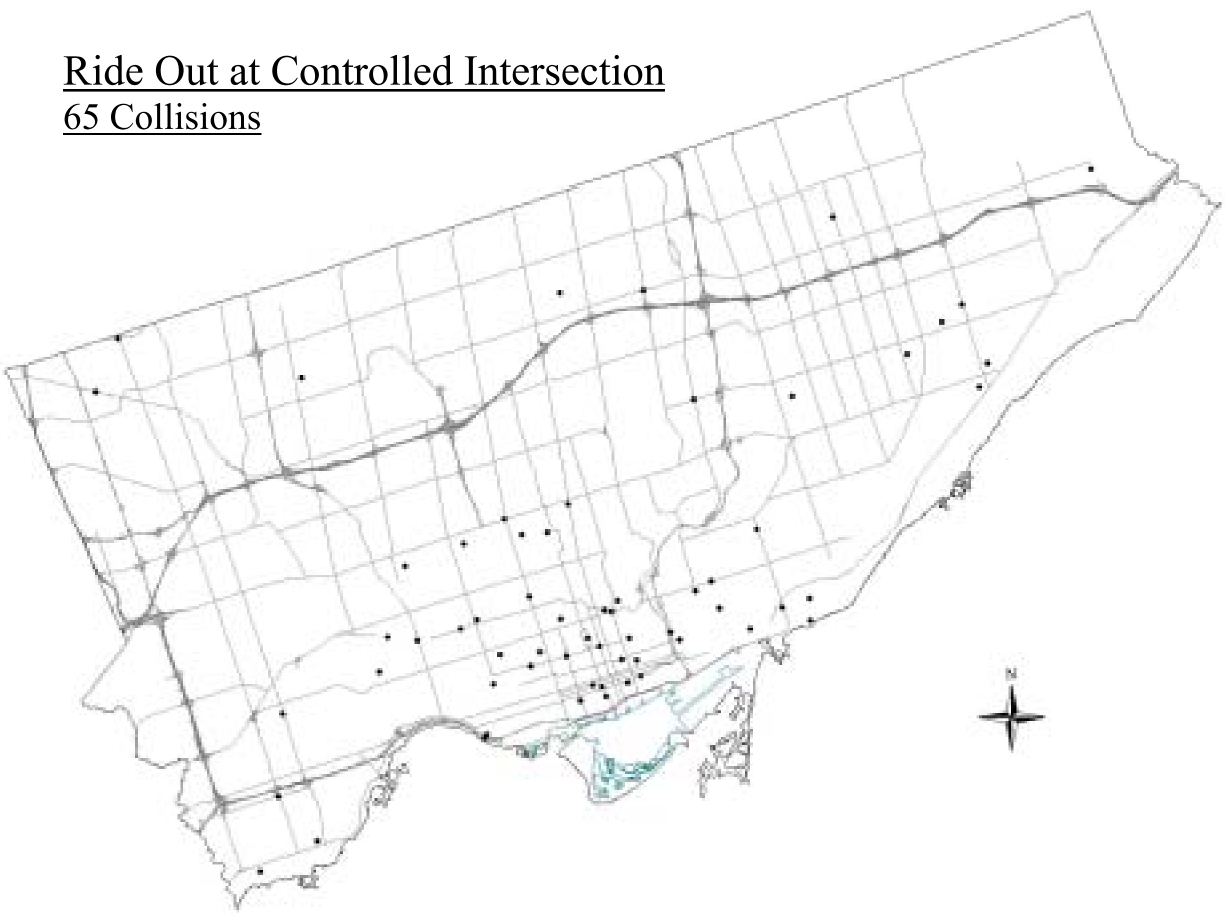
Weather Conditions



Number of Lanes



Ride Out at Controlled Intersection
65 Collisions

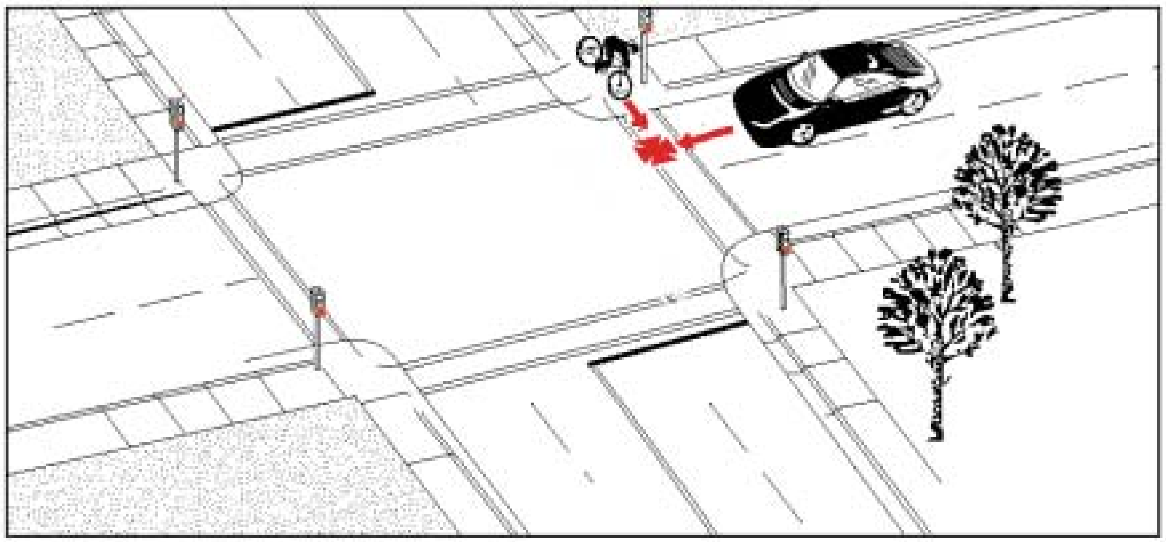


Type 13:

Ride Out From Sidewalk (at Intersection)

Frequency: 44 cases; 1.9% of all collisions

Severity: 11.6% resulted in major injuries
No fatalities



Description: The cyclist entered an intersection from the sidewalk, against the right of way.

Summary: In comparison to all crashes, this type tended to involve more young cyclists (under 18). Resulting injuries were slightly more severe than average. Drivers in their sixties may be over-represented, but the small number of cases limits the certainty of this statement.

Traffic Control:

Traffic Signal	59%
Stop Sign	33%
No Control	13.6%
Ped. Cross-Over	4.5%

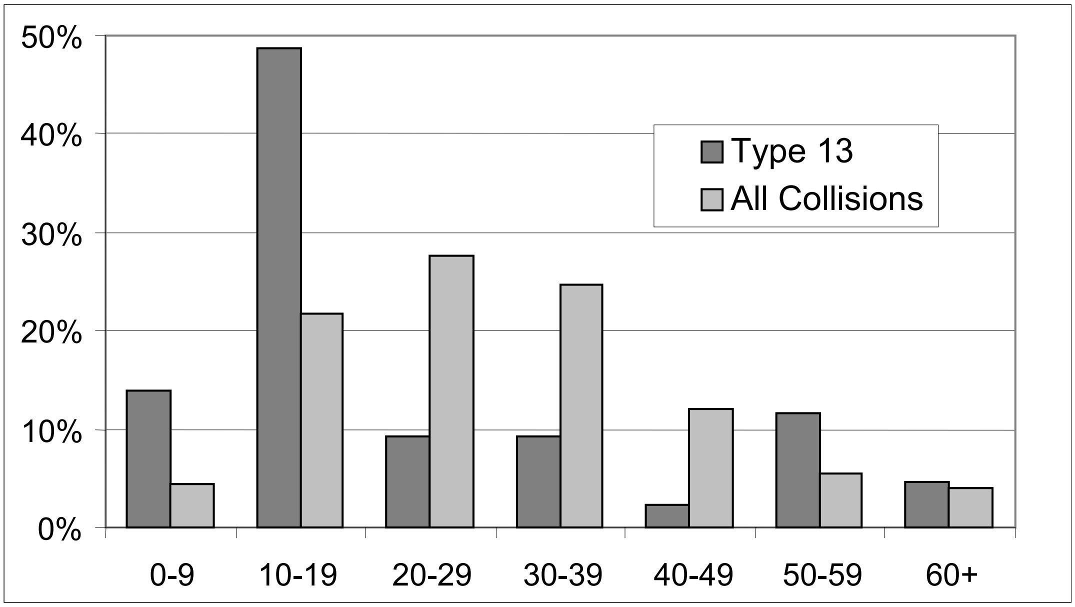
Environmental Conditions:
Darkness, poor weather and wet road conditions were not frequent factors.

Geographic Distribution:
More frequent in outer areas.

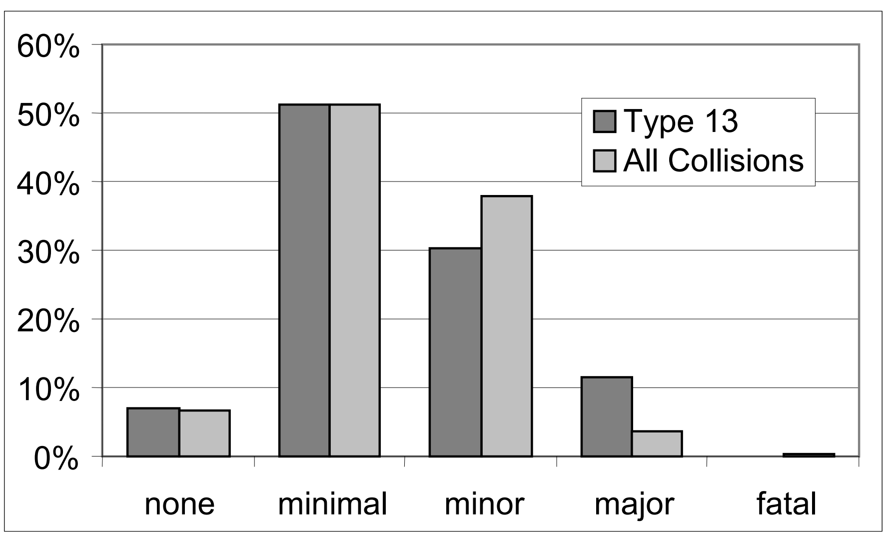
Other Significant Factors:	Type 13	All Collisions
Cyclist disobeyed traffic control	27%	1.9%
Child cyclist	25%	5.7%
Sight lines obstructed	11.4%	3.1%

