Two-way Cycling on Local One-way Streets

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This document is part of a series of briefing notes documenting innovative municipal norms that have the potential to help create environments promoting safe active transportation by changing the design of streets or the organization of public roadway networks.

Here, "municipal norms" refers to public policies that are adopted or endorsed by elected municipal officials. The technical planning and execution of the work associated with these norms is done by authorized professionals. Nothing in this document should be construed as a recommendation or opinion requiring the professional judgment of engineers, urban planners, architects or any other professional.

The document discusses the introduction of two-way cycling (TWC) on local streets that are one-way for motor vehicles. TWC implementation varies on public roadways. The lightest "design," often found on streets with relatively low speeds and little traffic, involves signage (Figure 1).

The most elaborate design involves a track that is segregated from traffic by an above-ground built feature (concrete strip, bollards or flower pots, for example), as in Figure 2.[1] A range of streetscapes falls between these two extremes. The literature does not allow us to distinguish between the different streetscapes, so this briefing note does not cover any differences in terms of safety or user-friendliness.

Figure 1 Meeting zone in Senlis, France

A sign is the only "design" feature that signals two-way cycling access to the street.

Source: Flickr.com

Photograph: Alain Rouiller.

Figure 2 Two-way cycling on a bike path in Boulder, United States

Source: Flickr.com

Photograph: Kevin Zolkiewicz.

[1] Bike paths are generally recommended in areas with heavy motor vehicle traffic moving at high speeds. Following the logic used in the hierarchy of public roadways that has been developing over the last few years in the country's large municipalities, local streets should not be expected to see heavy traffic or high speeds. Moreover, although some studies of two-way cycling cover paths developed on local streets, they do not make it possible to isolate this type of situation. This briefing note therefore does not address the issues that would apply specifically to setting up paths on local streets.

Briefing Note

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As in the other briefing notes, we first suggest wording for a model norm as well as alternative wording to take variations in local contexts into consideration. The relevance of the norms should be assessed based on where they would be implemented in a given municipality. These are suggestions, not recommendations.

Model formulation for the norm

Cyclists will be allowed to travel in both directions on local streets or street sections which are one-way for other vehicles, where the municipality restricts speed to 30 km/h.[2]

Alternate formulation

Cyclists will be permitted to travel in both directions on local streets designated by the municipality that are one-way for other vehicles.[3]

Normative context

Many Canadian cities have local streets on which vehicles can only travel in a single direction, called one-way streets.[4] Some of these streets were built for one-way vehicle traffic. Others were turned into one-way streets even though that was not the original plan. Previously, they were two-way streets. There is little historical record of the reasons for turning local two-way streets into one-way streets. Some clues suggest that many of the changes occurred starting in the 1950s and 1960s as part of a strategy to streamline motor vehicle traffic (Walker, Kulash & McHugh, 2000; Ryley & Davies, 1998).[5] On the other hand, more recently some collector and local streets that are one-way for motor vehicles have been the focus of traffic- calming efforts designed to improve the living environment for residents and enhance the conditions for pedestrians and cyclists.[6]

As we will see later, introducing two-way cycling on local streets that are one-way for motor vehicles is not new in Canada. However, the development potential for this type of cycling infrastructure is not being fully exploited compared with its use abroad.

Desired benefits

Documents that provide a rationale for two-way bike access suggest that such infrastructure could provide for better safety or enjoyment in a number of ways. For one thing, many cyclists already illegally travel against traffic flow on one-way streets. Sanctioning the practice with signage, roadway markings and other appropriate layouts would be one way to increase the safety and comfort of a practice many riders already favour for these qualities, notably because they have a better view of motor vehicles when facing them.

In addition, TWC is generally introduced on local streets with relatively low traffic volumes and speeds. In Vancouver, Toronto and Montréal, for example, TWC has been implemented on local streets with light traffic and speeds that are restricted to 40 km/h or even 30 km/h and have some features that can reduce speed and traffic volume (bike lanes, deflector islands, speed humps, etc.). Europe, where two-way bike access is broadly deployed on local streets, seems to generally privilege a speed limit of 30 km/h when introducing two-way cycling. This is true even though two-way cycling is increasingly being found, with more elaborate streetscapes, on collector and arterial streets with 50-km/h speed limits (Jouannot, Deboudt, Lacroux, Philipon, &

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2 This norm was first applied in a number of European municipalities. In the last few years, norms making two-way cycling general in 30-km/h zones have been established by supra-municipal entities in France (all French municipalities) and Belgium (municipalities in the Brussels area), among others.

