Overcoming barriers to cycling: Understanding frequency of cycling in a University setting and the factors preventing commuters from cycling on a regular basis

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ABSTRACT

Much local and regional transport policy is attempting to increase cycling as an everyday mode of travel through infrastructure changes, education initiatives, and safety campaigns. While considerable research has examined the influence of the built form on cycling, less research has examined the barriers that prevent people who wish to cycle more (as part of their routine) from doing so. This study examines several factors influencing the frequency by which people do (and do not) cycle in a campus setting in a large metropolitan area. Mixed methods reveal differences between barriers to cycling as well as the relative strength of these barriers across categories of age, sex, and current mode used. A multinomial logit model, which controls for residential self-selection effects, predicts whether and how often a respondent cycles based on socio-demographic and trip characteristics. The presence of cycle paths is found to be strongly associated with a higher frequency of cycling commutes. Additionally, an analysis of stated barriers reveals effort and a lack of safety as the most important barriers to potential cyclists. Finally, a qualitative analysis of respondents' open-ended responses confirms the influence of bicycle paths, but reveals other factors such as the importance of improved interactions among various street users. Findings from this research can be of benefit to transportation engineers and planners who are aiming to increase the use of cycling among various groups of commuters.

Keywords: Barriers, Active Transportation, Cycling, Mixed methods, Mode choice, Cyclist types

1.0 INTRODUCTION

Recent decades have seen an increase in urban policy geared toward increasing active transportation as well as a heightened awareness of its importance in terms of public health, the environment, and congestion alleviation. Therefore a substantial amount of research in the fields of transportation, health, and psychology has sought to identify factors influencing the uptake of cycling as a mode of transportation. Many have recognized spatial and built environment factors as influencing transport mode choice, especially how they affect cycling (Dill & Voros, 2007; Jensen, 1999). Others have identified socio-economic and demographic factors associated with active transport (Jensen, 1999; Kaczynski, Bopp, & Wittman, 2010; Larsen, El-Geneidy, & Yasmin, 2010; Manaugh & El-Geneidy, 2011; Titze, Stronegger, Janschitz, & Oja, 2008). In addition to looking at determinants of cycling, research has also turned to barriers to cycling, that is the factors that prevent people from cycling, such as safety, effort and comfort concerns. However, most of these studies do not gage the relative importance of these barriers in preventing potential users from adopting active modes (Forman et al., 2008; Yeung, Wearing, & Hills, 2008).

Furthermore, few examples of past research focus explicitly on barriers to active transportation for those who in fact intend or would like to use active modes on a regular basis but who currently do not. Thus, this study seeks to understand current cycle use and to answer the following research questions: What are the most important barriers preventing commuters from adopting cycling as a routine mode of transport? How do these barriers differ by spatial and socio-economic characteristics? This study examines commuters from a large University travel survey and aims to identify, measure, and compare the presence and relative importance of barriers for different socio-economic groups, based on actual cycling frequency as well as stated elements. This study contributes to the literature by using actual travel behavior and incorporating mixed methods. Also, by focusing on the commuters who wish to cycle more, this research can aid policy makers tapping into this latent demand for active transportation.

This paper is structured as follows: we briefly introduce key concepts and findings from the existing literature on motivators and barriers to cycling. Next, the data and methods are described, followed by our results and analysis. We conclude with a discussion of what these findings imply for policy.

2.0 LITERATURE REVIEW

Barriers to cycling are defined in the literature as factors that prevent commuters who wish to cycle more from doing so and can be classified in three broad categories: individual factors, social and cultural factors, and built environment factors. A large body of literature has looked at correlates, barriers, and facilitators to cycling (Bauman et al., 2008; Daley & Rissel, 2011; Gatersleben & Appleton, 2007; Titze et al., 2008). Yet, many of these studies focus on the physical infrastructure. As such, the lack of bicycle lanes and traffic characteristics have been found to be major barriers to cycling. To a lesser extent, some studies have also addressed the social- and individual-level factors (Gatersleben & Appleton, 2007). Winters *et al.* (2011) looked at 197 “potential” and 107 “regular” cyclists (the former having expressed willingness to cycle and the latter having claimed to cycle at least once a week) and found differences in the barriers to cycling. For example, while a distance of 10-20 km was identified as a barrier for potential cyclists, it did not influence regular cyclists. In addition, Heesch *et al.* (2012) found gender differences in how recreational cyclists perceive environmental constraints for cycling.