Type 13: Ride Out From Sidewalk – At Intersection

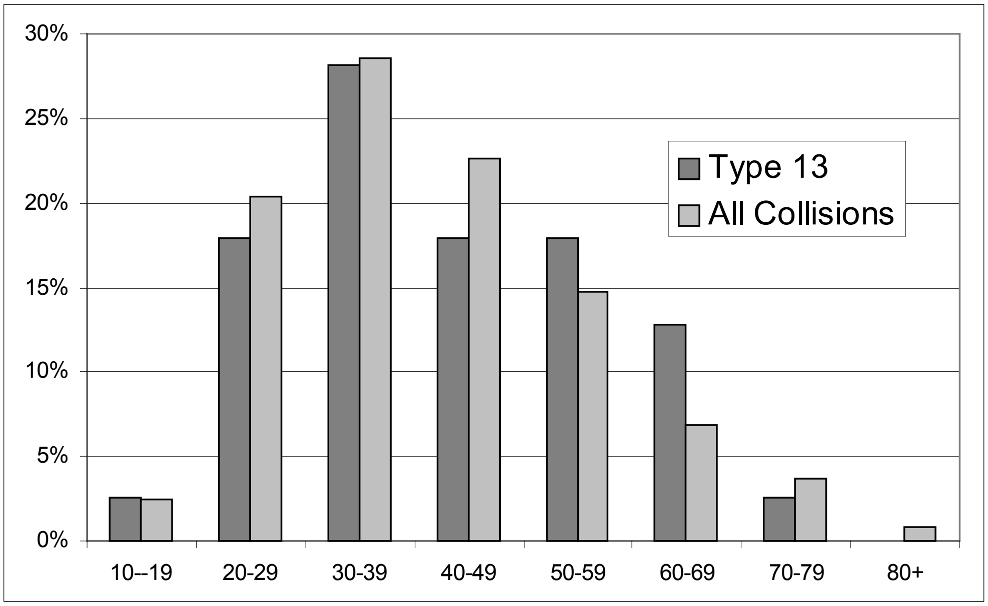
Cyclist's Age



Cyclist's Injuries

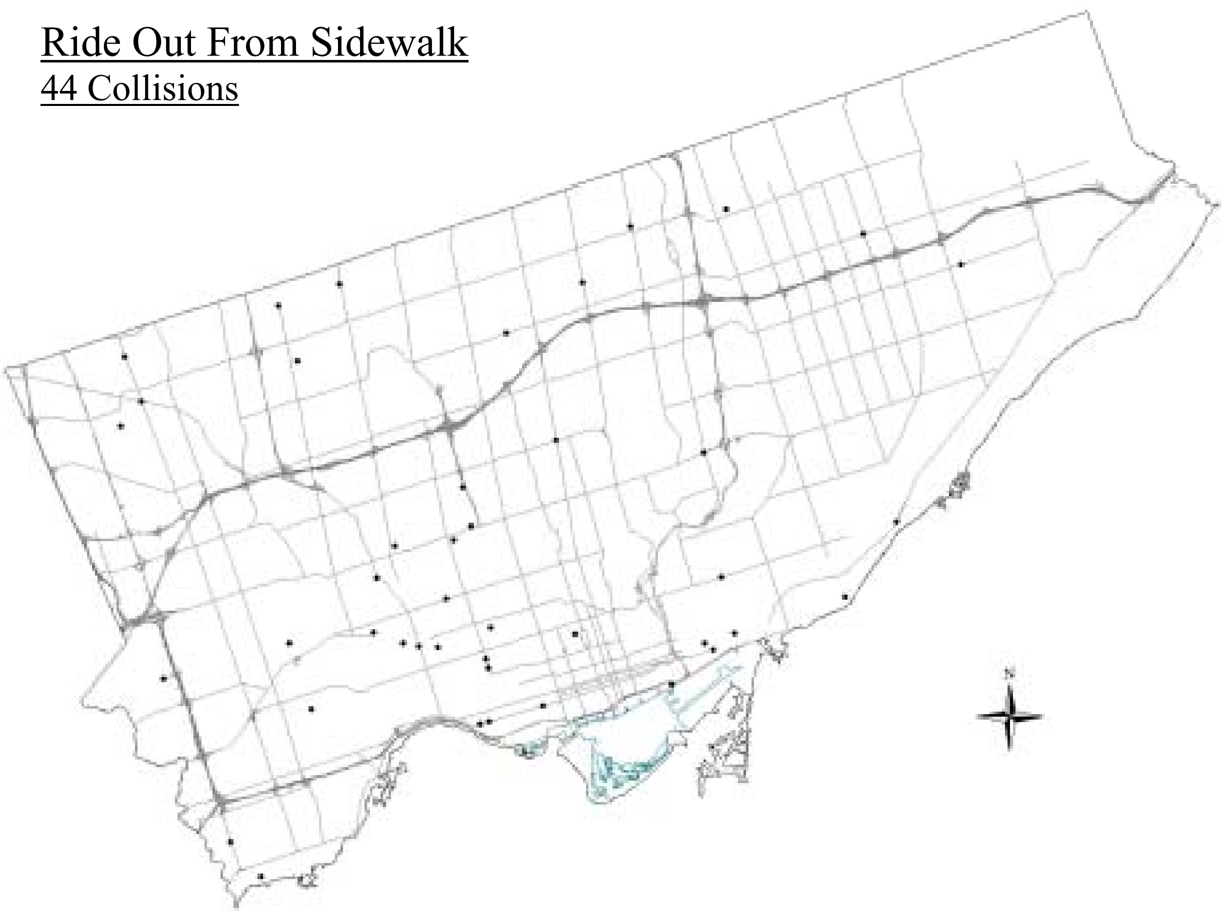


Driver's Age



Ride Out From Sidewalk

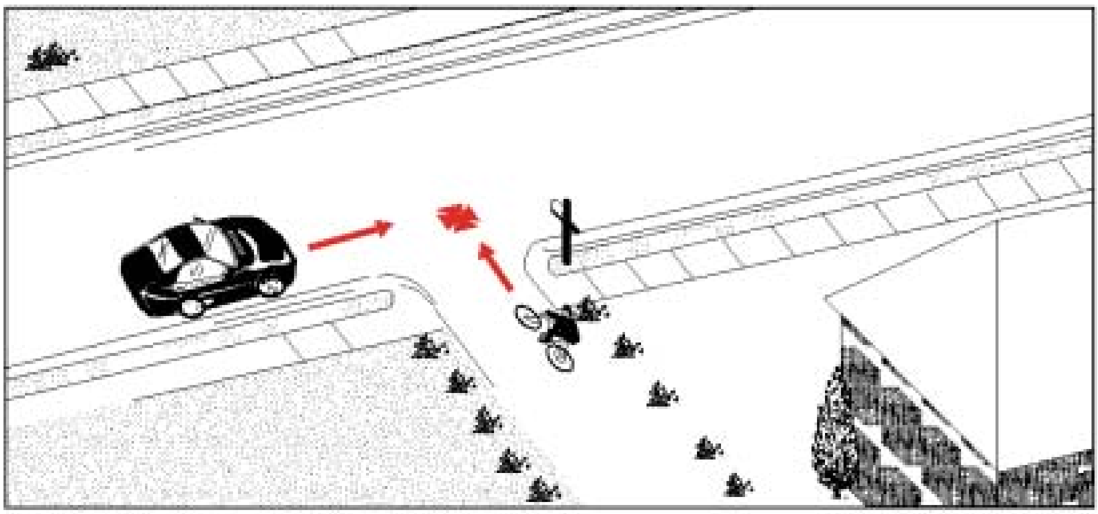
44 Collisions



Type 14:

Ride Out From Lane or Driveway

Frequency:	29 cases; 1.3% of all collisions
Severity:	1 major injury (4.3%) No fatalities



Description: The cyclist was emerging onto the roadway from a private or commercial driveway, or a lane. While the cyclist may have been initiating a turn, the turning movement was not considered the primary factor in the collision.

Summary: Almost all the cyclists in this type of collision were under 16. Resulting injuries seem to be more severe than average.

Environmental Conditions: Weather, light and road conditions were not factors in these crashes.

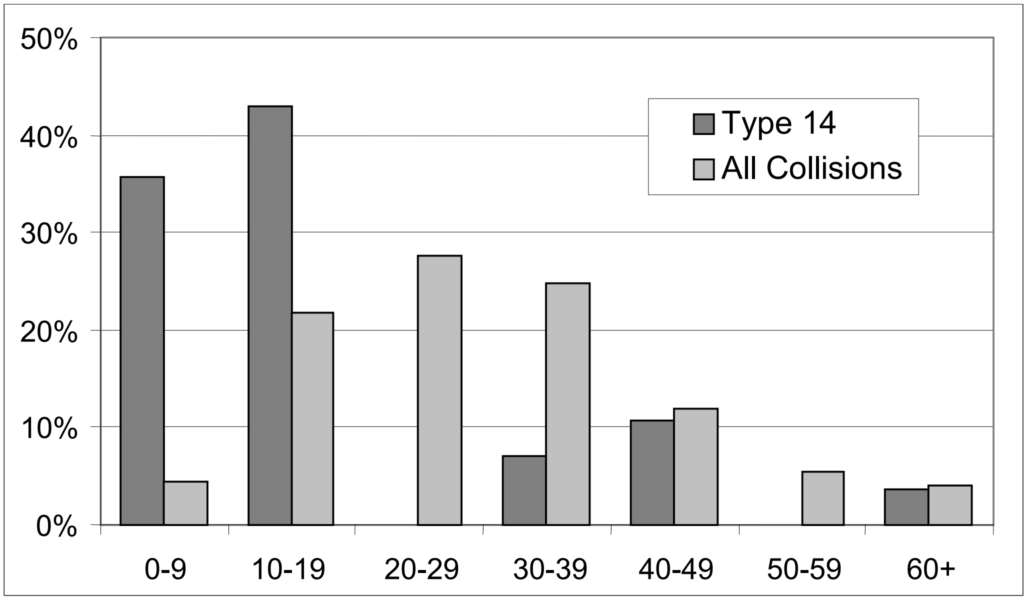
Geographic Distribution: Most occurred just outside core area.

Note: The small number of cases limits the confidence of some statements about this type of crash.

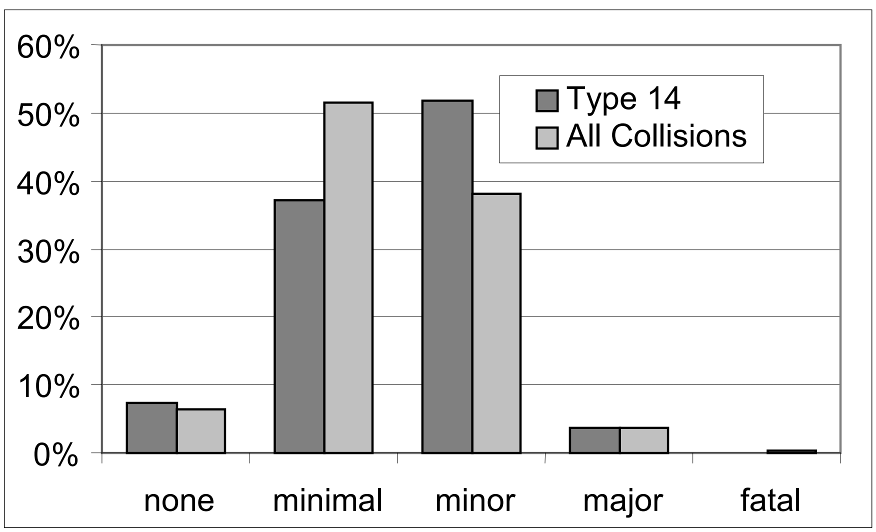
Other Significant Factors:	Type 14	All Collisions
Child cyclist	41.4%	5.7%
Sight lines obstructed	13.8%	3.1%

Type 14: Ride Out from Lane or Driveway

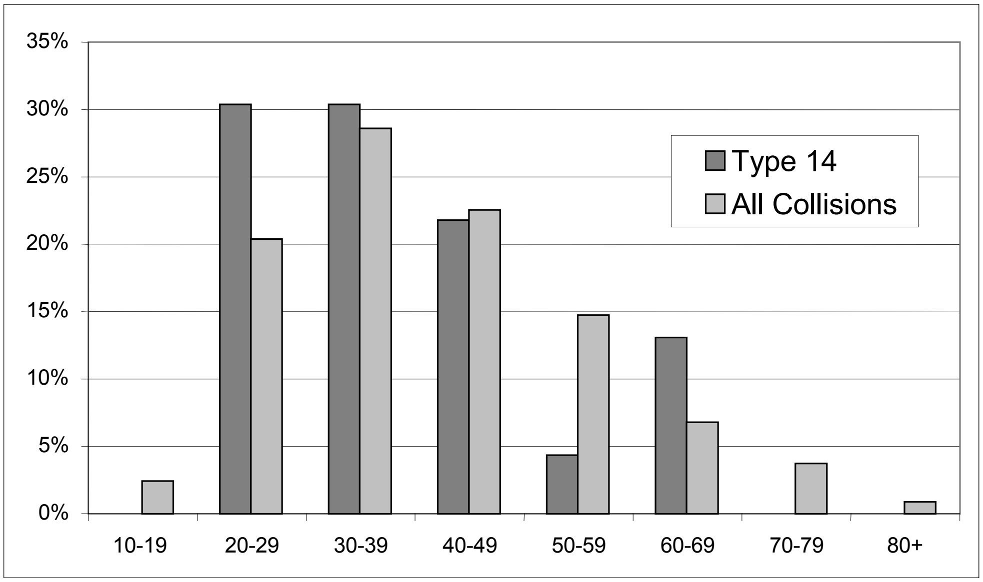
Cyclist's Age



Cyclist's Injuries



Driver's Age

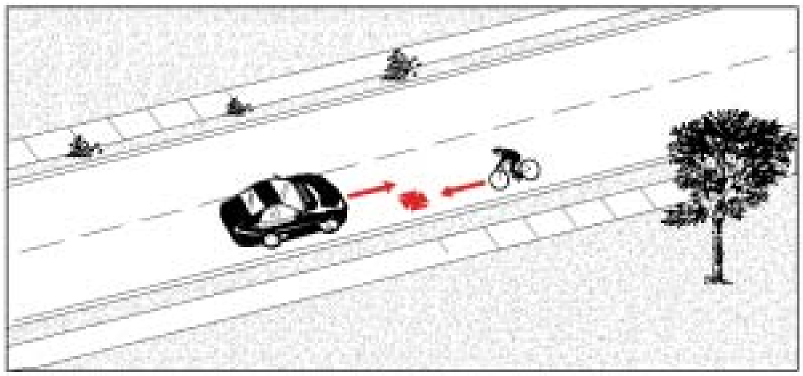


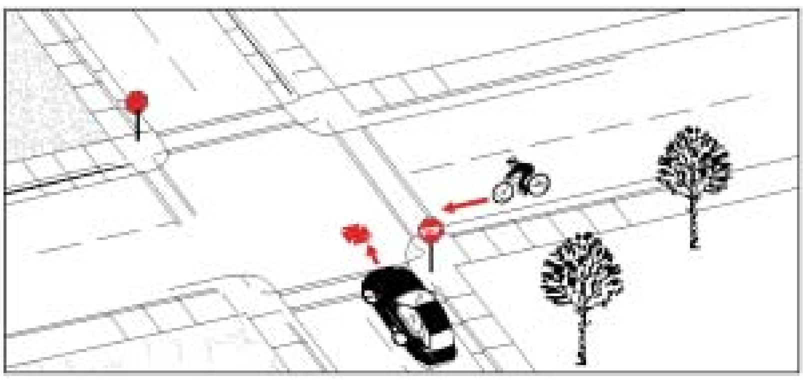
Ride Out From Lane or Driveway
29 Collisions

Type 15:

Wrong Way Cyclist

Frequency:	59 cases; 2.5% of all collisions
Severity:	2 major injuries (3.6%) No fatalities





Description: The cyclist was riding against the flow of traffic. This was considered the primary factor, regardless of other vehicle maneouvres involved.

Summary: This type of collision involved no children under 10. Adults over 60 were more frequently involved than average. Resulting injuries were generally less severe than the average injuries for all crashes. Drivers over age 50 under-represented.

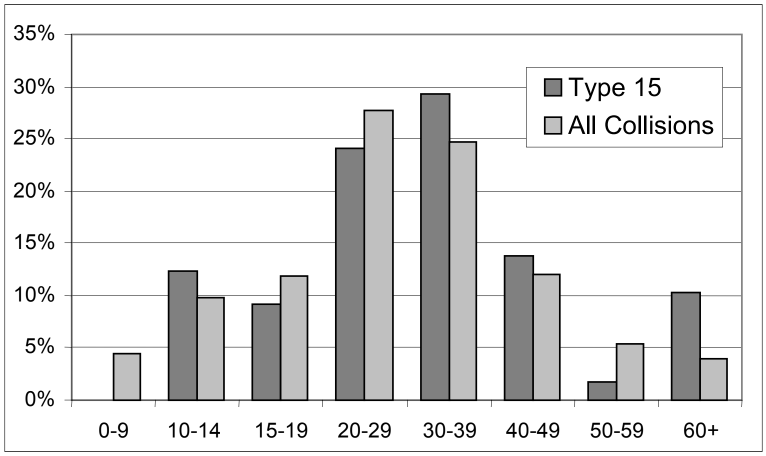
Environmental Conditions: All cases took place in clear dry weather. Darkness may have been a contributing factor in 11 cases.

Geographic Distribution: More frequent in central areas.