3 This norm is already in effect in a number of Canadian municipalities, and some provincial regulatory tools already provide a framework for it.

4 Many cities also have one-way arterial and collector streets, with some introducing cycling infrastructure in the opposite direction. For example, 91% of the 404 km of the “limited one way” capacity in *communes* in the Brussels area are found on local streets, with the rest on collector and arterial streets (Chantalon & Dupriez, 2014, 5). The norm discussed in this briefing note does not cover such collector and arterial streets. While introducing two-way cycling on collector and arterial streets seems to be spreading in Europe, the evaluations on which this briefing note is based focus almost solely on two-way cycling on local streets.

5 A presentation on the history of Montréal’s Ontario Street, for example, noted that the streets around Jacques Cartier Bridge were made one-way shortly before Expo 67 in order to regulate traffic flow. See: http://ville.montreal.qc.ca/portal/page?_pageid=5677,96817577&_dad=portal&_schema=PORTAL (retrieved June 29, 2015).

6 For example, a portion of Montréal’s Laurier Street was made one-way in the 2010s. At the same time, a two-way bike lane was added, along with a variety of features to improve walkability. See: http://ville.montreal.qc.ca/portal/page?_pageid=7297,89053614&_dad=portal&_schema=PORTAL (retrieved June 29, 2015, in French only).

Teissier, 2015). Among other things, the speeds on local streets are lower than on collector and arterial streets, so local streets are generally seen as having safety records that are appealing to those using active transportation, whether walking or cycling (Bellefleur & Gagnon, 2011; Grundy et al., 2009; Harris et al., 2013; Pucher & Dijkstra, 2003; Schepers, Twisk, Fishman, Fyhri, & Jensen, 2015). Streets with speed limits of 50 km/h or higher, as well as streets that also see heavy volumes of vehicle traffic, generally have a higher incidence of more serious collisions resulting in injury (Chantalon & Dupriez, 2014). Introducing two-way cycling on local streets would thus provide cyclists with a route in an environment that is already relatively user-friendly and relatively low risk in terms of the incidence and gravity of collisions resulting in injury. Similarly, it is thought that providing two-way bike routes could allow cyclists to avoid collector and arterial streets. This opportunity would be even more beneficial given that collector and arterial streets are not equipped with infrastructure to segregate bike traffic from areas where motor vehicle traffic can travel, which is generally the case in Canada.

Lastly, introducing two-way bike access would help make the bike network more dense. In many municipalities, collector and arterial streets are frequently separated by several hundred metres, or even one or two kilometres. Since users would not have to travel some distance off of the network in order to get to the network or to their final destination, the proportion of bike travel on the cycling network, and thus on safer, more user-friendly streets, would increase. A few studies have been done on two-way cycling that meet our selection criteria (n=6), enabling a partial assessment of whether such hopes are well-founded.[7] They concern both the safety and user-friendliness of two-way cycling access.[8]

Methodological information

The following terms were used to locate the evaluation literature: “double sens cyclable,” “double sens cycliste,” “sens unique limité ,” “contraflow cycling,” “contraflow cycle lane” and “two way cycling.” We used the INSPQ’s 360 meta search engine. It queried the following data banks: Ageline, BiomedCentral, PudMed, Ovid Medline, Medline Complete, CINAHL, EBM Reviews Full Text-ACP Journal Club, Cochrane DS and DARE, Embase, ERIC, Érudit, Health Policy Reference Centre, Highwire Press, ipl2, MetaPress Complete, Nature Journals, OAIster, Political Science Complete, Psychology and Behavioral Science, PsycInfo, Public Affairs Index, Science Direct, SocIndex. We also queried Google and Google Scholar. To be selected for this document, an evaluation had to feature a methodology that was explicit enough to be assessed and replicated, and deal with installed two-way bike access. “Predictive modeling” type evaluations were excluded. For Arlutz (2002), an English translation of the German original was used. For Bjornskau et al. (2012), the English abstract of the report (written in Norwegian) was used. The Ville de Paris evaluation includes a PowerPoint presentation and a written document.