Furthermore, Willis, Manaugh, and El-Geneidy (2013) found that cyclists' characteristics had more influence on trip satisfaction than built environment factors.

Recent studies have highlighted the need to go beyond quantitative methods to uncover social and individual barriers to cycling. Based on in-depth interviews, Schneider (2013) examined the thought processes of mode choice decision making; interview respondents provided rich detail on reasons why they do and do not use active transport. Recent work by Pooley and colleagues has taken a mixed method approach to investigate factors preventing from cycling. In a study examining the role of household level factors, 437 households responded to an online survey and eight households agreed to a more in-depth ethnographic interview. Among many findings, the authors explore the importance of time constraints, views, and perceptions about cycling for everyday activities as well as issues such as the need to plan ahead in order to make active trips cycle (wardrobe, choice of shoes etc.)(Pooley et al., 2011). A later study with respondents from four British towns identified several important aspects such as respondents believing that cycling would be a good way to save money, have health benefits, and be good for the environment, but that it would not be "enjoyable" (Pooley et al., 2013).

Gatersleben and Appleton (2007), in a mixed-methods study addressing barriers to cycling, categorized survey respondents by how frequently they cycled. Perceived constraints were compared between these groups in terms of "preparedness for cycling", on a scale from "pre-contemplation" to "maintenance". In a similar vein, much work in recent years has examined types of cyclists (Bergstrom & Magnusson, 2003; Damant-Sirois, Grimsrud, & El-Geneidy, 2014; Dill & McNeil, 2013; Geller, 2006). This body of literature is vital in understanding how different people will respond to policy, cycling infrastructure, and land use changes. The classification of people into cycling categories in the present paper most closely resembles the approach of Bergstrom and Magnussum (2003).

Although research has sought to identify the existence of barriers to active transportation, few evaluate their actual effect on commuters' actual use of active transportation (Shannon et al., 2006). In addition, relatively few have used a mixed-methods approach when doing so. This paper is among the first to both model the likelihood of cycling as well as to focus on the experienced barriers that prevent people from becoming cyclists or increase the frequency of bicycle commuting.

3.0 METHODS AND RESEARCH FRAMEWORK

This research was motivated by the desire to understand not only the correlates of current cycling behavior, but the factors that could be related to a change in cycling frequency. The stages of change model, an approach long used in behavioral change research (Prochaska & DiClemente, 1983), has recently been used in cycling research. This approach guides our research framework, design, and analysis here; we are interested in what physical and psychological factors may influence a person to move along a continuum from a "non-cyclist" to a regular commuting cyclist.

Using a large sample of cyclists and non-cyclists, four groups of cyclists were identified based on their cycling frequency. Then, acknowledging that one's frequency can either increase or decrease over time, we identified barriers to increased cycling, by comparing the cyclists with high and low frequency of cycling. After grouping commuters into four cycling frequency categories, statistical modeling allowed assessing the influence of the factors (socio-economic and built environment) associated with an increased frequency in cycling (from never to rarely, usually or always). The barriers were then further investigated through an analysis of the stated barriers and the respondents' open-ended responses.

The sample includes students, faculty and staff at McGill University in Montreal, Canada. Data for this study were collected using a survey that was active for 35 days in March and April 2013. A total of 20,851 survey invitations were distributed. Roughly 6600 people filled the survey (response rate of 31.7%). After data cleaning, 4,944 surveys were kept as usable responses for this study. In addition to socio-economic information (age, sex, employment or student status, household structure and income) and details of current travel patterns, respondents were asked to what degree they intend to use the modes of transportation they currently do not use. They were also asked to rate the barriers they faced for the mode that they were "least likely" to use again. Questions on barriers to mode use were asked as likert-type questions. The question was phrased, "Please specify why you don't cycle more often during your commute to McGill. Please choose the appropriate response for each item: Strongly disagree, somewhat disagree, neutral, somewhat agree, and strongly agree". The factors were: distance, effort, comfort, cost, safety, and availability of bicycle parking.