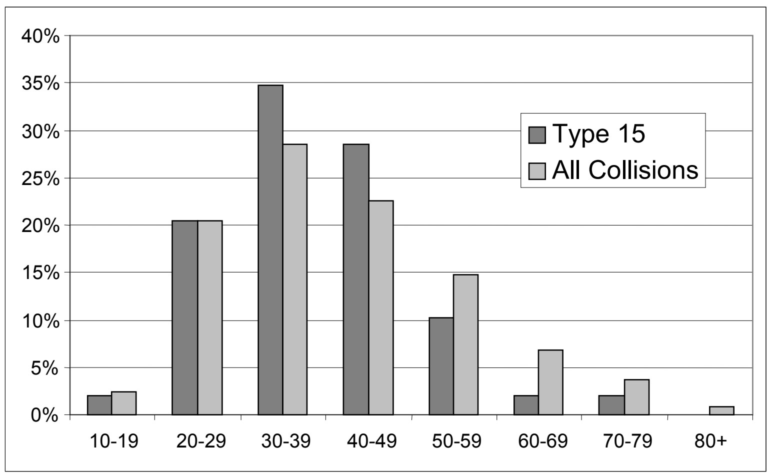
Other Significant Factors:	Type 15	All Collisions
Darkness	18.6%	14.9%
Sight lines obstructed	5.1%	3.1%

Type 15: Wrong Way Cyclist

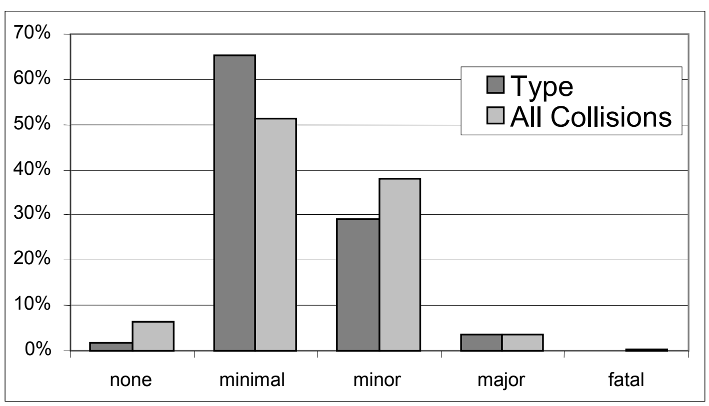
Cyclist's Age



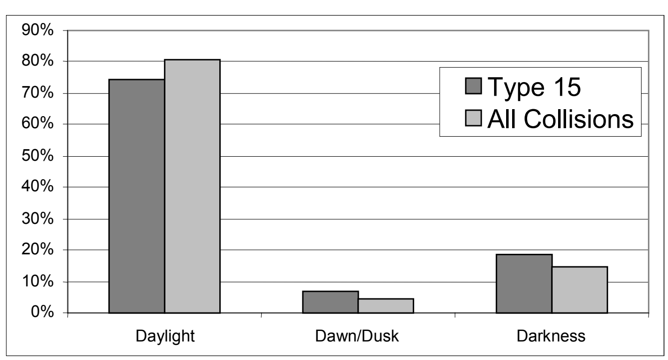
Driver's Age



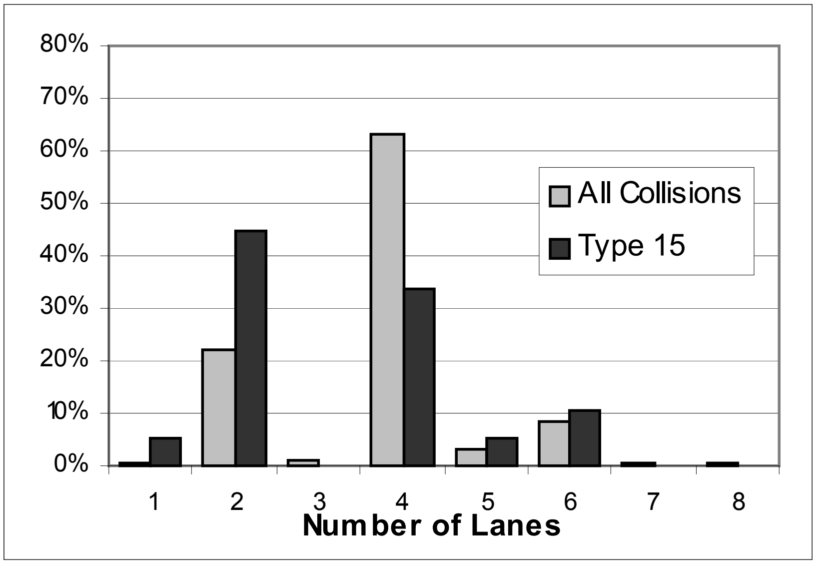
Cyclist's Injuries



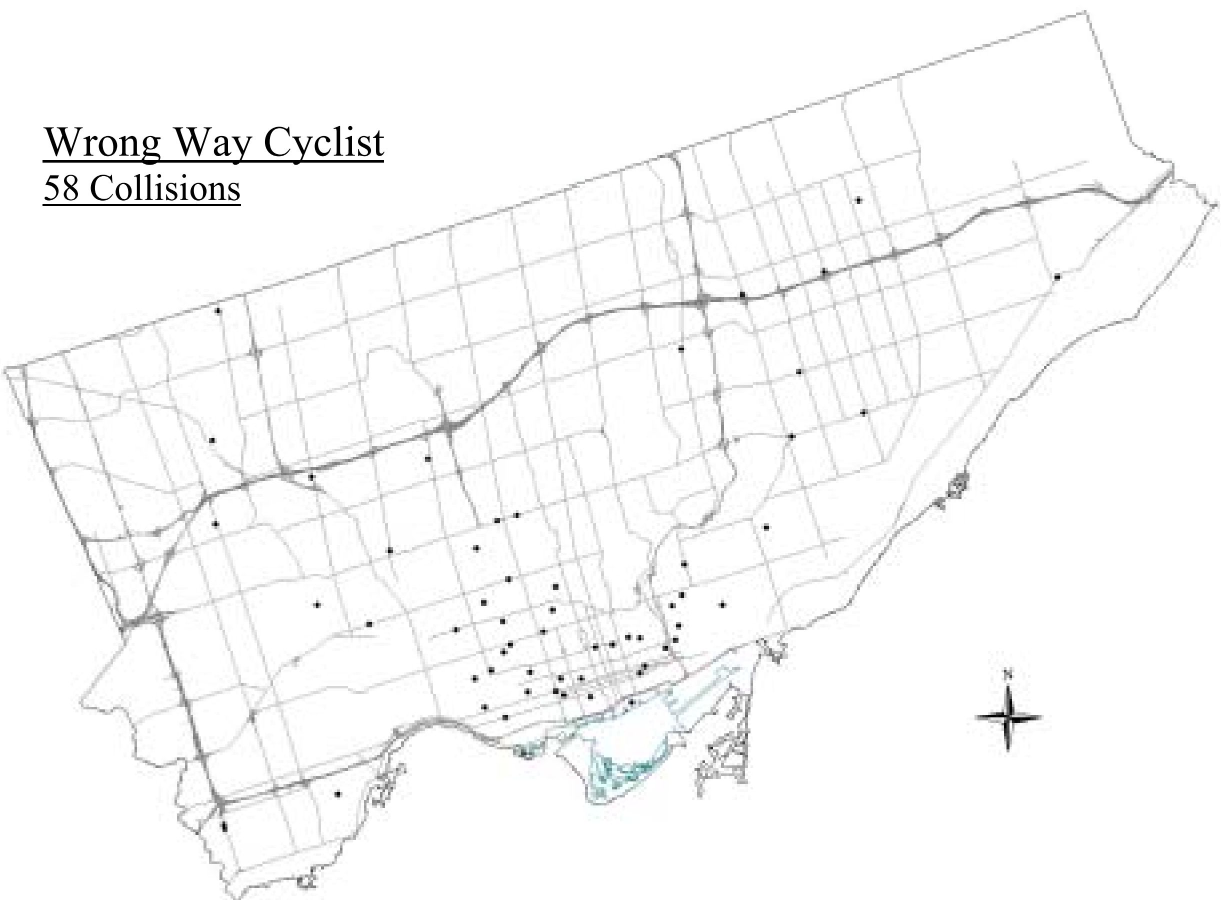
Light Conditions



Number of Lanes



Wrong Way Cyclist
58 Collisions

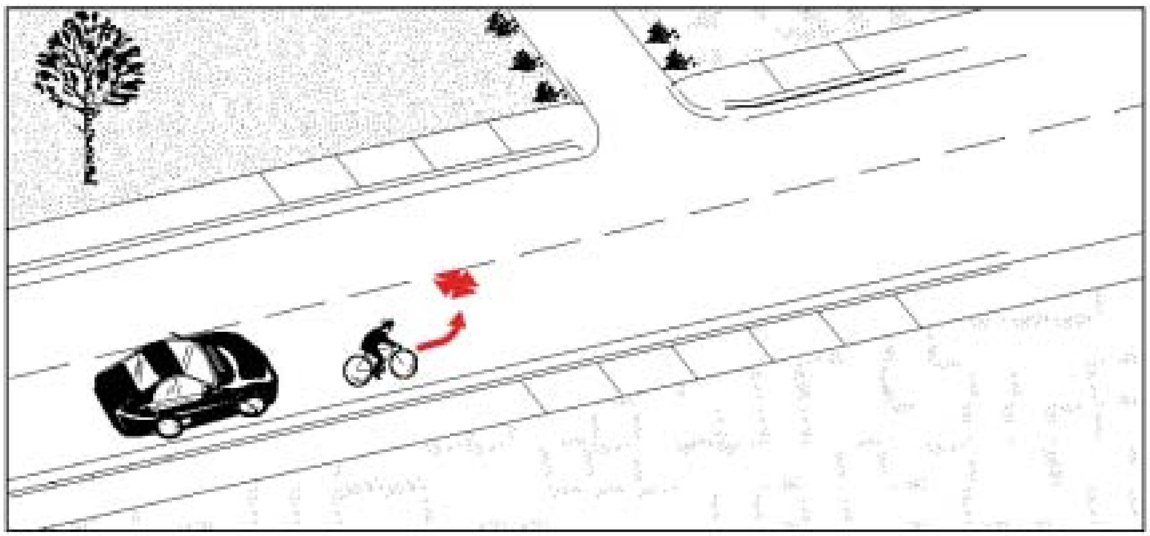


Type 16:

Cyclist Left Turn - In Front of Motorist

Frequency: 41 cases; 1.8% of all collisions

Severity: Six major injuries (16% of cases)
No fatalities



Description: The cyclist was executing a left turn across the path of the motorist, who was traveling in the same direction.

Summary: In comparison to all crashes, this type tended to involve more young cyclists (ages 10 to 19). Injuries, if any, were often more severe than average. Drivers over 60 may be under-represented.

Traffic Control:

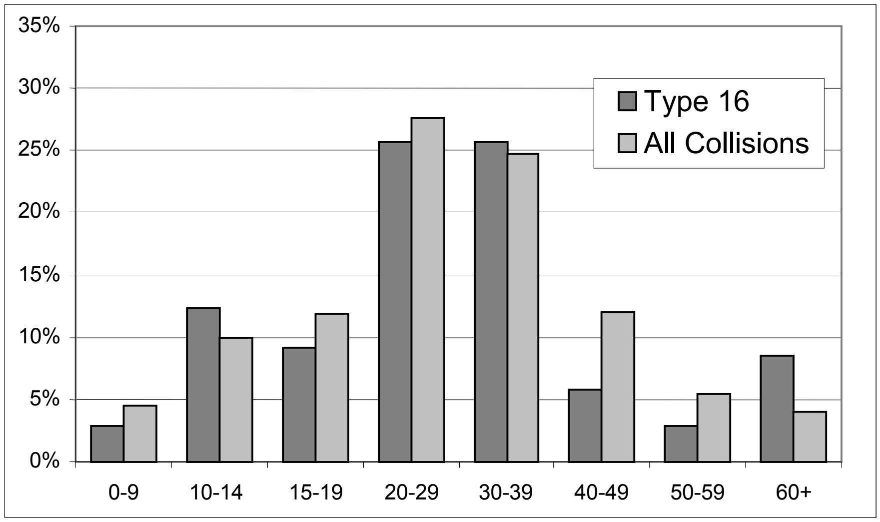
No Control	61%
Traffic Signal	34%
Stop Sign	4.9%

Note: The small number of cases may reduce the confidence of some statements about this type of crash.

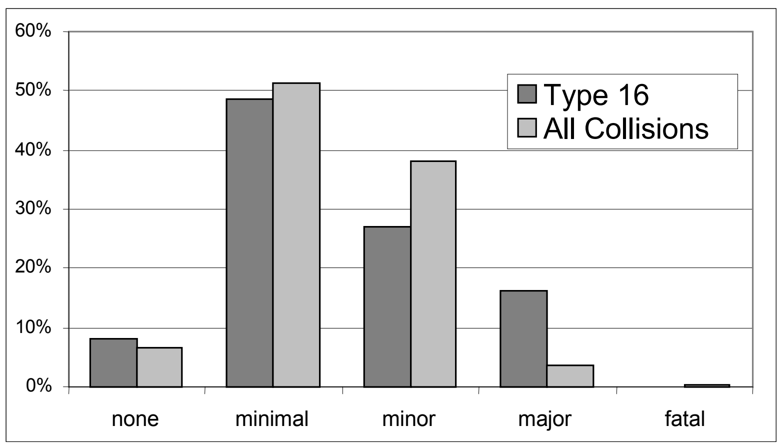
Other Significant Factors:	Type 16	All Collisions
Darkness and/or poor visibility	17.1%	14.9%

