Uniquely Satisfied: Exploring Cyclist Satisfaction

Devon Paige Willis
Research Assistant
School of Urban Planning
McGill University
Suite 400, 815 Sherbrooke St. W.
Montréal, Québec, H3A 2K6
Canada
Tel.: 514-398-4058
Fax: 514-398-8376
E-mail: devon.willis@mail.mcgill.ca

Kevin Manaugh
PhD Candidate
School of Urban Planning
McGill University
Suite 400, 815 Sherbrooke St. W.
Montréal, Québec, H3A 2K6
Canada
Tel.: 514-398-4058
Fax: 514-398-8376
E-mail: kevin.manaugh@mail.mcgill.ca

Ahmed El-Geneidy
Associate Professor
School of Urban Planning
McGill University
Suite 400, 815 Sherbrooke St. W.
Montréal, Québec, H3A 2K6
Canada
Tel.: 514-398-4058
Fax: 514-398-8376
E-mail: ahmedelgeneidy@mcgill.ca

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ABSTRACT:

Despite increasing interest and focus on cycling planning and infrastructure, many research and policy frameworks overlook two important aspects of cycling: motivations and trip satisfaction. While many studies have found that cyclists are more satisfied with their commute than other mode users, few have explored why. We hypothesize that different types of cyclists—defined by their reasons for cycling and seasonal mode patterns—will derive different levels of satisfaction from cycling. Therefore, this study attempts to 1) examine the effect of built environment characteristics (e.g. intersection density, land use), trip characteristics (e.g. distance and slope) and season on cycling trip satisfaction, 2) group respondents into 'cyclist types' based on a cluster analysis of motivations for cycling and their alternate (winter) mode, and 3) understand how these personal characteristics moderate the relationship between built environment and trip characteristics and expressed trip satisfaction. This is accomplished using a university-wide travel survey administered in winter 2011, in which commutes to McGill University were asked to report their last trip to McGill. If the person uses a different mode during the fall he was asked to report it as well. Individuals were also asked to report their level of satisfaction with these trips. Surprisingly, the expected relationship between distance, slope and objectively measured elements of the built environment and trip satisfaction was not found. Similar to previous research, cyclists are found to be more satisfied with their commute than other mode users. Year-round cyclists are less satisfied with their travel than those who only cycle in good weather; while "Cycling Enthusiasts" are significantly more satisfied than most cyclists motivated by convenience. This work emphasizes the need to look beyond the built environment and trip characteristics to better understand cyclist trip satisfaction.

KEYWORDS: Cycling, bikeability, trip satisfaction, motivation, active transportation, built environment

1. INTRODUCTION

Many studies have found that cyclists are more satisfied with their commute than other mode users (Turcotte 2005; London 2011). However, the reason for this high level of satisfaction is rarely explored. Much of the literature on cycling concerns motivators and deterrents to cycling. These studies have found that built-environment (e.g. land use, density, connectivity, street network) and personal (e.g. motivations, attitudes, perceptions) characteristics affect the likelihood to cycle for transportation (Timperio, Ball et al. 2006; Titze, Stronegger et al. 2007; Ogilvie, Mitchell et al. 2008; Robertson-Wilson, Leatherdale et al. 2008; Titze, Stronegger et al. 2008; Winters, Brauer et al. 2010). Fewer studies, however, have explored how these same elements may impact cyclist satisfaction. Many studies, especially those based on one-day travel surveys or cordon counts (without a corresponding questionnaire), may not be able to distinguish long-term, seasonal behavior. This study stresses that people, especially cyclists in our study area of Montreal, Canada use various modes throughout the year.

We hypothesize that the two most important factors in differentiating among cyclist types are a cyclist's "bad weather" or winter mode and their reasons for choosing to cycle (Jensen 1999). Further, we hypothesize that a person who cycles simply because public transit is not a convenient or affordable option will experience her trip differently than a person who is actively seeking exercise or trying to engage in environmentally-friendly behavior. An aspiring environmentalist who is "forced" to drive in winter due to distance or lack of transit service may view her fall cycling trip quite differently than a person who walks or uses public transit in the winter. In addition, we hypothesize that different types of cyclists will respond differently to commonly-cited elements of the built environment such as bicycle lanes and land use mix. For example, more experienced cyclists may be much less affected by the presence or type of bicycle lanes. Many studies of active transportation assume—at least implicitly—that these elements uniformly affect both mode choice and traveler satisfaction, however recent work (Waterman 2005; Manaugh and El-Geneidy 2011), has found significant variation in how elements of neighbourhood walkability affect members of different types of household and how reasons that people walk moderate perception and satisfaction with walking trips.