Respondents were asked to place a pin on an online map to represent their home location as well as the building on campus where they spend most of their time. This allowed for the calculation of the shortest network distance, elevation change, distance to cycling facilities, and presence of dedicated cycling infrastructure along the route to campus. Actual paths used by respondents were not available to the researchers; while this would have been ideal, the shortest path arguably better captures the variance in respondents' perception of their potential commute to work. Also, as the "never" cyclists would not have an observed path, this method does not introduce any biases or assumptions in regards to how far the respondents might be willing to divert from the shortest path distance (Gliebe and Dill, 2008).

Also, to account for issues of residential self-selection, respondents were asked to rate the importance of various home location factors (for example the desire to live close to campus or in close proximity to public transit). Respondents were also given the opportunity to respond to the following open-ended question: "Do you have any suggestions to encourage the use of sustainable transportation (cycling, walking, and public transit) to McGill?" All authors examined each open-ended response to code into a general theme, allowing us to measure the frequency of concepts mentioned. Quotes that illustrate important themes are presented in Section 4.

It is important to mention that while the sample is drawn from a University setting and so may not be representative of the region as a whole, an effort was made to oversample faculty and staff (itself a diverse category including technicians, janitors, and administrative assistants). Students make up 48% of the sample; the average age is 34.9.

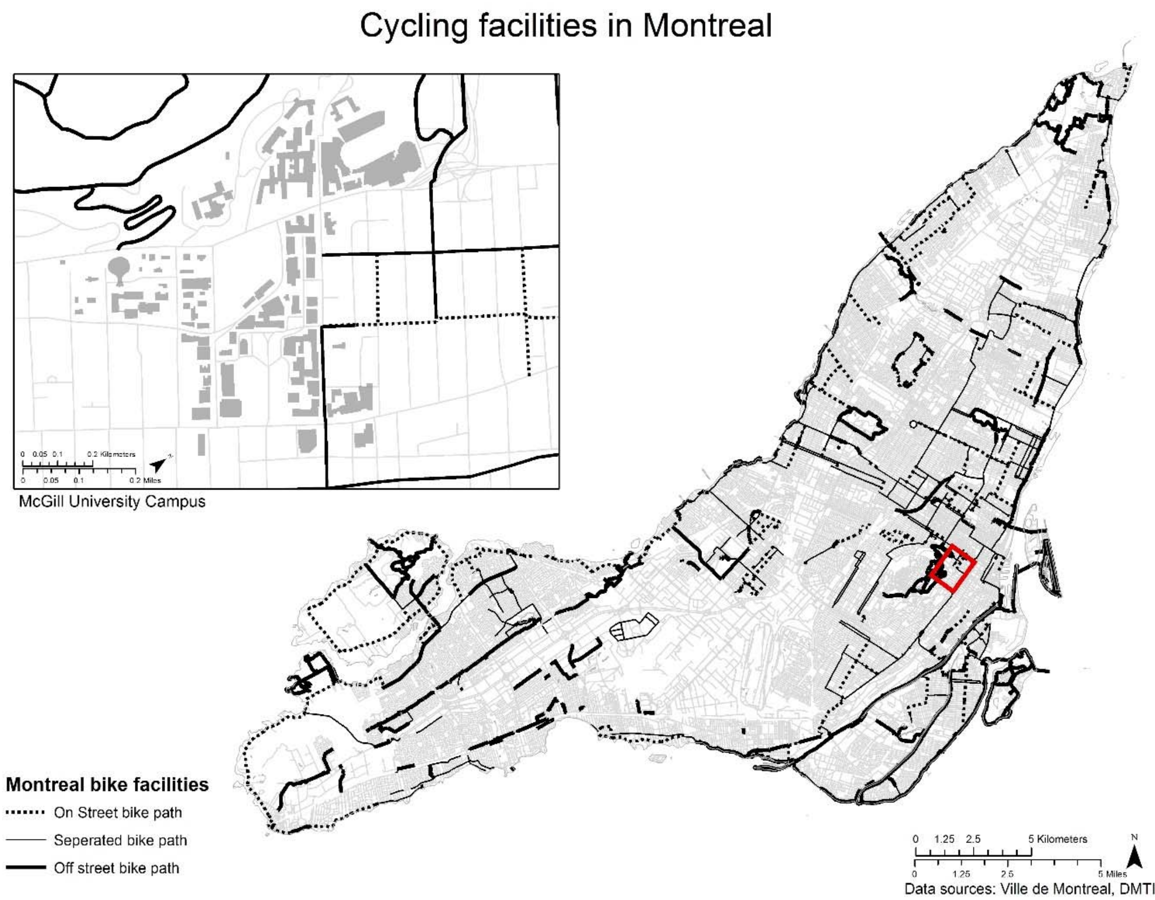
Based on information given in response to questions that asked respondents to describe their typical "warm dry" and "cold snowy" commute, as well as what modes they had used in the past year, respondents were divided into four categories of cycling types. These are "never" (have never cycled from their current home location to campus), "rarely" (had cycled at least once in the past year, but most often commute by other modes), "usual" (those that cycle as main mode during "warm dry" periods) and "always" (year-round cyclists).