Type 16: Cyclist Left Turn – In Front of Motorist

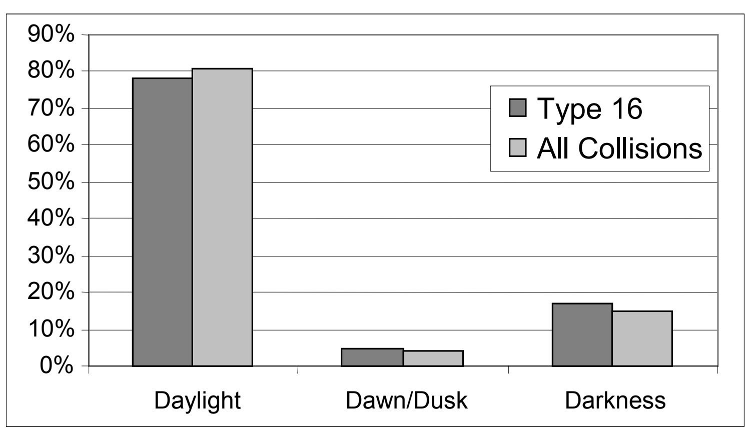
Cyclist's Age



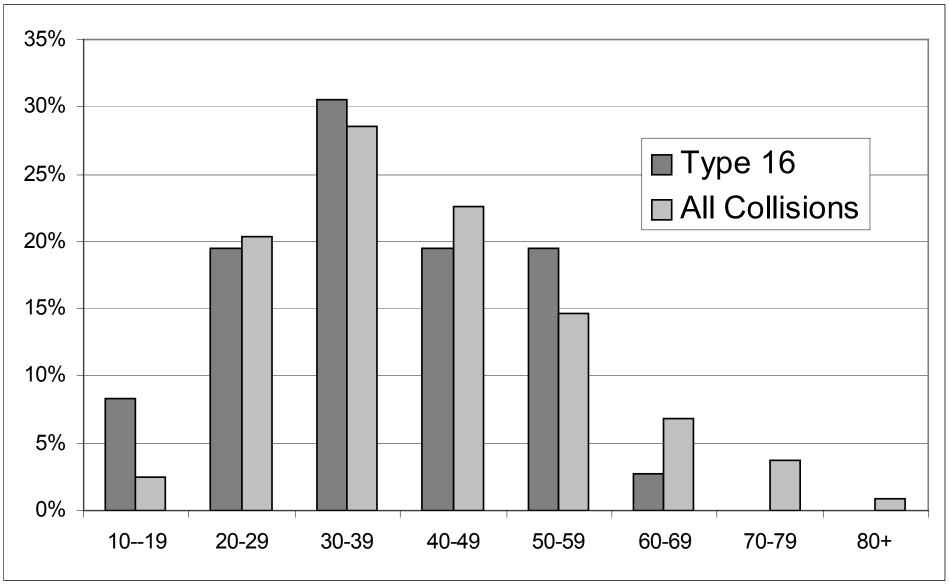
Cyclist's Injuries



Light Conditions

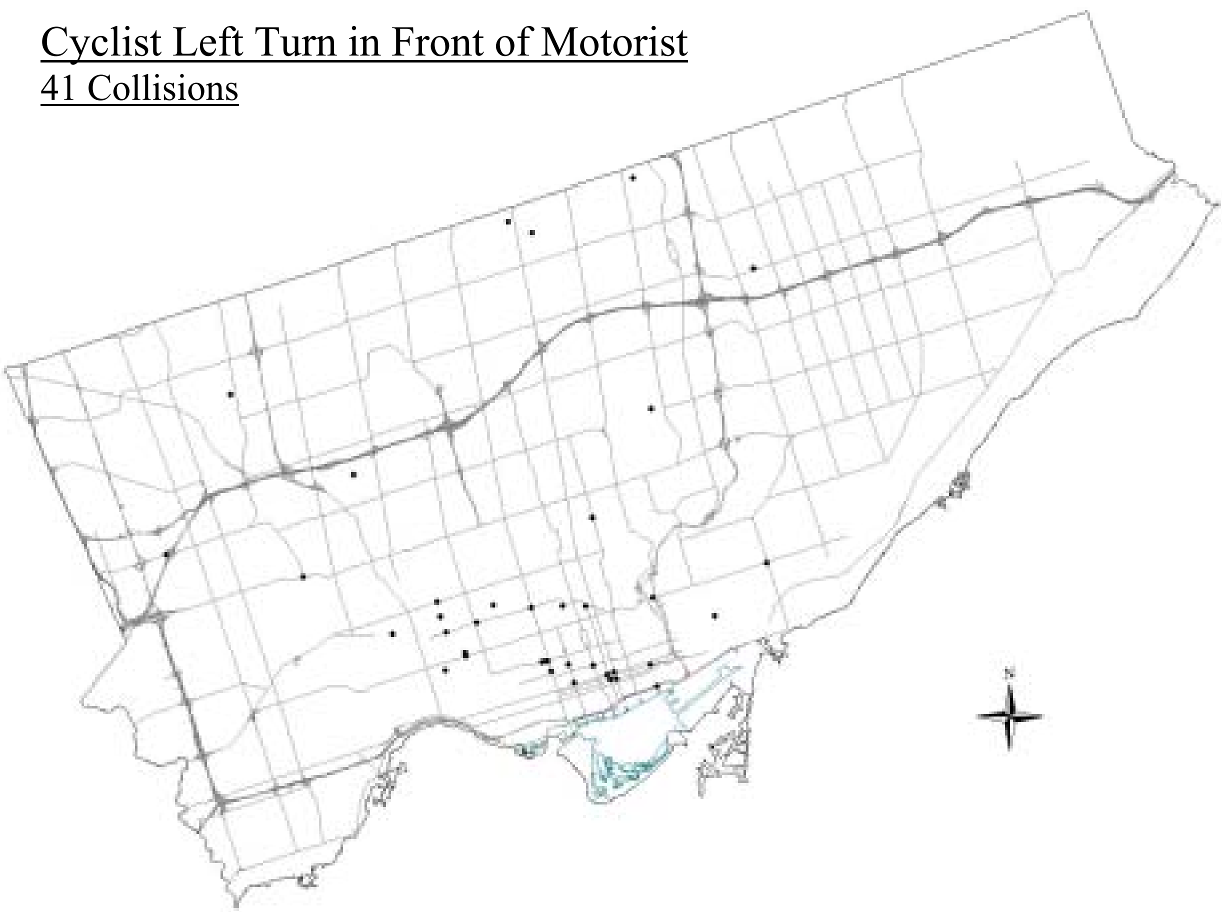


Driver's Age



Cyclist Left Turn in Front of Motorist

41 Collisions

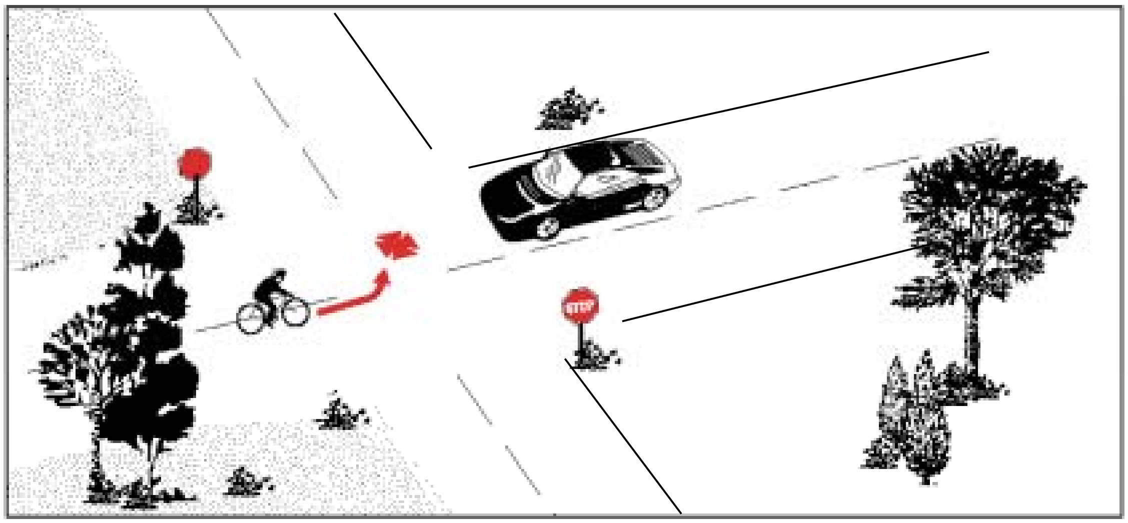


Type 17:

Cyclist Left Turn - Facing Motorist

Frequency: 11 cases; 0.5% of all collisions

Severity: 2 major injuries (18.2%)
No fatalities



Description: The cyclist was executing a left turn across the path of the motorist, who was traveling in the opposite direction.

Summary: In comparison to all crashes, this type seems to involve more young cyclists (ages 15 to 19). Resulting injuries apparently were more severe than average.

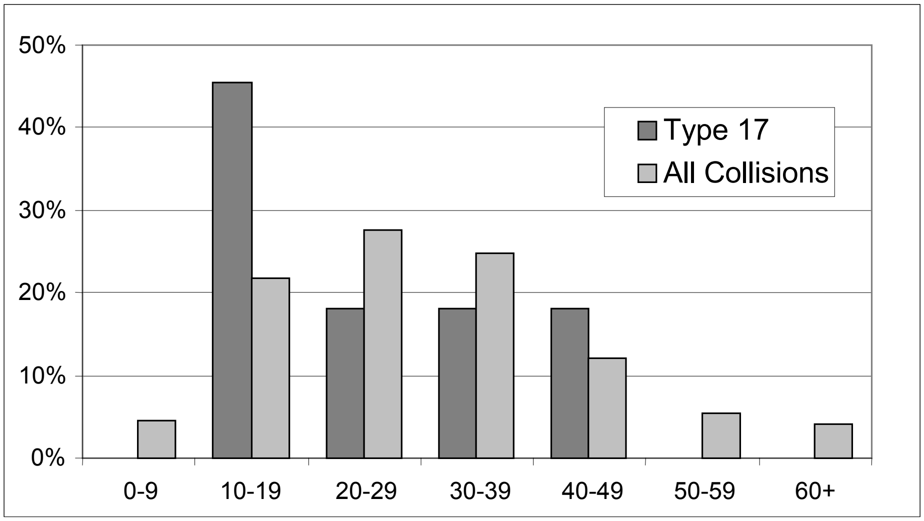
Significant Factors:
There are too few cases to identify any common contributing factors.

Environmental Conditions:
All of the collisions of this type occurred in clear weather, with dry road conditions. Only one incident occurred in darkness.

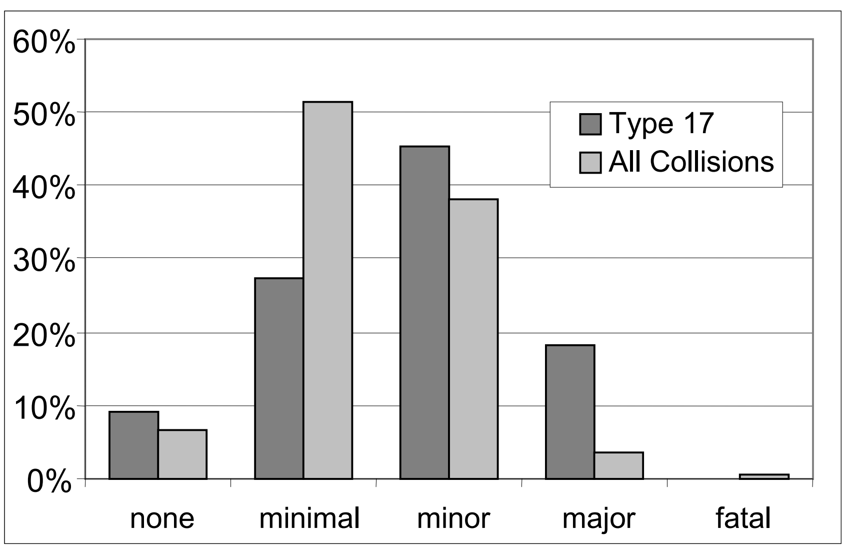
Note: The small number of cases limits the confidence of statistical statements about this type of crash.