In the United Kingdom, an evaluation of the introduction of five two-way cycling areas examined motor vehicle traffic flow at three of them, before and after two-way cycling was introduced. Traffic grew heavier in two cases, and fell in the third. The study also looked at traffic speeds before and after three TWC streets were introduced, showing an average decrease of 5 km/h in the V85, the speed under which 85% of motor vehicles travel (Ryley & Davies, 1998). The studies stress that speeds may be influenced by the presence of cyclists, but could also be affected by the fact that the roadway for motor vehicle traffic is narrower after a bicycle lane is added (Bellefleur, 2014).

The studies presented relative and absolute indicators regarding collisions and injuries.

Two studies used absolute indicators. The first study deals with the introduction of seven TWC streets in Paris, for which collisions (C), collisions with minor injuries (CMI), and collisions with serious injuries (CSI) were measured for different types of users (not just cyclists). Two measurements were taken before TWC were introduced, and one was taken afterward. Although cyclist traffic increased overall on the TWC streets, the absolute number of collisions and injuries

[7] No study was excluded based on the type of methodology, aside from a prospective modelling study. To be included, studies had to be empirical, deal with implementing two-way cycling, and include a methodology that was explicit enough for its details to be understood.

[8] Appendix 1 contains the detailed results of the evaluation, alongside results on the user-friendliness of two-way bike access for cyclists.

remained stable in relation to the first pre-introduction measurement and declined from the second pre-introduction measurement (Boulanger, 2012). These results seem consistent with the results of evaluations that used relative indicators, as will be seen in the next paragraph. According to another study, which compared the TWC network with the rest of the city's road network, 40 collisions resulting in injury or death (CID) were recorded over the entire network, none on the TWC streets, in the five years following introduction (Centre d'études techniques de l'équipement [CETE] de l'Est, 2008).[9]

With respect to relative indicators, a study in the Brussels area of Belgium shows that (1) the rate of collisions involving cyclists on streets with TWC is proportional: TWC streets represent 33% of the road network and have 31% of the collisions; (2) the rate at which cyclists are involved in collisions is slightly lower than the contraflow use rate of TWC streets: 44% of bicycle trips are contraflow on TWC streets, while contraflow use is implicated in 37% of collisions on TWC streets; (3) the rate for collisions on TWC streets which result in serious injury or death (CSID) is 4% for contraflow users and 8% for users travelling in the same direction as motor vehicle traffic (Chantalon & Dupriez, 2014).

The author of another study emphasizes that (1) the density of collisions involving cyclists (collisions per km of street) is the same on TWC streets and off them in 30-km/h zones; (2) the density of collisions involving cyclists is slightly lower on TWC streets in 30-km/h zones than on adjacent two-way streets; (3) collision density drops slightly after streets are turned into TWCs (Arlutz, Angenendt, Draeger, & Gündel, 2002).

Indicators of the user-friendliness of TWC streets for cyclists make it possible to measure the perception of the infrastructure's safety.[10] Thus, 79% of 134 survey respondents said they felt "very" or "somewhat" safe on TWC streets, 18% said they felt "somewhat unsafe," and none reported feeling "very unsafe." The same survey showed that motor vehicle speed was a factor in perceived lack of safety for respondents (Ryley & Davies, 1998). In another survey, most respondents reported considering the travel conditions on TWC streets to be "very good." In the same survey, pedestrians reported feeling less safe on the streets, but appreciated seeing fewer bikes travelling on sidewalks. In counts recorded at the same time as the survey, researchers found that bike traffic on sidewalks was lower (Bjornskau, Fyhri, & Sørensen, 2012).

Perception of the utility of TWC streets is another indicator of TWC user-friendliness covered by the first survey, which shows that a broad majority of respondents (133 out of 134) found being able to travel against traffic useful (Ryley & Davies, 1998).