After separating respondents into one of the four cycling categories, a multinomial logistic regression is used, as part of the mixed-methods analysis, to understand and quantify the effects of socio-demographic factors, route characteristics, and residential choice factors on the likelihood of falling into one of the four categories. After this, we focus on the "potential" cyclists (these are defined as people who are currently not cycling regularly ("never" or "rarely") but have expressed a desire to do so) and their expressed reasons for not cycling more often (both likert-type and open-ended questions). This approach allows us to capture nuances not only in what objective physical factors (age, presence of hills and bicycle paths) may influence cycling, but also to explore what reasons and perceptions respondents give to why they do not regularly cycle.

3.1 Area of Study

The City of Montreal has recently invested heavily in cycling infrastructure. The latest budget includes $10 million CAD per year for new and upgrading cycling infrastructure (Ville de Montreal, 2013). Figure 1 shows the location and type of dedicated cycling lanes in the city, the inset map shows a close-up of the McGill University campus, giving a sense of how well the campus is connected to cycle paths. The city currently has roughly 650 km of cycle paths, of which 41% is off street, although some of this, particularly in parks, is more used for recreation than for commuting. This is a higher than average amount for a North American city. For simplicity's sake, several different types of cycling infrastructure have been consolidated into the "on-street" category, these include, "sharrows", as well as lanes separated by a line of paint.

FIGURE 1 CYCLING INFRASTRUCTURE IN MONTREAL



4.0 RESULTS & ANALYSIS

4.1 Quantitative Results and Analysis

To begin, basic descriptive statistics for our subsamples of current cyclists and non-cyclists are presented in Table 1. Respondents are described in terms of age, gender, university status, and distance from destination. Similar to past research, we see that the vast majority fall into the "never" category (71%), and only 1.4% are in the "always" category. 13% of the respondents fall in the "rarely" category and 15% in the "usually" category.

ANOVA and Chi-square tests examine whether socio-demographic and physical characteristics are significantly different across groups. ANOVA post-tests allowed for the determination of which specific groups were different. We see that, for example, distance between home and destination is significantly longer for "never" cyclists. However, there is no significant difference among the other three groups of cyclists. Being male, on the other hand, is only statistically significant for the "always" cyclists. The "other" mode used by "rarely" and "usual" cyclists is also noteworthy; 41% of "rarely" cyclists walk as their most common mode; this speaks to the fact that many respondents live close enough to their destination that walking is a viable option. "Never" cyclists are also more likely to be automobile drivers than the other categories. The proportion of dedicated cycle path along the actual or potential cycling route is significantly different and as expected, higher proportion of cycle path availability is associated with higher levels of cycling.

The average elevation change is consistent across groups, although when expressed as a percentage of respondents with an elevation change of more than 30 meters, more "never" cyclists fit into this category. Lastly, roughly 75% of "rarely" and "usual" cyclists express the desire to cycle more often. This "latent demand" is important and points toward the value of understanding the barriers to cycling.

Table 1: Description of subsamples by frequency of cycling

	Never	Rarely	Usual	Always
Socio-Demographics				
Count	3502	642	731	69
Age	35.5	32.2	34.6	32.8
Male	33.4%	46.4%	43.5%	75.4%*
Staff	37.3%*	24.1%	28.9%	21.7%
Faculty	17.3%	19.0%	24.5%	21.7%
Student	45.4%	56.9%	46.7%	56.5%
Current Mode[1]				
Cycling	0%	0%	0%	100%
Automobile	19%*	8%	6%	0%
Park and Ride	11%	2%	1%	0%
Transit	49%	49%	68%*	0%
Walking	21%	41%*	25%	0%
Trip Characteristics				
Distance (m)	10865.0*	4972.4	5582.3	4947.5
Length of bike path (m)	2600.1	1541.4	2541.5	2147.9
Share of bike path	29.1%*	37.4%*	50.8%*	44.0%*
Elevation change (m)	59.0	58.4	59.2	58.7
Presence of Hill	62.7%*	54.4%	59.1%	52.2%
Mode Change Intention				
Percent who wish to cycle more	38.2%	74.9%	75.0%	43.5%

* Significantly different across groups (based on Tukey and LSD procedures)
[1] For "usual" cyclists, this refers to the "cold wet" mode.