Type 17: Cyclist Left Turn – Facing Motorist

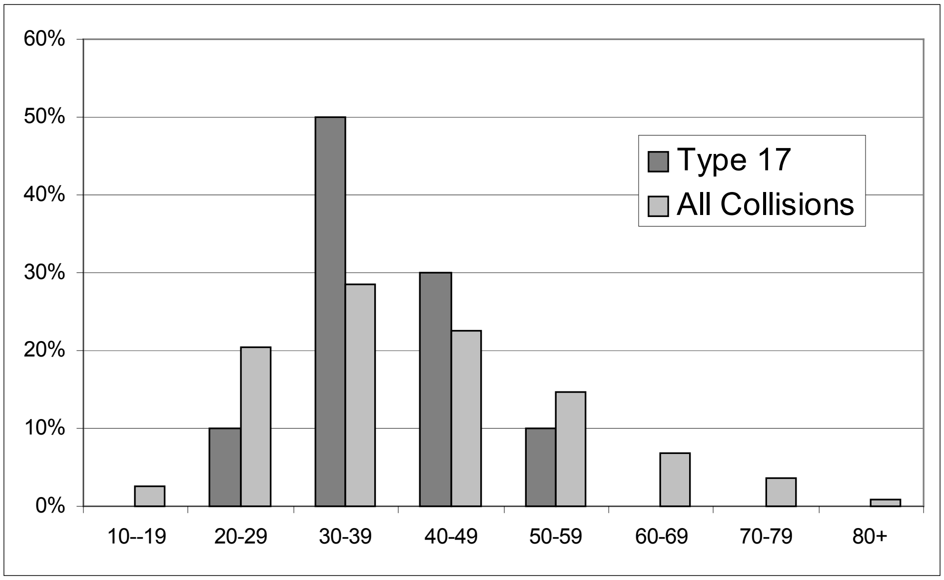
Cyclist's Age



Cyclist's Injuries

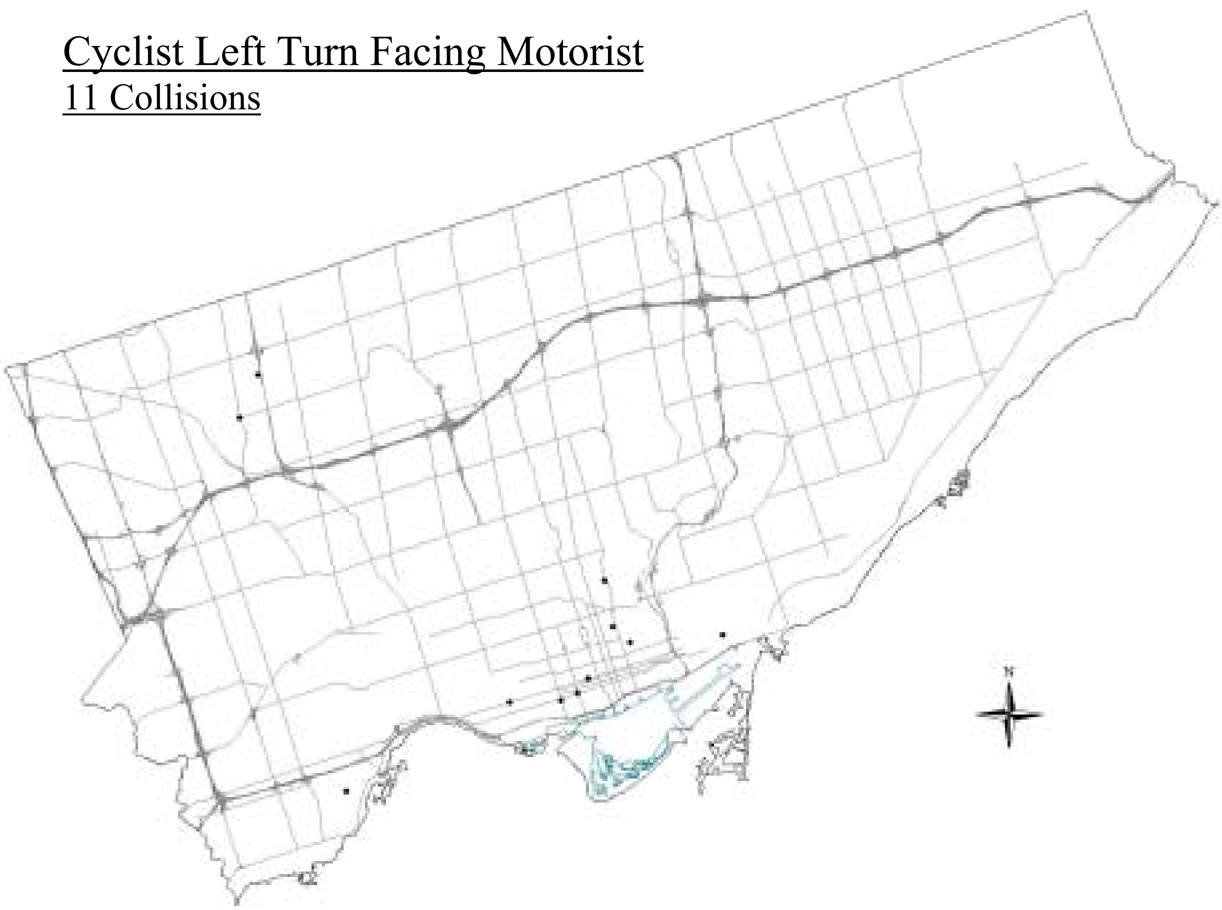


Driver's Age



Cyclist Left Turn Facing Motorist

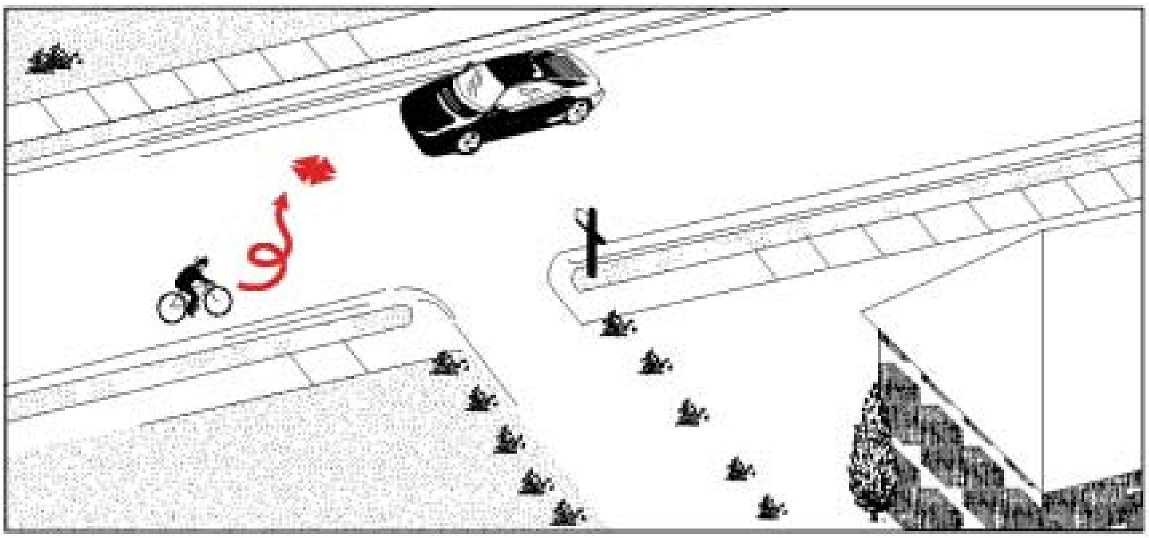
11 Collisions



Type 18:

Cyclist Lost Control

Frequency:	44 cases; 1.9% of all collisions
Severity:	2 major injuries (5%) No fatalities



Description: The cyclist lost control and, as a result, came into collision with a motor vehicle.

Summary: This type of collision involved mainly young cyclists, especially children under 10. Resulting injuries appear more severe than average. Drivers in their twenties seem to be under-represented.

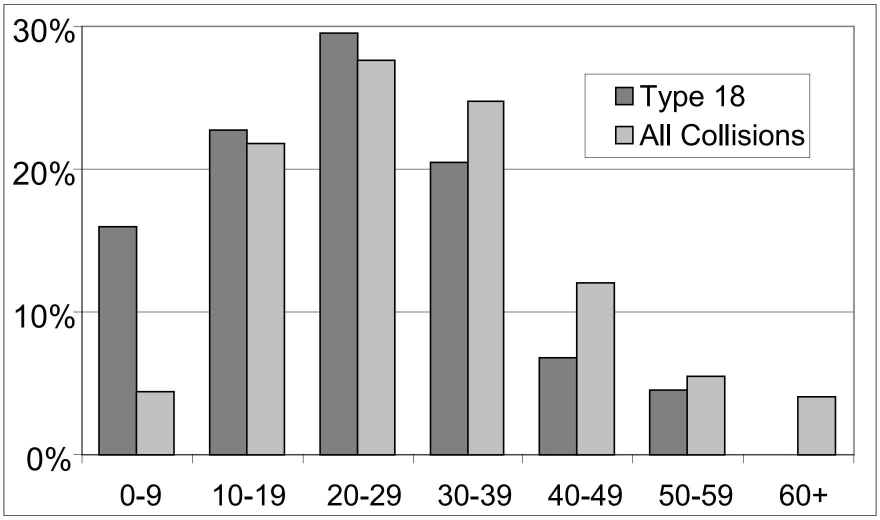
Environmental Conditions: Weather and light conditions do not appear to have been factors in these collisions.

Note: The small number of cases reduces the confidence of some statements about this type of crash.

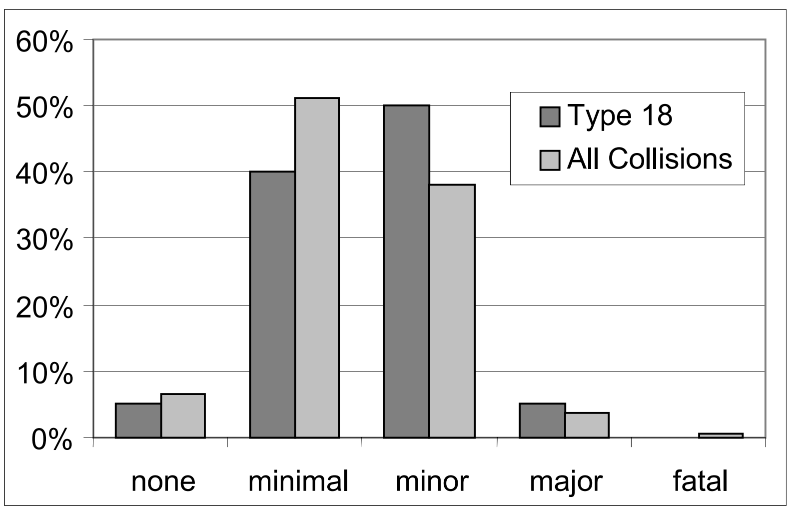
Other Significant Factors:	**Type 18**	**All Collisions**
Child cyclist	21%	5.7%
Streetcar tracks	21%	0.6%
Mechanical defect	11.4%	0.6%
Cyclist's path obstructed	9.1%	0.7%

Type 18: Cyclist Lost Control

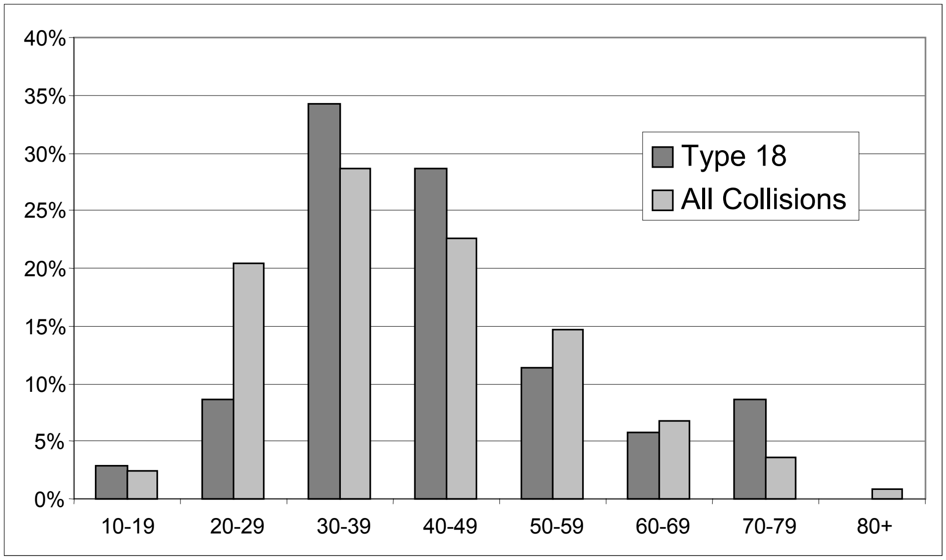
Cyclist's Age



Cyclist's Injuries



Driver's Age

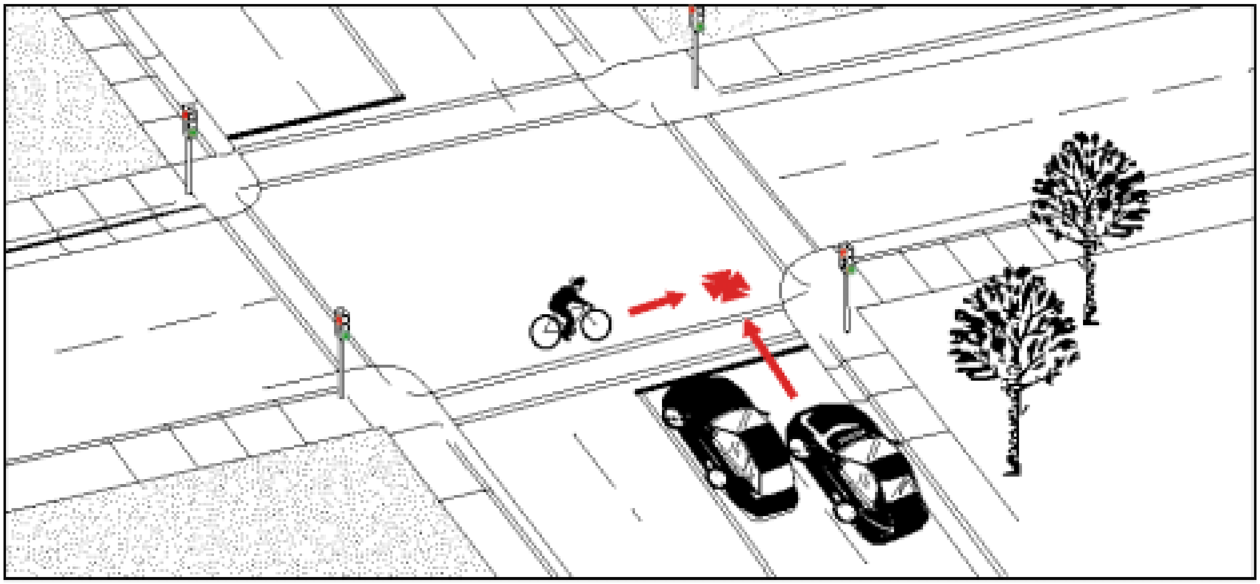


Cyclist Lost Control
44 Collisions

Type 19:

Frequency:	30 cases; 1.3% of all collisions
Severity:	No major injuries or fatalities

Cyclist Caught in Intersection



Description: The cyclist was traversing an intersection when the traffic signal changed to red. A motorist proceeding on the green light then struck the cyclist.

Summary: In comparison to all crashes, this type tended to involve more young cyclists (under age 15). Resulting injuries were generally much less severe than average. Drivers in their twenties appear to be over-represented.

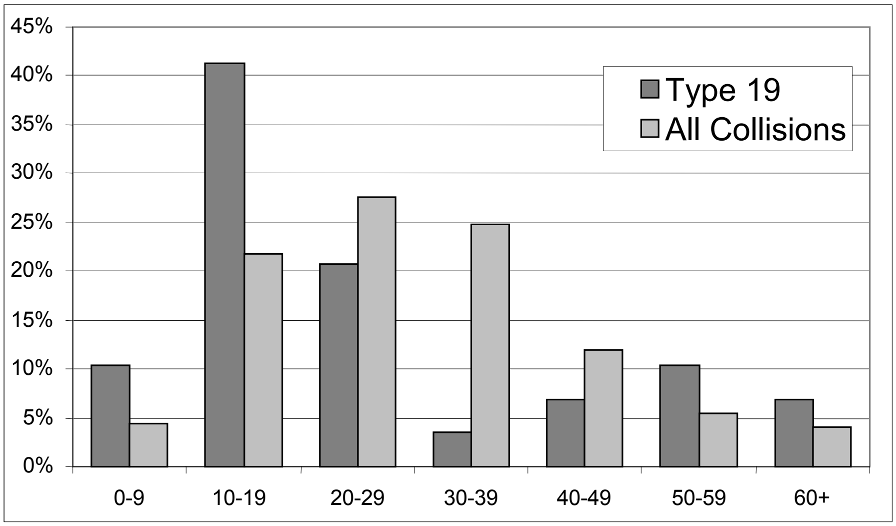
Environmental Conditions: There were too few cases to determine if weather and light conditions were factors in these collisions.

Note: The small number of cases may reduce the confidence of some statements about this type of crash.