Cyclist volume on TWC streets was covered differently by 4 of the 5 evaluations selected. The evaluations indicate that, in the vast majority of cases, cyclist volume increases substantially after TWC streets are introduced. This is true for both contraflow cyclist traffic (apart from one specific case in Paris) and for two-way cyclist flow (Bjornskau et al., 2012; Ryley & Davies, 1998; Boulanger, 2012). One case also showed that the increase occurred in conjunction with a decline on nearby "control" streets, suggesting that users changed their routes to take TWC streets. Another thing that emerges from the evaluations is that cycling's modal share is higher on TWC streets than on average in a city (Boulanger, 2012) or on similar non-TWC streets (Chantalon & Dupriez, 2014).

Summary

It seems that introducing TWCs tends to have no impact or to slightly improve safety on the streets involved. It also seems that TWC streets also have safety records equal to or better than comparable local one-way or two-way streets. Here, the results of the speed readings and safety record assessments are rather consistent. Also, cyclists seem very appreciative of TWCs for their contribution to the user-friendliness of the streets and road networks.

Potential drawbacks

Conflicts could arise between cyclists and people crossing on foot without looking in the direction opposite the one-way traffic flow. Because moving bikes are frequently almost inaudible, the sound signals that guide people who are moving (sound emissions of motor vehicles) do not alert pedestrians that a vehicle is coming. The evaluations frequently

9 The authors used the term "accidents corporel" which could be translated as "casualty accident," but we have used the terminology already introduced for consistency's sake.

10 A determinant of the perception of road safety, motor vehicle speeds were covered above.

noted this type of conflict, but collisions are rare and, in general, inconsequential.

Car dooring (a collision triggered by a motor vehicle's door suddenly opening) of cyclists is another phenomenon some authors report as a potential drawback of TWC streets. The evaluations reviewed did document some cases of this type of collision on TWC streets, but they did not seem to be more frequent or serious on these streets than on those without TWC. That being said, collisions do not seem to be more frequent or serious on TWC streets than when cyclists travel with the flow of traffic. Among other things, it seems reasonable to assume that car dooring is unlikely or even impossible in practice when bike traffic is protected by aboveground features (as in the Boulder example above), or when there is no parking on the TWC route's contraflow side of the street.

Implementation context

Some of the frequently-consulted TWC design guides set out criteria regarding the width of the roadway and the speed and volume of motor vehicle traffic to rule out instituting TWC on some streets, or to suggest specific designs. To illustrate, we present a few guidelines that are often found in TWC design guides, and provide some examples of their potential results:

- Minimum width. The guides frequently advise against introducing TWC on overly narrow streets. In France, the recommendation is not to set up TWC if the pavement is less than 2.5 m wide excluding the parking area (Centre d'Études sur les réseaux, les transports, l'urbanisme et les constructions publiques [CERTU], 2008).
- Maximum width. Beyond a given pavement width, specific designs are also frequently recommended. In the same French guide, a 4.5-m wide pavement prompts a recommendation for full separation markings (CERTU, 2008).
- Thresholds for motor vehicle flow. The volume of motor vehicle traffic (annual average daily traffic [AADT]) often determines specific design recommendations, or even the exclusion of some streets. This French guide advises against introducing a TWC on a street with an AADT of 5 000 when the volume is combined with a pavement width of less than 3.5 m (CERTU, 2008).
- Speed thresholds for motor vehicles. The speeds posted or practised lead to some recommendations or even regulatory requirements tied to the introduction or exclusion of TWC on some streets. Since 2010, it has been mandatory to put TWC on low-speed streets or street sections (30 km/h zones, meeting zones, for example) (CERTU, 2008). In Belgium, one exemption from the requirement to introduce TWC on one-way streets is an inability to limit motor vehicle speed (Chantalon & Dupriez, 2013).

Precedents

As mentioned above, the development of two-way cycling is fairly widespread in Europe, whether it involves an ad hoc or sector-based approach. Some jurisdictions that are most renowned for supporting safe cycling (cities in Germany, Denmark and the Netherlands) have been using TWC since the start of the 1990s in large sectors (in some countries of those countries, 80% of local streets are estimated to be TWC) (CERTU, 2008). Other jurisdictions, like France, Belgium and Switzerland, have been working to develop broad areas in which most local streets include TWC after having spot tested the design. In many cases, municipal implementation of TWC streets is actively supported by the state's regulatory framework (in some cases, as in Belgium and France, it is mandatory on streets labelled "30 zones" or "meeting zones).