4.1.1 Multinomial Regression Results

Table 2 presents the results of the multinomial logistic regression with the Relative Risk Ratio (RRR), this is similar to an odds ratio in a binary logistic regression and can be interpreted in a similar manner. In other words, the RRR represents the probability associated with a unit change in a given variable relative to the reference case ("never cycle for commuting purposes"). Other variables (including interaction terms gender*distance, and age*distance) were tested but were not significant in the models. Also, other variables commonly used in travel behavior research such as possession of a driver's license and car ownership were dropped from the model; over 80% of respondents possess a driver's license. While other modeling approaches were considered (such as a binary never/rarely and usual/always), the multinomial better captures the progression from a non-cyclist to a year-round cyclist which lies at the heart of the theoretical approach here. In other words, the MNL attempts to answer the question, what factors could convince a non-cyclist to sometimes, often, or always cycle.

Table 2 Multinomial Regression Results

		Rarely[1]	Usual	Always
Socio-Demographics	Faculty	1.441***	1.760***	1.225***
	Staff[2]	1.042	1.153***	0.878
	Male	1.694***	1.434***	5.934***
	Age	1.044	1.159***	1.104
	Age squared	0.999	0.998***	0.999
Trip Characteristics	Length (km)	0.918***	0.948***	0.918
	Percent Cycle path	1.008***	1.033***	1.019***
	Hill (>20 meters)	0.847**	0.983	0.822
Home Location Factors	Proximity to campus	0.959	0.917**	1.046
	Proximity to Transit	1.005	1.023	0.703***
	Desire to not use non-motorized transport	1.066*	1.166***	1.346**

[1] Reference case is "Never cycled from current home to work"
[2] Reference category is “student”
***= p<0.001, ** p<0.01, *p<0.1
Pseudo R square 0.135 McFadden
N=4944

Socio-demographic characteristics

The model has a reasonable explanatory power compared to previous research and most variables are significant with intuitively signed coefficients. Being male is significant in all models but the difference among the groups is striking. On average, the effect of age is positive, older respondents are more likely to cycle than younger respondents. Plotting the age and age squared terms shows that age has a positive effect on the likelihood of cycling until the age of 45. It is important to note, however, that given the characteristics of the sample, this may be due to the fact that many younger respondents live close to or on campus, potentially making walking a more attractive mode than cycling. Being a staff or faculty member is, on average more associated with being a cyclist than being a student.

Trip characteristics

The most interesting aspect in terms of potential infrastructure and policy change is the share of bike path along the respondent’s potential route. For a unit change in the increase of the proportion of designated cycle path, the associated RRR is 1.033 for a “usual” cyclist, and 1.019 for an “always” cyclist relative to a “never” cyclist. In other words, each percentage increase in cycle path coverage is associated with an increase of 3.3% and 1.9% respectively for being a “usual” or “always” cyclist. While the presence of elevation change has a small effect between being a “never” and a “rarely” cyclist, the effect is not significant for the other categories.

Home location factors

Distance from home to campus is significant in each of the model iterations, although the magnitude does not vary by cycling outcomes. The residential choice factors test the “self-selection" issue by attempting to control for the fact that some respondents may live in their current home location in order to use desired modes of transport. The associated coefficients show the importance of these factors. The "desire to use non-motorized transport" is positively associated with cycling, while controlling for trip characteristics. As would be expected, the effect of this attitude is increasingly important for each level of cycling use, being associated with a 34% increase in the likelihood of being an "always" cyclist. Having chosen the current home location based on "proximity to public transit" is significantly and negatively associated with being an "always" cyclist.