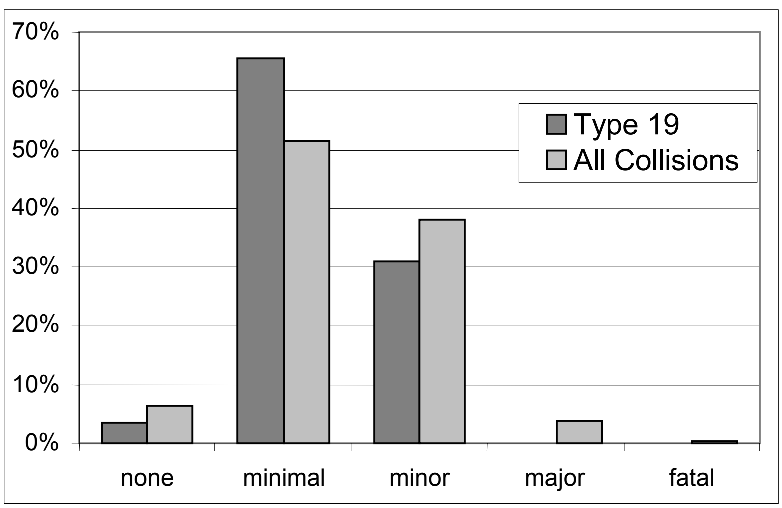
Other Significant Factors:	Type 19	All Collisions
Child cyclist	20%	5.7%
Darkness	17.2%	14.9%
Cyclist disobeying traffic control	10%	1.9%
Sight lines obstructed	6.7%	3.1%

Type 19: Cyclist Caught in Intersection

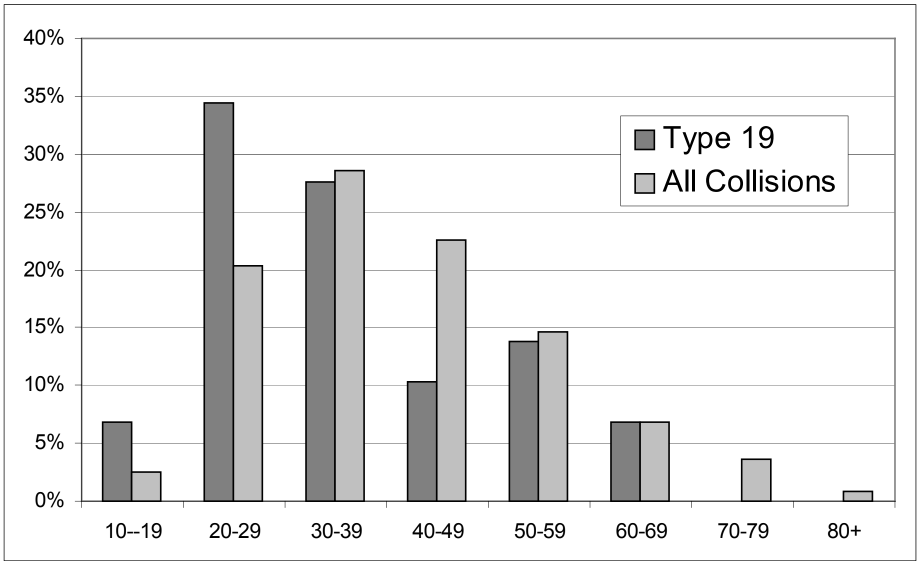
Cyclist's Age



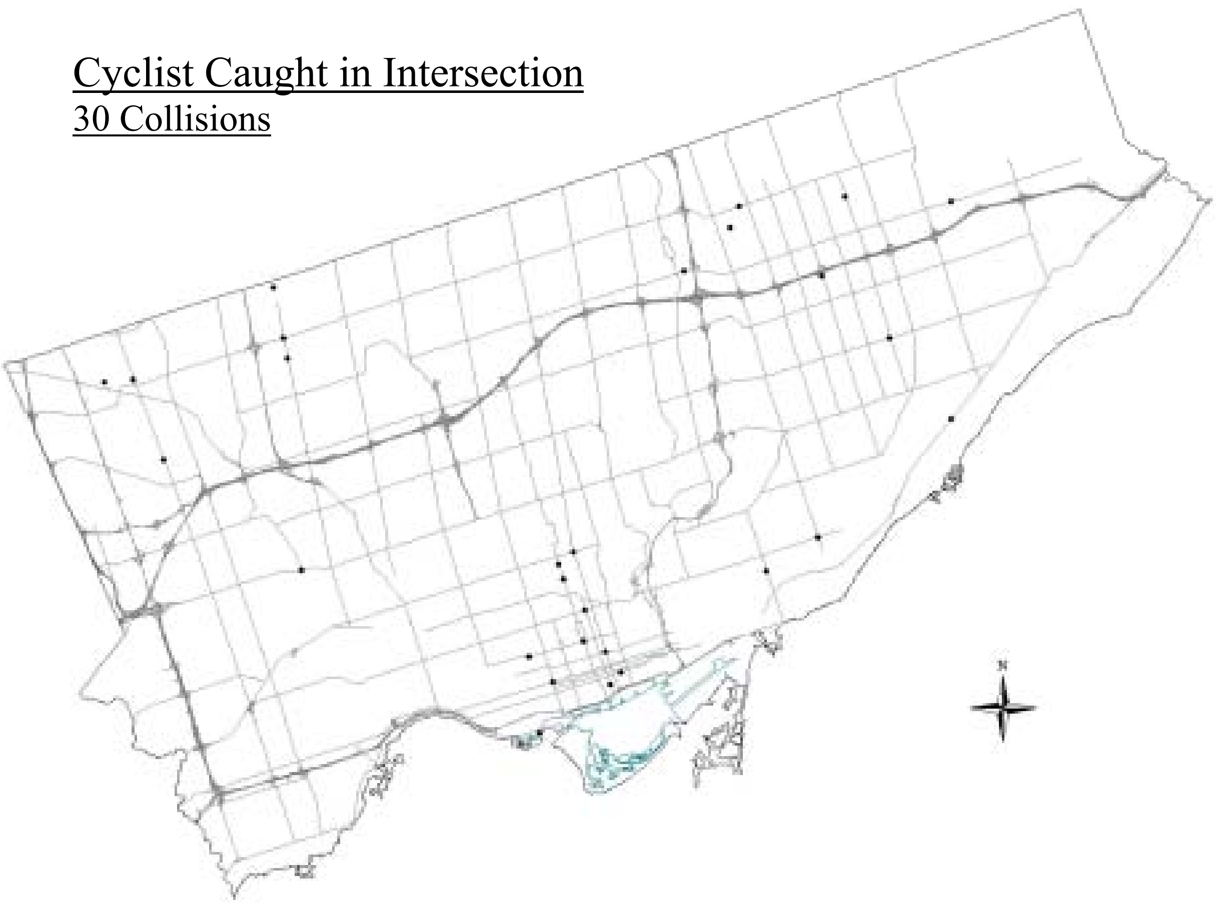
Cyclist's Injuries



Driver's Age



Cyclist Caught in Intersection
30 Collisions

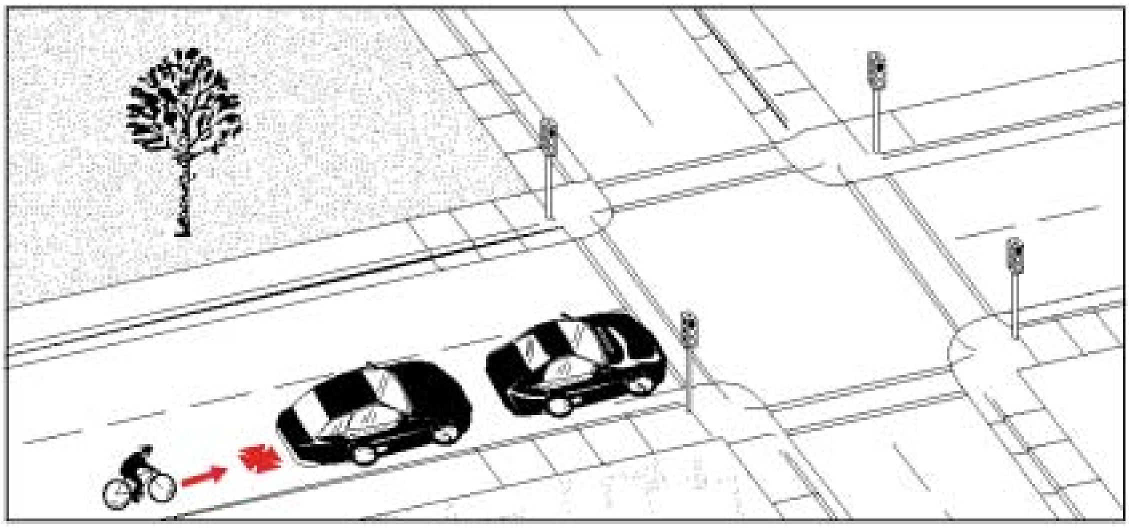


Type 20:

Cyclist Overtaking Motorist

Frequency: 31 cases; 1.3% of all collisions

Severity: No major injuries or fatalities



Description: Both parties were traveling in the same direction. The cyclist was either passing or approaching from the rear.

Summary: This type of crash involved mostly adult cyclists (ages 20 to 35). Resulting injuries were slightly more severe than the overall average. Drivers in their thirties may be over-represented.

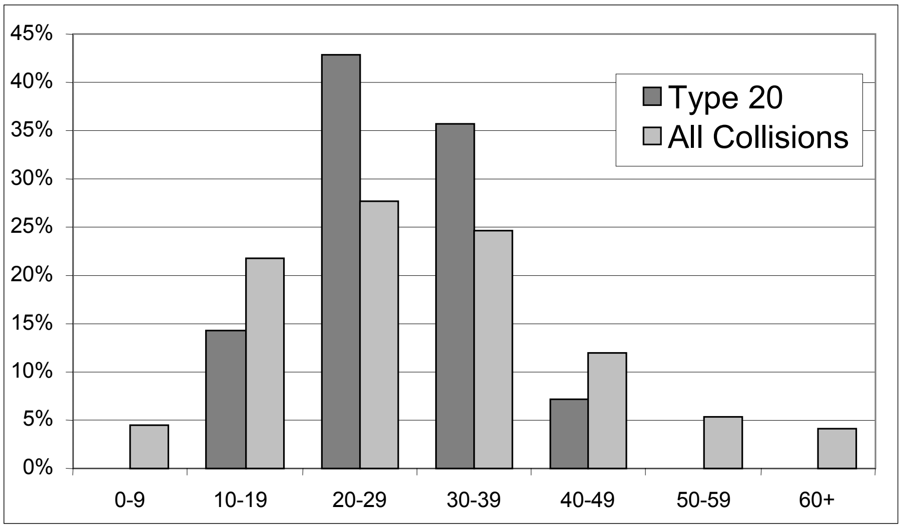
Environmental Conditions: Weather and light conditions do not appear to have been factors in these crashes.

Note: The small number of cases may reduce the confidence of some statements about this type of crash.

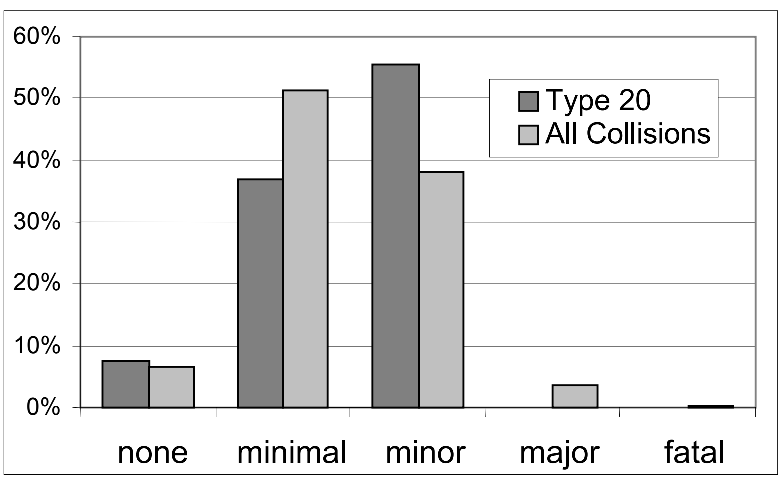
Other Significant Factors:	Type 20	All Collisions
Motorist improper/unsafe lane change	19.4%	2.9%
Cyclist passing on the right	13%	2.5%
Mechanical defect (bicycle)	9.7%	0.6%