In Canada, the current trend in municipalities is to restrict use of TWCs to specific streets, insofar as the aim is to create links between larger bikeways, such as designated streets, or bike lanes or paths. This is already occurring in Calgary, Edmonton, Halifax, Montréal, Toronto and Vancouver, among other places. In Vancouver and Toronto, two-way paths are often marked at the entrance to a street by a streetscape that defines the space for contraflow bike traffic (see Figure 3). Such devices are used to moderate the speed of motor vehicle traffic and create a feeling of safety for cyclists. As intersections pose a particular risk for collisions and the resulting injuries, it is interesting to note that special attention is being paid to these points in the network, even though the evaluative literature does not, to date, allow us to assess how they perform in terms of safety.

Facilitators

As shown by the development of numerous municipal plans for cycling and the extension of cycling infrastructure in Canadian cities, there seems to be strong demand in many Canadian municipalities to create denser cycling networks that are better linked and safer. If, in general, we first think of introducing protected bike lanes or bike paths on the arterial network to achieve this, the compromises in terms of the space available for motor vehicles and the costs involved in developing protected paths are among the main reasons for the slow development of such cycling networks. Whether here or in countries that actively encourage the use of cycling on a daily basis (utility cycling), bike paths that are segregated by design features other than marking or signage are only generally built on municipal arterial networks or along rural roads. However, the magnitude of the local street networks (together, two- and one-way streets often account for 70% to 80% of a municipality's roads), the relatively high level of acceptability of lowering speed limits on this network, and the relatively light infrastructure needed to deploy two-way cycling make this design a relatively easy solution for decision makers.

Among other things, the breadth of the roadways of local one-way streets in Canadian cities means that most streets are wide enough to host TWC, even if we consider cases that, according to European guides, would call for separation layouts. Frequently, such streets have more than enough space to add a 3 m-wide traffic lane (the stipulated minimum in the Transportation Association of Canada's Geometric Design Guide) and a sufficiently wide bike lane.

Moreover, many geometric and technical design guides[11] sanction TWCs (Ministry of Transportation of Ontario, 2013; Vélo Québec, 2009). The Québec and Ontario highway safety codes have sanctioned TWC since 2011 and 2015 respectively, providing an additional facilitator.[12] [13]

[11] A geometric design guide is a document that defines the recommended standards for engineers in planning road infrastructure. It does not have the force of law, but sets out the approach privileged by the engineering community.

[12] See: http://www2.publicationsduquebec.gouv.qc.ca/dynamicSearch/telecharge.php?type=2&file=/C_24_2/C24_2_A.html (retrieved February 12, 2016).

[13] See: http://www.ontla.on.ca/web/bills/bills_detail.do?locale=en&Intranet=&BillID=3057 (retrieved August 11, 2015).

Figure 3 A two-way cycling street in Vancouver, Canada

The entrance for contraflow bikes is marked by a deflector island that features a curb extension.

Source: Flickr.com

Photograph: Richard Durdl.

Obstacles

The perceived dangerousness of two-way cycling paths seems to be the primary reason for their limited development in Canadian cities. Based on the evaluations reviewed, this perception seems unjustified, at least on routes on which the speed practised is 50 km/h or less.

Another potential obstacle to the full development of TWC on local streets is the regulatory impossibility of introducing unsegregated TWC, (i.e., TWC streets where a line marking off the space reserved for bike traffic would not be required). This requirement could impede the development of TWC on streets whose pavement is not wide enough to accommodate such demarcation. To address this, it would be necessary to propose and wait for changes to normative provincial codes.

Related norms and regulations

30 km/h on local streets; pedestrian priority streets; roadway width.