4.2 Barriers to cycling on a regular basis

The regression analysis sheds some light on the factors that determine what type of cyclist a respondent is. However, a more nuanced examination will allow us to make more informed recommendations as to policy and infrastructure changes. This is accomplished in three ways:

- A sensitivity analysis using the outputs of the logistic regression.
- An examination of "potential cyclists'" stated reasons for not cycling.
- An analysis of open-ended responses.

4.2.1 Sensitivity Analysis

To better understand the effects of socio-demographic, spatial, and infrastructure elements on the likelihood and frequency of cycle commuting, a sensitivity analysis was done. This was performed by predicting the likelihood of falling into each of the four cycling types given changing variables concerning age, distance, and proportion of potential path which is a cycle lane. Table 4 shows simplified results of this analysis with only three distances shown (3, 5, and 7 kilometers). Each row of the table shows the relative probability of a 34 year-old male of being in each of the cycling categories given changing distance and cycle path characteristics. It is important to reiterate that as year-round cycling is such an uncommon outcome, the model rarely predicts this outcome. This has important implications for the potential of mode shift, the model predicts that even under favorable conditions (3 km trip with 50% cycle path availability) 48% of the population will still fall into the "never" cycle category. In other words, this finding presents a realistic idea of how many people will cycle given these ideal conditions without exaggerating the potential market for cycling. The area of most interest is in examining at which thresholds the probability becomes higher to be "usual" cyclist than a "never" or "rarely" cyclist.

Table 3 Sensitivity Analysis

Distance (km)	Share of bicycle path	Never	Rarely	Usually	Always
3	0.33	0.57	0.21	0.19	0.03
	0.5	0.48	0.2	0.28	0.04
	0.75	0.35	0.17	0.44	0.04
5	0.33	0.6	0.19	0.18	0.03
	0.5	0.52	0.18	0.27	0.04
	0.75	0.38	0.16	0.43	0.04
7	0.33	0.63	0.16	0.17	0.03
	0.5	0.55	0.16	0.26	0.03
	0.75	0.41	0.14	0.41	0.04

The most striking aspect is the power of the presence of a bicycle lane. While the probability of “usually” cycling three kilometers (less than the average overall cycling commuting distance) with 33% cycle path coverage for a 34-year-old male is relatively low (19%), increasing the amount of coverage to 75% increases the probability to 44%. Interestingly, this stays roughly the same even with a much longer commute, 41% for a seven kilometer commute with 75% bicycle path availability. Similarly, a 5 km commute with 50% bicycle path coverage predicts a higher probability of “usually” cycling than being a “rarely” cyclist.

4.2.2 Barriers identified by potential cyclists

This section of the analysis focuses on “potential” cyclists and their expressed barriers to not cycling more regularly. This section uses data from both likert-type questions on the importance of different barriers and open-ended questions. This section is derived only from the responses of people who are not currently regularly cycling but have expressed a strong desire to do so (these respondents are drawn from both the “never” and “rarely” categories), this is a subsample of 295 people. Two key reasons make it important to perform this analysis in addition to the multinomial regression model. Firstly, many potentially important factors (secure bike parking, showers, for example) cannot be variables in the model (as there is no variance across respondents in the sample). Secondly, we are interested in knowing respondents’ perceptions about their reasons for not cycling. The model could easily lead us to overstate the importance of distance of (lack of) cycle paths, for example, as deterrents to cycling in the absence of corroborating evidence from respondents.

The survey asked respondents to rate the importance of elements that have been found to discourage cycling: distance, effort, comfort, safety, cost, and presence of bicycle parking. Table 4 presents these findings stratified by age, distance, and most common mode used.

Safety and effort were the most commonly cited barriers with the availability of bicycle parking following closely behind. Lack of safety was more prevalent among potential cyclists, being a concern for roughly half of them. The importance of safety in influencing cycling has effectively been shown in past literature (Gatersleben & Appleton, 2007; Heesch et al., 2012; Timperio et al., 2006).