Type 20: Cyclist Overtaking Motorist

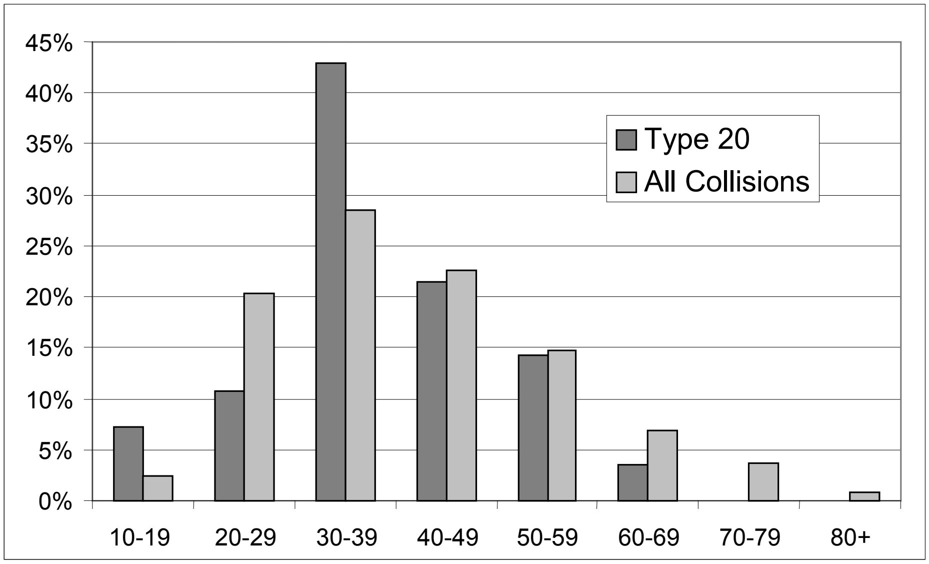
Cyclist's Age



Cyclist's Injuries

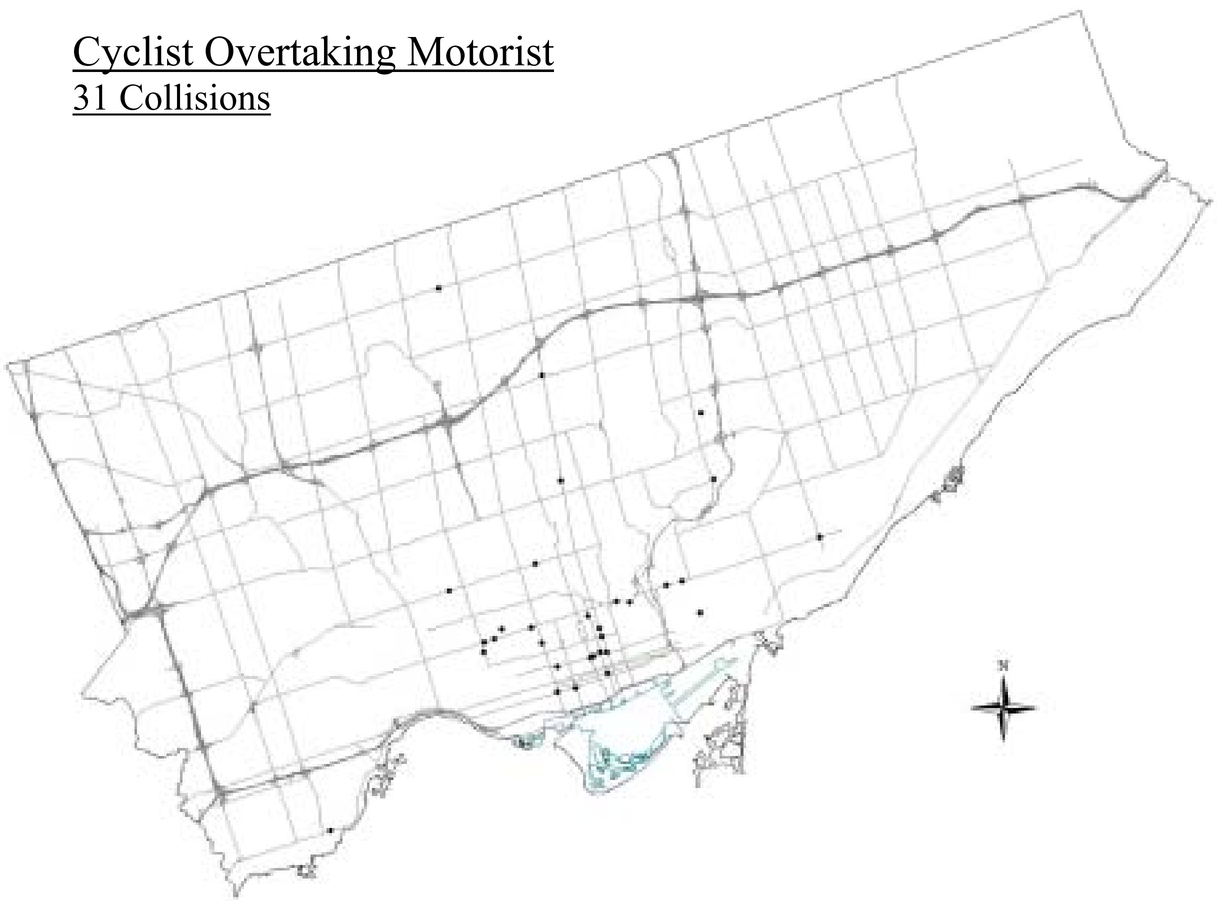


Driver's Age



Cyclist Overtaking Motorist

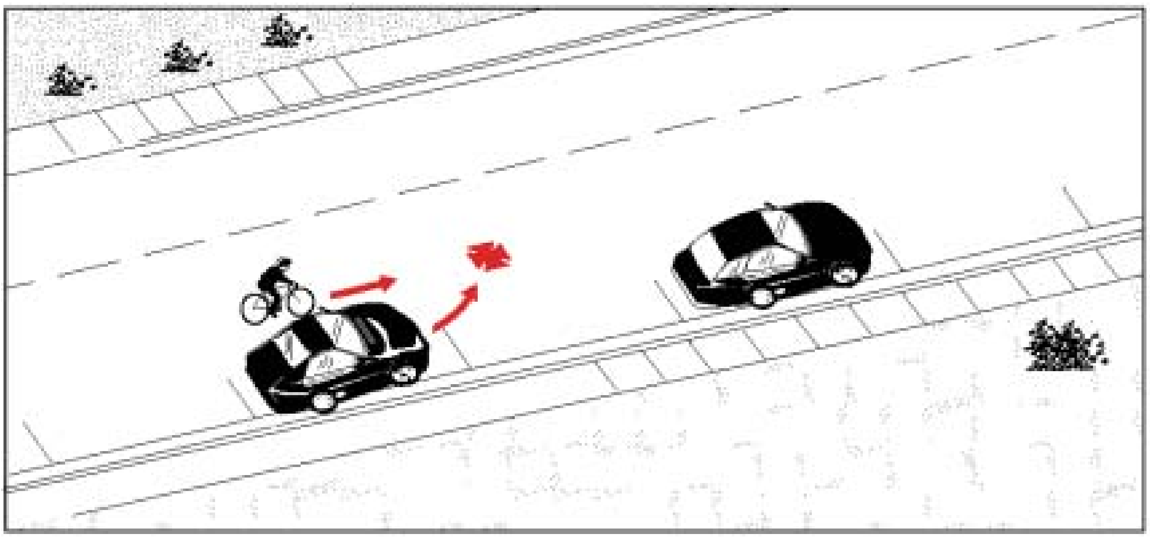
31 Collisions



Type 21:

Frequency:	28 cases; 1.2% of all collisions
Severity:	No major injuries or fatalities

Drive Into or Out of On-Street Parking



Description: The motorist was entering or exiting an on-street parking spot.

Summary: This type of collision involved mostly adult cyclists, age 20 to 30. Resulting injuries were generally less severe than average.

Environmental Conditions: Poor weather and road conditions do not appear to be significant factors in these crashes.

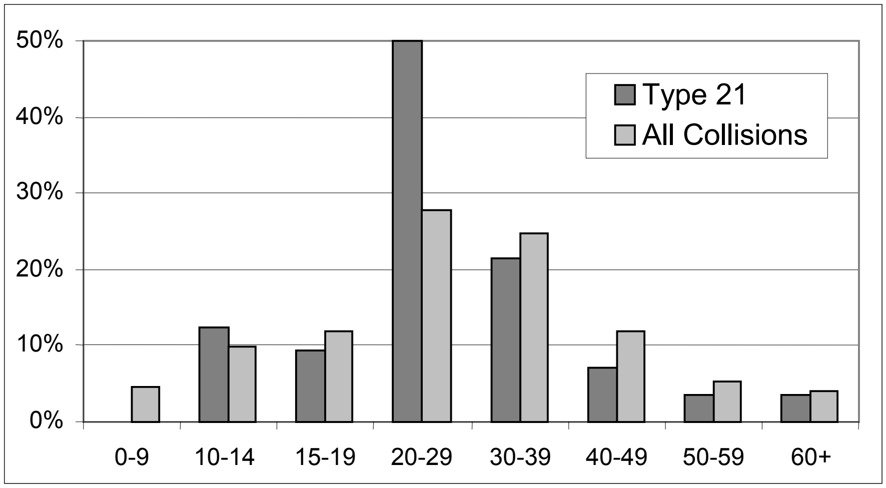
Geographic Distribution: Almost all occurred in central areas.

Note: The small number of cases may reduce the confidence of some statements about this type of crash.

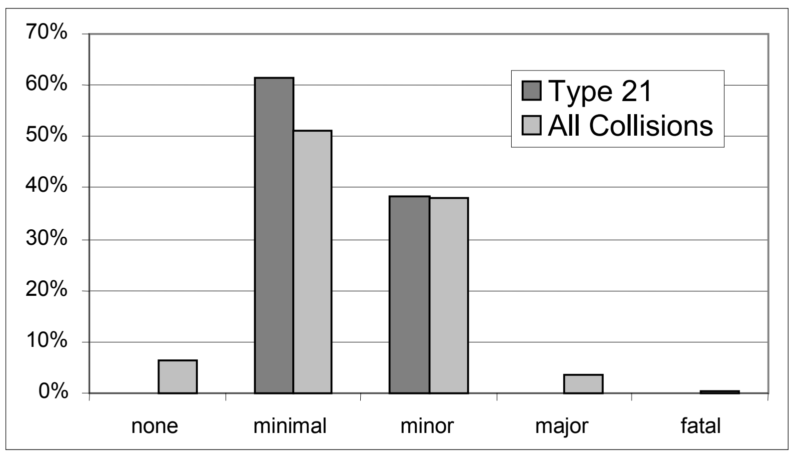
Other Significant Factors:	Type 21	All Collisions
Darkness	32%	14.9%
Motorist improper/unsafe lane change	14.3% (4 cases)	2.9%

Type 21: Drive Into/Out of On-Street Parking

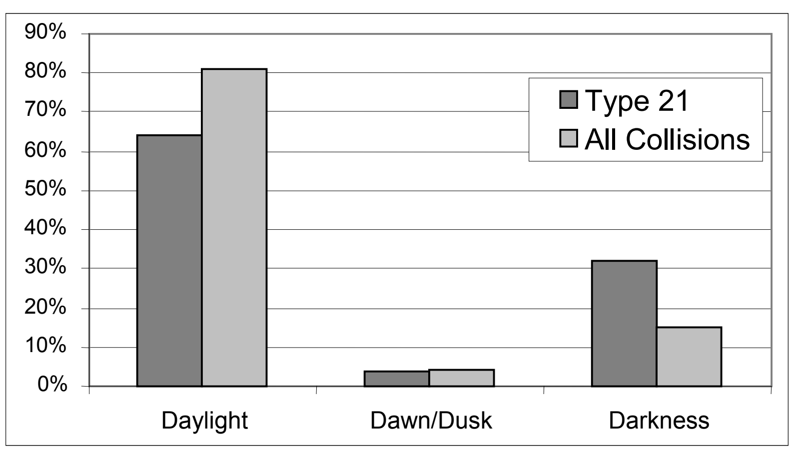
Cyclist's Age



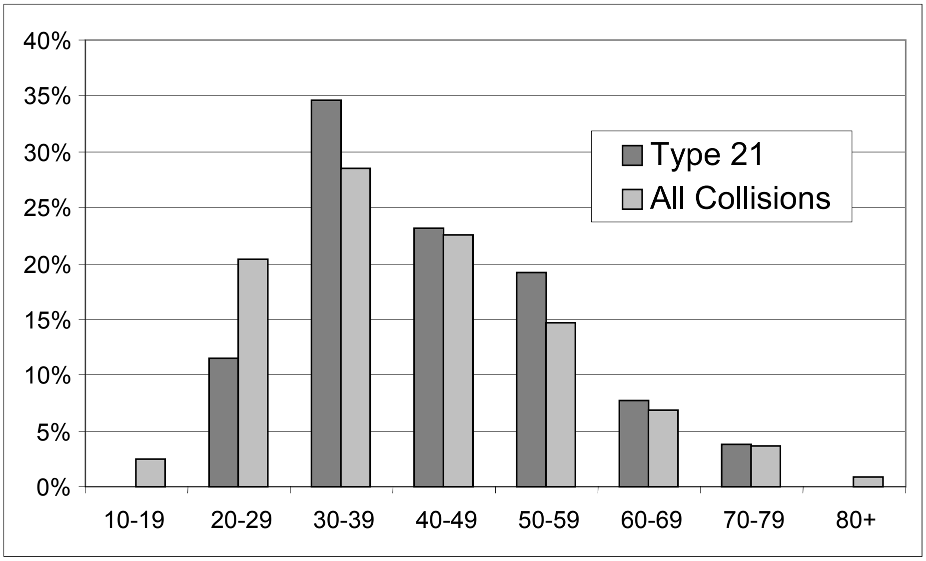
Cyclist's Injuries



Light Conditions



Driver's Age



Drive Into/Out of On-Street Parking

28 Collisions

Type 22:

"Other" Type

Frequency: 101 cases; 4.3% of all collisions

Severity: 10.6% resulted in major injuries
2 fatalities

No Diagram

Description: While detailed information regarding the collision was available, it did not fit into any of the established categories.

Comments: Any trends that appear to emerge in these collisions are likely to be coincidental.

Type 23:

Type Unknown

Frequency: 247 cases; 9.6% of all collisions

No Diagram

Description: Information on these collisions was not sufficient to allow classification. Information that was available was used in the overall analysis.

Comments: Any trends that appear to emerge in these collisions are likely to be coincidental.

Appendix A: Relevant Collision Typologies

The crash types of the U. S. Federal Highway Administration's typology are listed here, along with those of the system developed for the City of Toronto Bicycle Collision Analysis Project. Also listed are the "impact types" of the Toronto Police Services scheme for classifying motor vehicle collisions, used in MVA reports.

FHWA

1 Ride Out At Residential Driveway
2 Ride Out At Commercial Driveway
3 Ride Out From Sidewalk
4 Ride Out At Mid-block
5 Ride Out At Stop Sign
6 Trapped
7 Multiple Threat
8 Drive Out At Mid-block
9 Drive Out At Stop Sign
10 Unknown
11 Right On Red
12 Backing
13 Drive Through
14 Motorist Overtaking Failed To Detect
15 Motorist Lost Control
16 Motorist Overtaking - Counteractive Evasive Actions
17 Motorist Overtaking - Misjudged Space
18 Motorist Overtaking - Bicyclist Path Obstructed
19 Bicyclist Left Turn In Front Of Traffic
20 Bicyclist Left Turn - Facing Traffic
21 Bicyclist Lost Control
22 Bicyclist Right Turn
23 Motorist Left Turn In Front Of Bicyclist
24 Motorist Left Turn - Facing Bicyclist
25 Motorist Right Turn
26 Uncontrolled Intersection - Other
27 Wrong Way Bicyclist
28 Bicyclist Overtaking
29 Wrong Way Motorist
30 Non-Roadway
31 Drive Out From On-Street Parking
32 Weird
33 Motorist Overtaking - Other
34 Play Vehicle
35 Bicyclist Strikes Parked Vehicle
36 Drive Out At Intersection - Other
37 Ride Out At Intersection - Other
38 Controlled Intersection - Other

City of Toronto Collision Study

1 Drive Out At Controlled Intersection
2 Drive Out From Lane or Driveway
3 Motorist Reversing
4 Motorist Right On Red
5 Motorist Right Turn-Other
6 Cyclist Strikes Open Vehicle Door
7 Cyclist Strikes Stopped Vehicle-Other
8 Motorist Left Turn - Facing Cyclist
9 Motorist Left Turn In Front Of Cyclist
10 Motorist Overtaking
11 Ride Out At Mid-block
12 Ride Out At Controlled Intersection
13 Ride Out From Sidewalk
14 Ride Out From Lane or Driveway
15 Wrong Way Cyclist
16 Cyclist Left Turn In Front Of Traffic
17 Cyclist Left Turn - Facing Traffic
18 Cyclist Lost Control
19 Cyclist Caught in Intersection
20 Cyclist Overtaking
21 Drive Into/Out of On-Street Parking
22 Other
23 Unknown