Implications for practice

The norm discussed in this briefing note excludes the issue of introducing TWC on collector or arterial streets. The only evaluation that focused on this type of infrastructure suggests that the installation of TWC on these types of streets is not as critical a determinant for the incidence and gravity of collisions involving cyclists as the street's place in the road hierarchy (Chantalon & Dupriez, 2013). The study stresses that the distribution of the level of risk in TWC and non-TWC streets in the Brussels area is of the same order, at a comparable hierarchical level. According to the study, the level of risk is, overall, 2 to 4 times lower respectively for local streets than for collector and arterial streets. Still, given the paucity of experiments abroad and the low number of evaluations, we have taken a conservative position and postponed discussion of TWC on collector and arterial streets. Among other things, it seems more prudent to broaden testing of TWC in Canada on local streets, where the potential is great, and then to expand implementation after that, somewhat as was done in Brussels.

Public health actors who believe the model norm discussed is relevant but who are working in contexts that are so far without TWC streets could have difficulty gaining immediate acceptance for a norm that calls for TWC on most local streets. It could be best to proceed in accordance with the current Canadian trend, that is, to target specific sections that can link up a municipality's large bikeways. This could be a first step toward eventual normalization.

For public health actors who think TWC is relevant and are working with municipalities that already have TWC streets, the main issue is broadening implementation. Deployment could occur by identifying other specific sections that could round out the existing bike network, but it could also come through an effort to have the practice accepted as normal which, in return, requires pinpointing exceptions in which TWC would not be introduced for a variety of reasons. To do this, at the outset it would be possible to rely on the exceptions noted above (limited lane widths and other constraints), while remaining alert to local characteristics that could justify others. A related issue—one that is inextricably linked given the model wording of the norm—is limiting motor vehicle speed. The evaluations summarized here primarily focus on TWC on local streets where speed is limited to 30 km/h or less, which is uncommon in Canada, although a growing share of the municipal road network is being given this rating on an ad hoc basis (around schools and parks, for example) or sector basis.[14] If limiting speed this way is deemed essential, discussions would have to be launched concerning speed limits on local streets. However, it may be desirable, although not required, to produce a safety report on TWC implemented on 40 km/h roads before going any further. For now, there is no indication that TWC on local streets with this speed limit pose a particular safety problem. Once again, the model norm reflects a conservative perspective based on existing evaluations.

Also, an issue common to both contexts of practice is to advocate for changes to the provincial normative framework, i.e., highway safety codes and design guides. Where codes and guides already permit it, the main issue is to codify the implementation of TWC with no bike lane, but with either pictogram markings or arrows on the pavement. This approach would make it possible to put TWC on streets that are slightly narrower than the currently required width.

Lastly, it may seem important to differentiate between the various types of two-way cycling streetscapes—from the lightest to the most elaborate. However, as was emphasized above, the evaluative literature does not yet differentiate between the various effects produced by each type. It could suffice to simply follow existing European practice guides, which suggest that layouts should be made more elaborate as factors such as speeds and traffic volumes rise. It seems reasonable to accept this proposal until such time as evaluations point to a different conclusion.

[14] On Montréal's South Shore, Saint-Lambert set a 30 km/h speed limit for local streets in 2009, while five Montréal boroughs (Outremont, Sud-Ouest, Rosemont-La-Petite-Patrie, Plateau-Mont-Royal and Mercier-Hochelaga-Maisonneuve) did the same for much or all of their respective local street networks; two Toronto community wards (East York and Downtown) did the same in June 2015.

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Appendix 1 Evaluation results of two-way cycling routes

Indicator / Evaluation	Speeds and volumes of motorized vehicles	Collisions	Conviviality for bicycle users
Ryley & Davies (1998). **Evaluation of 5 two-way cycle (TWC) routes (one was cut into two segments for the purpose of the evaluation).** **TWC routes present variations in their design with respect to the volumes and speeds of motorized vehicles, in the pedestrian and cycle users' flows, and in the right of way.** **Data gathering techniques: municipal databases, video recordings, and interviews with cyclists.** **Before/after comparison for 3 out of 5 interventions. Interviews conducted after the TWC implementation with 134 bicycle users at each of the 5 interventions.**	Traffic flow (7h) of motor vehicles 110 to 903 (average: 495). In two cases, the volume increased, and it decreased in the other. V85 after: between 24 and 37 km/h. * In the three cases where a measurement was taken, the V85 had slightly reduced (from 2 to 8 km/h, with an average of 5 km/h).	No collisions before (3 years) or after for 4 of the TWC routes. No collisions before (4 years) or after (3 years) the fifth TWC evaluated.	Average increase of 54% of the number of cyclists passing on the streets where TWC was implemented (n=167 before and 257 after). Cyclists passing in counterflow: 41% before, 49% after (not statistically significant). During the 56 hours of video footage, no dangerous situation for bicycle users was observed. 133 of the 134 respondents claimed it was useful to be allowed to cycle in counterflow; 79% claimed feeling very secure or sufficiently secure, with 18% feeling a low sense of security and none reporting a very low sense of security. The speed of motor vehicles was noted as a factor of insecurity by the respondents.

