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Proximity to four bikeway types and neighbourhood-level cycling mode share of male and female commuters

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1 INTRODUCTION

In countries with little cycling, route safety concerns are the major deterrent and designated bike infrastructure is the major motivator. [1-3] In North America, large cities with more bike infrastructure have city-wide mode shares of 2 to 6%, while those with little often have mode shares near zero. [4,5] Within cities, there can be even greater differences in mode share (e.g., 0 to 34% across census tracts in 24 US and Canadian cities), and neighbourhood mode shares are positively associated with nearby bike infrastructure. [4]

There is consistent evidence that bike infrastructure in general is associated with more cycling, but could the type of infrastructure also make a difference? Survey data indicate preferences for certain bikeway types, especially among those who are most concerned about safety: women and people with children. [1-3,6] Here we examine two of the largest Canadian cities, Montréal and Vancouver, both with higher than average cycling mode shares and substantial between-neighbourhood variability in cycling. Both provide a variety of bike infrastructure including designs perceived and demonstrated to be safer [7,8], but the extent of each and the resulting network patterns differ. We examined whether commuter cycling mode shares at the neighbourhood (census tract) level are higher when bikeways were closer to where people live, and whether the type of bikeway, slope on the routes to bikeways, and commute duration made a difference. We also examined whether associations differed for male and female commuters.

2 METHODS

Commuting data were abstracted from the 2011 National Household Survey, which included input from households with approximately 460,000 residents in Montréal and 140,000 in Vancouver. For each census tract, data were abstracted on commute time by any mode, the total number of commuters, and the number of commuters usually using each of the following modes to commute from home to work: cycling; walking; public transit; and car, truck or van as driver or passenger. Data were also abstracted for females and males separately.

ESRI Shapefiles were used to perform Geographic Information Systems analyses using ArcGIS 10.2. The surface displacement distance from each parcel along the route network to the nearest bikeway access point was calculated for the bikeway network as a whole and each of four bikeway types: cycle tracks (alongside streets and also called separated, segregated, or protected bike lanes); on-street painted bike lanes; residential street bikeways (also called bike boulevards); and paved off-street bike paths. For each route from a parcel to a bikeway, the maximum absolute slope and maximum uphill slope were calculated.

All data analyses were conducted using R or JMP 12. Inferential analyses (generalized linear model, quasi-Poisson) examined the associations between cycling commute mode share and each of the following independent variables: proximities to any bikeway and to each of the four individual bikeway types; maximum directional and absolute slopes to the nearest bikeway; and commute time. City was included as an independent variable in every model to account for within-city correlation not explained by the other fixed effects. Analyses were repeated for male and female commuters separately.

3 RESULTS AND DISCUSSION

In 2011, Montréal had ~ 450 km of bikeways with similar lengths of the four bikeways types. The city had an overall cycling commute mode share of 2.7%, with a broad range across its 517 census tracts, from 0 to 20.4%. Vancouver had ~ 240 km of bikeways, 65% of which were residential street bikeways. The city had an overall cycling commute mode share of 4.3%, and a range across its 117 census tracts of 0 to 14.9%.

Table 1 provides summary data for four categories of cycling commute mode share. Montréal had a higher proportion of census tracts with zero mode share, not surprising because the area included (the "census consolidated subdivision") includes not only urban but also suburban and rural areas. In addition to the large number of census tracts where no one commuted by bike, Montréal also included a large number with mode shares of 7% and higher (n=87). In census tracts with higher cycling mode shares, the proportions of bike commuters who were female were considerably higher, approaching parity with males, underscoring how important it is to appeal to women to achieve high cycling mode shares. Census tracts with higher mode shares had consistently closer mean proximities to any bikeway and to each of the four bikeway types. Census tracts with higher mode shares also had lower mean maximum uphill slopes to the nearest bikeway of any type, but no pattern was seen for absolute slopes. Commute times were shorter in census tracts with higher mode shares.