Toronto Police Services

Initial Impact Type

01 Approaching
02 Angle
03 Rear end
04 Sideswipe
05 Turning movement
06 Single Moving Vehicle & Unattended Vehicle
07 Single Moving Vehicle-Other
99 Other

This table shows how categories in the FHWA typology were combined, split, or deleted to create the Toronto typology. (See also: www.tfhrc.gov/safety/pedbike/ctanbike/ctanbike.htm)

Toronto Typology	FHWA Typology
Drive Out At Controlled Intersection	Drive Out At Stop Sign Drive Through Drive Out At Intersection – Other Controlled Intersection – Other (a)
Drive Out From Lane or Driveway	Drive Out At Mid-block
Motorist Reversing	Backing
Motorist Right At Red Light	Right On Red
Motorist Right Turn (Not at Red Light)	Motorist Right Turn
Motorist Opens Vehicle Door in Cyclist's Path	Bicyclist Strikes Parked Vehicle (door open)
Cyclist Strikes Stopped Vehicle	Bicyclist Strikes Parked Vehicle (other)
Motorist Left Turn – Facing Cyclist	Motorist Left Turn - Facing Bicyclist
Motorist Left Turn – In Front Of Cyclist	Motorist Left Turn In Front Of Bicyclist
Motorist Overtaking	Motorist Overtaking Failed To Detect Motorist Overtaking - Counteractive Evasive Actions Motorist Overtaking - Misjudged Space Motorist Overtaking - Bicyclist Path Obstructed Motorist Overtaking - Other
Ride Out At Mid-block	Ride Out At Mid-block
Ride Out (on road) At Controlled Intersection	Ride Out At Stop Sign Ride Out At Intersection – Other (cyclist on road) Controlled Intersection – Other (b: cyclist on road)
Ride Out From Sidewalk (at intersection)	Ride Out At Intersection – Other (cyclist on sidewalk) Controlled Intersection – Other (c: cyclist on sidewalk)
Ride Out From Lane or Driveway	Ride Out At Residential Driveway Ride Out At Commercial Driveway Ride Out From Sidewalk
Wrong Way Cyclist	Wrong Way Bicyclist
Cyclist Left Turn In Front Of Traffic	Bicyclist Left Turn In Front Of Traffic
Cyclist Left Turn – Facing Traffic	Bicyclist Left Turn - Facing Traffic
Cyclist Lost Control	Bicyclist Lost Control
Cyclist Caught in Intersection	Trapped Multiple Threat
Cyclist Overtaking	Bicyclist Overtaking
Drive Into/Out of On-Street Parking	Drive Out From On-Street Parking
Other (Not Classified)	Motorist Lost Control Non-Roadway Weird Bicyclist Right Turn (while riding facing traffic) Wrong Way Motorist
Unknown	Unknown
Not represented in Toronto data:	Uncontrolled Intersection – Other Play Vehicle

Appendix B: Data Coding System

MVA Data

Information entered in code boxes on the Motor Vehicle Accident Report forms is listed below.

ACCIDENT LOCATION

ON HIGHWAY		OFF HIGHWAY
Non intersection	At railway crossing	Trail
Intersection related	Underpass or tunnel	Frozen lake or river
At intersection	Overpass or bridge	Parking Lot
At/near private drive	Other	Other

IMPACT LOCATION

Within intersection	Two-way left turn lane	Non on roadway-right side
Thru lane	Passing lane	Off highway
Left turn lane	Left shoulder	Other
Right turn lane	Right shoulder	
Right turn channel	Not on roadway-left side	

ENVIRONMENT CONDITION Multiple Choices Allowed

Clear	Freezing rain	Fog, mist, smoke, dust
Rain	Drifting snow	Other
Snow	Strong wind	

LIGHT

Daylight	Dawn-artificial	Dark
Daylight-artificial	Dusk	Dark-artificial
Dawn	Dusk-artificial	Other

TRAFFIC CONTROL

Traffic signal	Police control	Traffic Controller
Stop sign	School guard	No control
Yield sign	School bus	Other
Ped. Crossover	Traffic gate	

TRAFFIC CONTROL CONDITION

Functioning	Obscured	
Not functioning	Missing Damaged	

ROAD CHARACTER

Undivided - one-way	Divided – no barrier	Express lane
Undivided – two-way	Ramp	Transfer lane
Divided with restraining barrier	Collector lane	

ROAD CONDITION

Good	Poor	Under repair or construction

ROAD SURFACE

Asphalt	Concrete	Steel
Oil treated gravel	Earth	Brick interlocking stone
Gravel or crushed stone	Wood	Other

ROAD SURFACE CONDITION

Dry	Packed	Spilled Liquid
Wet	Ice	Other
Loose snow	Mud	
Slush	Loose sand or gravel	

ROAD ALIGNMENT

Straight on level	Curve on level	
Straight on hill	Curve on hill	

ROAD PAVEMENT MARKINGS

Exist	Obscured	
Non-existent	Faded	

VEHICLE TYPE

Automobile-station wagon	Municipal transit bus	Other farm vehicle
Motorcycle	Inter-city bus	Construction equipment
Moped	Bus (other)	Railway train
Passenger van	School bus	Street car
Pick-up truck	School van	Snow plow
Delivery van	Other school vehicle bus	Ambulance
Tow-truck	Motor home	Fire vehicle
Truck-open	Off-road 2 wheels	Police vehicle
Truck-closed	Off-road 3 wheels	Other emergency vehicle
Truck-tank	Off-road 4 wheels	Bicycle
Truck-dump	Off-road – other	Unknown
Truck-car carrier	Motorized snow vehicle	Truck-other
Truck-tractor	Farm tractor	Other

TOWED VEHICLE

Recreation trailer or semi-trailer-house, tent	Large full trailer	Farm equipment
Boat trailer	Large semi-trailer	Towed motor vehicle
Small utility trailer	Double (semi-trailer - semi-trailer)	Other
Wheeled device or apparatus	Double (semi-trailer – trailer)	

TRAILER TYPE

Van	Tank	Livestock
Flat bed/flat bed with racks	Dump	Other
Low bed/float	Car carrier	

TRAILER CONNECTION-Double Semi-Trailers Only

Single draw bar dolly (A train)	Double draw bar dolly (C Train)	
5th wheel connection only (B Train)	Other	

VEHICLE CONDITION

No apparent defect	Defect	

APPARENT DRIVER ACTION

Driving properly	Improper turn	Wrong way on 1-way road
Following too close	Disobeyed traffic control	Improper lane change
Exceeding speed limit	Failed to yield right-of-way	Other
Speed too fast for condition	Improper passing	
Speed too slow	Lost control	

DRIVER / PEDESTRIAN CONDITION

Normal	Ability impaired, drugs	Unknown
Had been drinking	Fatigue	Other
Ability impaired, alcohol (over .08)	Medical or physical disability	
Ability impaired, alcohol	Inattentive	

PEDESTRIAN ACTION

Crossing with right-of-way	Walking on roadway with traffic	Running onto roadway
Crossing without right-of-way	Walking on roadway against traffic	Person getting on/off school bus
Crossing – no traffic control	On sidewalk or shoulder	Person getting on/off vehicle
Crossing ped. crossover	Playing or working on highway	Pushing/working on vehicle
Crossing marked crosswalk without right-of-way	Coming from behind parked vehicle or object	Other

ROAD JURISDICTION

Municipal (excl. Twp. Rd)	County or district	Federal
Provincial highway	Regional municipality	Other
Township	Private property	

CLASSIFICATION OF ACCIDENT

Fatal injury	P.O. only	Other
Non-fatal injury	Non-reportable	

INITIAL DIRECTION OF TRAVEL

North	East	
South	West	

INITIAL IMPACT TYPE

Approaching	Turning movement	
Angle	SMV unattended vehicle	
Rear end	SMV other	
Sideswipe	Other	

VEHICLE MANOEUVER

Going ahead	Changing lanes	Pulling away from shoulder or curb
Slowing or stopping	Merging	Pulling onto shoulder or toward curb
Overtaking	Reversing	Unknown
Turning left	Stopped	Other
Turning right	Parked	
Making 'U' turn	Disabled	

SEQUENCE OF EVENTS (Multiple Choices Allowed)

Moveable Objects		
Other motor vehicle	Railway train	Animal-wild
Unattended vehicle	Street car	Other
Pedestrian	Farm tractor	
Cyclist	Animal-domestic	
Other Events		
Ran off road	Fire/explosion	Debris falling off vehicle
Skidding/sliding	Submersion	Other
Jack knifing	Rollover	
Load spill	Debris on road	
Fixed Objects		
Cable guide rail	Culvert	Crash cush/end treat
Concrete guide rail	Bridge support	Building or wall
Side guide rail	Rock face	Water course
Pole (utility, tower)	Snow bank/drift	Construction marker
Pole (sign, parking meter)	Ditch	Tree, shrub, stump
Fence/noise barrier	Curb	Other

Fixed Object Offset	
Left of Roadway	**Right of Roadway**
Less than 3.1 m	Less than 3.1 m
3.1 m to 6.0 m	3.1 m to 6.0 m
6.1 m to 9.0 m	6.1 m to 9.0 m
Greater than 9.0 m	Greater than 9.0 m

VEHICLE DAMAGE

None	Moderate	Demolished
Light	Severe	

LOCATION OF VEHICLE DAMAGE OR AREA OF IMPACT (Multiple Choices Allowed)

Right front corner	Left rear	Back complete
Right front	Left centre	Left side complete
Right centre	Left front	Top
Right rear	Left front corner	Undercarriage
Right rear corner	Front centre	No contact
Back centre	Front complete	Unknown
Left rear corner	Right side complete	

Data Matrix Fields

All the fields in the final data matrix are listed here. Although some of the information initially provided electronically by the Traffic Data Centre was not used in the statistical analysis, it is also listed here (the last 16 items).

Collision Report Number
Missing MVA Report?
Environment Condition
Light Conditions
Traffic Control Device
Road Condition
Vehicle Type
Cyclist's Age
Cyclist's Sex
Cyclist's Injuries
Wearing Helmet?
Number of Traffic Lanes
Speed Limit
Bike Lane?
Crash Type
Contributing Factors 1
Contributing Factors 2
Contributing Factors 3
Contributing Factors 4
Date
Day
Time
Longitude
Latitude

Street Name 1
Street Name 2
Street Name 3
Municipality
Patrol Area
Investigating Officer's Badge Number
Charges Laid
No. of Persons Involved
No. of Vehicles Involved
Accident Class (Non-reportable, Property Damage Only, Personal Injury)
Accident Location (Intersection, Non-Intersection, Non-Roadway)
Vehicles Towed
Initial Vehicle Direction (Impacting Vehicle)
Manoeuvre (Impacting Vehicle)
Impact Type (See Toronto Police Services Collision Typology, Appendix A)
Safety Equipment in Use

Code Book

Data that was coded for analysis is listed here. Some data (not listed here) did not require special coding (time and date of the collision, etc.). Other information was provided by the Traffic Data Centre but not incorporated into the statistical analysis (see Data Fields, above).

Crash Type

Code	Description
1	Drive Out At Controlled Intersection
2	Drive Out From Lane or Driveway
3	Motorist Reversing
4	Motorist Right On Red
5	Motorist Right Turn-Other
6	Motorist Opens Vehicle Door
7	Bicyclist Strikes Stopped Vehicle
8	Motorist Left Turn - Facing Cyclist
9	Motorist Left Turn In Front Of Cyclist
10	Motorist Overtaking
11	Ride Out At Mid-block
12	Ride Out At Controlled Intersection
13	Ride Out From Sidewalk
14	Ride Out From Lane or Driveway
15	Wrong Way Cyclist
16	Cyclist Left Turn In Front Of Traffic
17	Cyclist Left Turn - Facing Traffic
18	Cyclist Lost Control
19	Cyclist Caught in Intersection
20	Cyclist Overtaking
21	Drive Into/Out of On-Street Parking
22	Other
23	Unknown

Contributing Factors

Code	Description
1	vehicular assault
2	child cyclist (inexperience)
3	cyclist inattentiveness/fail to yield
4	cyclist passing on right
5	cyclist disobeying traffic control
6	cyclist impaired
7	cyclist on wrong side of road
8	darkness/poor visibility
9	poor/wet road surface
10	mechanical defect (bicycle)
11	motorist inattentiveness/fail to yield
12	cyclist riding on sidewalk or crosswalk
13	streetcar tracks
14	motorist discharging passenger in l. lane
15	motorist improper/unsafe lane change
16	motorist impaired
17	sight lines obstructed
18	cyclist path obstructed
19	motorist failed to detect cyclist
20	motorist misjudged passing space
21	Motorist disobeying traffic control

Environment Conditions

Code	Description
1	Clear
2	Rain
3	Snow
4	Freezing Rain
5	Drifting Snow
6	Strong Wind
7	Fog, mist, smoke, dust
99	Other

Light Conditions

Code	Description
1	Daylight
2	Daylight, artificial
3	Dawn
4	Dawn, artificial
5	Dusk
6	Dusk, artificial
7	Dark
8	Dark, artificial
99	Other

Road Surface Condition

Code	Description
1	Dry
2	Wet
3	Loose snow
4	Slush
5	Packed Snow
6	Ice
7	Mud
8	Loose sand or gravel
9	Spilled liquid
99	Other

Traffic Control

Code	Description
1	Traffic Signal
2	Stop Sign
3	Yield Sign
4	Ped Crossover
5	Police Control
6	School Guard
7	School Bus
8	Traffic Gate
9	Traffic Controller
10	No Control
99	Other

Injuries

Code	Description
0	none
1	minimal
2	minor
3	major
4	fatal

Vehicle Type

1	Automobile
2	Motorcycle
3	Moped
4	Passenger van
5	Pick-up truck
6	Delivery van
7	Tow truck
8	Truck - open
9	Truck - closed
10	Truck - tank
11	Truck - dump
12	Truck - car carrier
13	Truck - tractor
14	Municipal transit bus
15	Inter-city bus
16	Bus (other)
17	School bus
18	School van
19	Other school vehicle
20	Motor home
21	Off-road 2 wheels
22	Off-road 3 wheels
23	Off-road 4 wheels
24	Off-road - other
25	Motorized snow vehicle
26	Farm tractor
27	Other farm vehicle
28	Construction equipment
29	Railway train
30	Streetcar
31	Snow plow
32	Ambulance
33	Fire vehicle
34	Police vehicle
35	Other emergency veh.
36	Bicycle
37	Taxi
0	Unknown
98	Truck - other
99	Other