* V85 = the speed under which 85% of vehicles travel. CID = Collisions with injuries and death. CSID = Collisions with serious injuries and death.

Appendix 1 Evaluation results of two-way cycling routes (cont'd)

Indicator / Evaluation	Speeds and volumes of motorized vehicles	Collisions	Conviviality for bicycle users
Chantalon & Dupriez (2014). **Evaluation of the relative risk for bicycle users in TWC routes in relation to the balance of the Brussels region (between 2008 and 2010 for the whole region, but also between 2005 and 2007 for the few municipalities where TWC routes were implemented in 2005). Identification of the ratio of collisions where a bicycle user was travelling in counterflow on a TWC route. Analysis of the circumstances of the collisions and of the role of the infrastructure in the collisions.** **Methods: mapping of the collisions that distinguish if they happened on a TWC route or not. Use of collision analysis forms (systematic underestimation of the number of collisions, especially for light injuries).** **234 collisions involving cyclists on TWC routes were assessed in detail - from the 992 collisions involving cyclists registered in the reference period. Analysis carried out from the police reports examined factors associated with the spaces where they happened, the users involved, the process of the event and multiple factors precipitating collisions. In situ visits were made to understand the potential role of infrastructure in the collisions.**		12.7% (126) of the 992 collisions involving cyclists happened on a TWC route or when they were in an intersection, moving toward a TWC route. 4.7% of the 992 collisions involving cyclists happened while they were moving counterflow on a TWC route. 48% of the 992 collisions involving cyclists happened in an intersection. 49% of the 126 collisions involving cyclists on a TWC route happened in an intersection. 50% of the collisions of cyclists in a TWC in an intersection happened while the cyclist was moving counterflow TWC streets represent 33% of the total length of the local streets and 31% of the collisions involving cyclists on the local network. Bicycle users involved in one of 126 collisions on a TWC route were moving counterflow in 37% of the cases and with the flow in 55% of the cases. Rate of collisions resulting in CSID in a TWC: 3.8% for bicycle users moving counterflow ; 8% for bicycle users moving with the flow	Slightly more users per 20-minute period on TWC streets as compared to one-way streets without TWC. 44% of the movement is counterflow on TWC routes.

* V85 = the speed under which 85% of vehicles travel. CID = Collisions with injuries and death. CSID = Collisions with serious injuries and death.

Appendix 1 Evaluation results of two-way cycling routes (cont'd)

Indicator / Evaluation	Speeds and volumes of motorized vehicles	Collisions	Conviviality for bicycle users
Centre d'études techniques de l'équipement de l'est (2008). **Evaluation of the safety record of TWC on local streets of a municipality in the suburbs of Strasbourg (France). The municipality transformed most of its 30-km/h zone local streets to include TWC. Some function as links between two cycle paths, others are intended to shorten the distance that cyclists need to travel.**		Over a period of five years after the implementation of TWC (presumably 2003-2008), 40 CID (for cyclists) happened in the city, but none where TWC was implemented.	
Arlutz et al. (2002). **Evaluation of the safety record of 669 local 30-km/h zone one way street sections, including some TWC routes. Before/after analysis on TWC street sections.**		The density of collisions (collisions/km of street) involving cyclists is equivalent in street sections with or without TWC. The density of collisions involving cyclists is slightly lower in 30-km/h zone one way street sections than in nearby TWC street sections. The density of collisions lowers slightly after the transformation of the street section to a TWC route.	

* V85 = the speed under which 85% of vehicles travel. CID = Collisions with injuries and death. CSID = Collisions with serious injuries and death.

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