Table 4: Barriers to Cycling as cited by Potential Cyclists (expressed in percentages)

Barrier	Length	Effort	Comfort	Cost	Safety	Parking	N
Average (out of 5)	**2.3**	**2.9**	**2.5**	**1.6**	**3.1**	**3.1**	**295**
Overall (%)	25.0	43.0	29.4	7.8	48.4	41.6	295
Age							
<25	20.9	41.9	24.7	11.4	52.3	46.6	105
25-34	25.8	52.8	37.1	7.8	44.9	35.9	89
35-44	21.7	43.4	19.5	6.5	34.7	47.8	46
45-54	30.4	17.3	21.7	4.3	65.2	43.4	23
55-64	45.8[1]	41.6	45.83[1]	0	58.3	33.3	24
>65	12.5	25	37.5	0	37.5	25	8
Sex							
Female	24.6	48.1[1]	28.5	9.1	48.1	45.4[1]	154
Male	24.6	38.8	30.6	5.9	50	36.5	134
Distance (km)							
<2.5	3.9	38.1	26.9	10.3	50	39.6	126
2.5-5	20.2	50.7	31.8	5.8	43.4	42.0	69
5.01-7.5	42	44	24	4	36	42	50
7.51-10	68.4[1]	52.6	36.8	10.53	57.8	42.1	19
>10	67.7	38.7	38.7	6.45	67.7[1]	48.3	31
Main mode of transportation							
Drivers	47.6	38.1	38.1	0	52.3	42.8	21
Transit users	45.0	48.8	32.1	6.8	45.8	39.6	131
Pedestrian	3.5[1]	38.4	25.8	9.8	50.3	43.4	143

[1] Statistically significant across comparison (vertical) category chi test ($p<0.05$)

It is not surprising that the perception of distance as a deterrent to cycling increases with actual distance. However, the importance of distance as a barrier to cycling increased and plateaued at different distances for men and women. While overall distance is a barrier for both men and women, the actual distance at which people state it as a barrier varies by sex. Starting at around 7.5 km, the difference in the proportion of men and women who cite distance as a major barrier to cycling increases, with 63% of women ‘agreeing' or strongly agreeing' that distance is a barrier to cycling at this distance, compared to roughly 50% for men at the same distance. While distance and elevation were determining factors for predicting cycling frequency, length of commute was the second least important barrier after cost according to the survey responses. This echoes the small effect of distance on cycling frequency, as found in the MNL. Yet, lack of bicycle parking and cost of cycling were generally higher for those living closer to their destination.

The importance of certain barriers differ by age group. Safety as a barrier to cycling increases in importance as age increases whereas discomfort remains fairly consistent across age groups (Table 4). Effort differs significantly by age group, with the youngest and oldest agreeing most with the presence of this barrier ($p<0.05$). Youth are also overrepresented among those perceiving cost as a barrier to cycling (p<0.05), a finding that contrasts with other studies that cite the low cost of cycling as a motivator for youth (Shannon et al., 2006).

The importance of certain barriers also varies by gender, as mentioned above. Despite being important for both females and males, effort and lack of safety stood out among females as being significantly more important as a barrier to cycling (p<0.05, p<0.1). A majority of cyclists would like to cycle more, further suggesting a relatively high potential and opportunity for growth in cycling among potential and even current users (Heesch et al., 2012).

4.2.2 Open-ended questions on barriers to cycling

In order to gain an understanding beyond what is provided by a structured survey questions, an analysis of open-ended questions was conducted. Both authors and a research assistant read each comment and coded according to general theme. This was done iteratively until both authors agreed on the proper category. We present basic percentages by theme and provide illustrative quotes in this section.

Somewhat surprisingly, weather conditions were not a prevalent concern among potential cyclists. The most common response (28%) concerns path infrastructure. For example, a 46 year-old male responded: *"1) Have bike paths put in practical places -- not impractical places like [a busy street]. 2) Enforce safety regulations for bike paths, ie: get cyclists to obey traffic signals, get pedestrians to look both ways on bike paths."* A 33-year male suggests *"[…] having bicycle lanes that are separated from traffic,"* would impact his sense of safety. Several others listed specific streets that they would like to see cycling infrastructure.

Other frequent responses relate to the bicycle facilities, such as parking, showers and BIXI stations. Bicycle parking and concerns of theft are quite common for potential cyclists; 24% of comments concern the availability and security of bicycle parking as a main deterrent of use. For example, a 27-year-old male pedestrian says, *"I worry about the safety of my bicycle locked outside. I've heard many stories of people losing their bikes to thieves."* Another was more direct, *"I would bike to school more if I had a cheap bike. The reason I do not bike to school is because I'm afraid my bike (or parts of it) will get stolen even if I lock it up." (32 year-old female).* "Shower and changing facilities were another theme (10% of comments). A 45-year male and current car driver says. "*Provide showers and secure/supervised bicycle parking*." Another surprising outcome has to do with the frequency by which BIXI (the local bicycle-sharing network) is mentioned (12%). The comments concern the number and location of stations, as well as the number of available bicycles. For example, a 28 year male responds, "*More BIXI stations around campus, especially [in the northern part of campus]*.