Table 1. Census tracts categorized by cycling commute mode share: summaries for various characteristics

	Cycling commute mode share categories (%)			
	0	**0.5 to < 2.5**	**2.5 to < 7**	**7 to 20.4**
Number of census tracts	203	156	163	112
% of census tracts Montréal (n=517)	35.6	24.0	23.6	16.8
Vancouver (n=117)	16.2	27.4	35.0	21.4
% of bike commuters who were female	-	11.2	30.3	43.5
Mean distance (km) to Any bikeway	0.63	0.50	0.33	0.30
Cycle tracks	1.41	1.42	1.14	0.79
Painted bike lanes	1.68	1.39	1.06	0.84
Residential street bikeways	1.42	1.24	0.69	0.69
Off-street bike paths	1.35	1.27	1.20	0.94
Mean maximum uphill slope (%) on route to nearest bikeway	0.94	0.94	0.63	0.68
Median commute time (minutes)	30.1	26.0	25.7	25.5

In inferential analyses, closer proximity to any bikeway was associated with more cycle commuting; one-kilometer closer proximity was associated with 3.9 times higher cycling commute mode share. Closer proximity to cycle tracks was associated with higher cycling commute mode share in both cities, about 1.5 times higher with 1 km closer proximity. Cycle tracks provide especially safe space for cycling alongside major streets [7,8], and since such routes often provide access to work destinations, their consistent association with commute mode share is reasonable. Associations with all other individual bikeway types differed by city. In Montréal, all bikeway types were associated with higher cycling mode share. In Vancouver, residential street bikeways had strong associations with cycling mode share, but proximity to painted bike lanes (less safe than cycle tracks on

busy streets) [7] and off-street bike paths (less en route to destinations) did not. These differences suggest that the network formed (Figure 1) by all bikeway types in Montreal and by residential street bikeways in Vancouver may be a more important driver of cycling mode share than some bikeway design characteristics. Higher maximum uphill slopes along the route to the nearest bikeway were associated with lower cycling mode share. Census tracts with median commute times of 20 to 29 minutes had higher cycling mode share than those with both shorter (< 20 minutes) and longer (≥ 30 minutes) commute times. All results were similar for male and female commuters, but associations were stronger for females.

4 CONCLUSIONS

In Montréal and Vancouver in 2011, there was substantial variation in cycle commuting at the neighbourhood level. The variation was positively associated with intermediate commute times, and with greater proximity to any bikeway and to specific bikeway types. Cycle tracks and bikeways that formed a connected network were associated with higher neighbourhood commute mode shares. These features were even more important to women, and their cycling (or not) was strongly related to overall cycling mode shares.

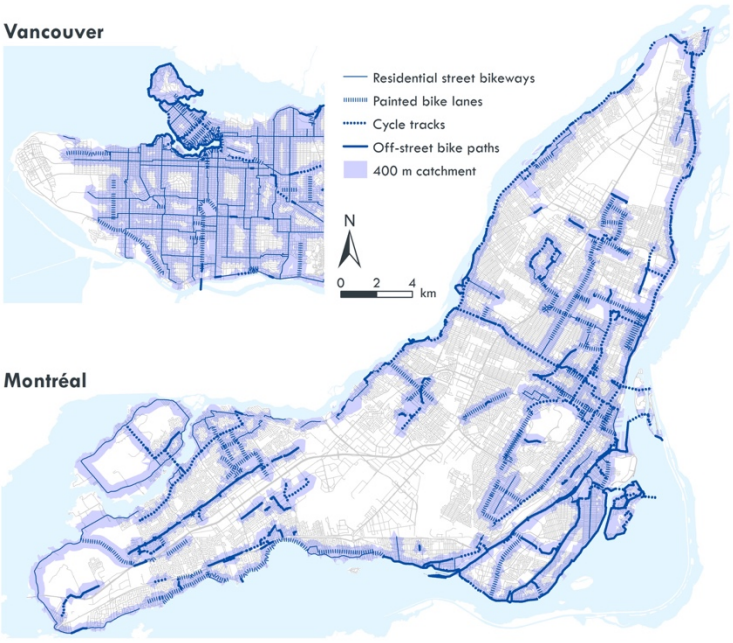

Figure 1. Maps of the Montréal and Vancouver census consolidated subdivisions showing four different bikeway types available in 2011.

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