Interactions between different mode users also came up. Interestingly, some mentioned not only driver, but also cyclists' behavior *"Educate and regulate young bikers. Feelings of road entitlement work both ways"* (34 year-old male). Another (31 year-old female) mentions, "*jay-walkers downtown are very dangerous to bikers on paths.* Regarding the trip characteristics, elevation was a prevalent theme among potential cyclists with words like "mountain" and "hill" coming up fairly often, cited by 8.8% of the potential cyclists. Also, a 20 year-old female who lives 500 meters from her most common destination on campus wrote, "*I'd rather walk*" pointing out the importance of personal taste as well as the fact that trips that are *too* short may be difficult to convert to cycling trips (it is also debatable whether converting walking trips to cycling trips is a desirable goal). Another (30 year-old male student) pointed out *"I'm close enough that it would be insane to do anything other than walk".*

Finally, while they represent a smaller percentage, several people pointed out the effect that dropping children at daycare facilities. "*I have to bring my children to daycare at McGill and to school so there is no way to take a bike! If I were commuting without children, I would consider biking*" (38 year-old male student). *"I have to drop off a child at daycare on the way to work and I live too far away. That's why I don't bike"* (31 year-old female staff).

These results help to reinforce the model results and point to where policy can play a role. For example, cycle path coverage and the location of BIXI stations are under control of city transportation planners, while concerns of elevation change are, of course, not. Other comments and barriers are directly under the control of University policy such as showers, parking and change facilities. More importantly, many of the comments deal with factors that are difficult to capture and model in a mode choice model, such as the location of a child's daycare. Furthermore, while certain elements, such as elevation, were not significant—or had a smaller than expected effect sizes in the statistical models—the written comments allow us to capture the importance of this element for particular respondents. The variation in the distance and elevation change of people citing these factors also points toward the subjectivity of these elements, some people will perceive a given travel distance as acceptable while others will not.

5.0 DISCUSSION AND CONCLUSION

By examining current and desired travel patterns as well as barriers to change, this research identified four distinct groups of cyclists and has drawn attention to the latent demand for cycling among a large sample of commuters in Montreal, Canada. By better understanding the barriers experienced by those who wish to engage in active modes of transportation, public policy can be more appropriately oriented to affect behavior and mode switch. Since active modes have important public health, environmental and social benefits, it is a central goal of many regions, cities, and institutions to improve conditions for these modes.

Potential cyclists are affected by a complex array of barriers. The multinomial choice model and comparison of expressed barriers, revealed the importance of cycle paths, safety, and secure parking facilities. Comments and suggestions also confirmed and elucidated the importance of connected bicycle paths and proper intersection design, accompanied by a need for more secure and available bicycle parking.

This study reveals latent demand to take up or increase the frequency of cycling as a regular commuting mode among both cyclists and non-cyclists, roughly 75% of "rarely" cyclists and 38% of "never" cyclists wish to cycle more often. It is, however, also important to note that the model results as well as the responses to open-ended questions suggest that many people will never become "usual" or "always" cyclists although in many cases they are within a reasonable cycling distance. Furthermore, while it is important to bear in mind that the authors cannot with certainty claim that respondents would begin to cycle or increase the frequency at which they cycle, readers should be reminded that these barriers constitute expressed reasons preventing potential cyclists from changing modes. Most respondents in these subgroups explicitly said they would like to cycle more. Therefore, these findings have relevant implications for where active transportation policy needs to be oriented.

The findings concerning the relationship between perceived distance and objectively measured elevation change deserve more careful examination in the future. Future research should look further into distance perception and how it differs by a variety of factors that were unexplored in this study. Other important factors that were not explicitly explored in this study include: variance in the propensity to cycle by time of day (darkness and traffic levels), and influence of peer groups. Finally, the qualitative findings presented here point toward the usefulness of continuing to look beyond traditional travel survey methods to capture and understand what may be preventing desired travel behaviors.

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