This research framework expands on the work of Alfonzo (2005) who identified a "hierarchy of walking needs". Alfonzo's social-ecological framework sheds much-needed light on how personal, household, and cultural factors interact with objective physical elements of the natural and built environment to lead to travel choices. The general research framework is presented in Figure 1 showing that physical characteristics of a cycling trip (which include distance, slope, land uses, density, and connectivity), do not lead directly to trip satisfaction but are filtered through socio-economic factors (age, income, gender). Finally, and perhaps most importantly, personal values, beliefs, and reasons to cycle will ultimately moderate the derived satisfaction from a cycling trip.

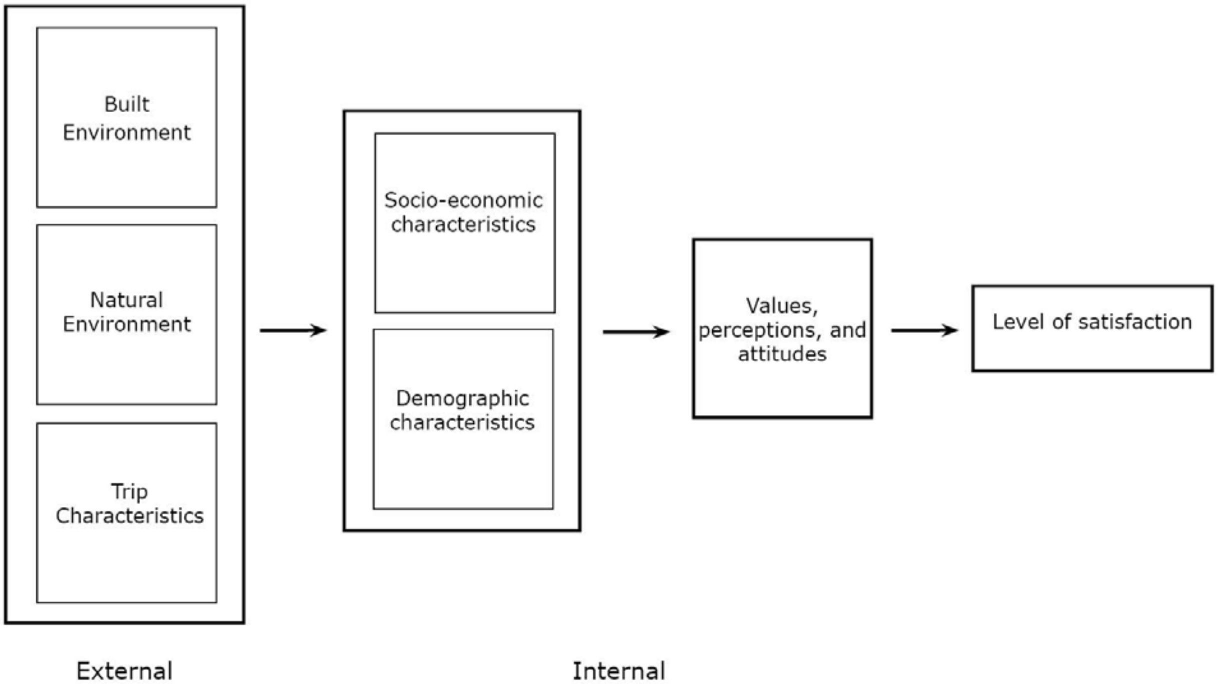


FIGURE 1: Research Framework

With these issues in mind, this research aims to address three main questions: 1) Do established correlates of bicycle commuting (built environment, distance, slope) also influence cyclist trip satisfaction? 2) What types of cyclists can be identified based on motivations and seasonal mode use? And 3) How do cyclists' personal characteristics (winter mode, motivations) affect trip satisfaction? As mentioned above, we hypothesize that the reasons that one cycles may have a greater impact than elements of built environment and distance.

The next section will provide a brief review of relevant literature, followed by a description of the survey instrument and methodology. This will be followed by our findings and discussion, finally, directions for future research will be presented.

2. LITERATURE REVIEW

The literature on cyclist trip satisfaction is generally limited. It concentrates on surveys describing cyclist satisfaction without analyzing this satisfaction (Turcotte 2005; London 2011). The literature of types of cyclists is bigger, segmenting cyclists according to the frequency of their bicycle trips, trip purpose, stereotypes about cyclists and cyclists' motivations and attitudes (Jensen 1999; Bergstrom and Magnusson 2003; Anable 2005; Gatersleben and Haddad 2010; Larsen and El-Geneidy 2011). This brief literature review covers four broad topics: satisfaction in general; elements that have been found to influence satisfaction with cycling trips (as well as other modes); the important non-utilitarian benefits of cycling and travel in general; and, finally, types of cyclists.

2.1 Measuring Satisfaction

Perhaps the most important theory put forth to explain customer satisfaction has been the expectancy disconfirmation model which defines satisfaction as a comparison of pleasant past-purchasing experience (Oliver, Balakrishnan et al. 1994; Oliver 2010). Along with Fornell's satisfaction model, the expectancy disconfirmation model has been used in econometric analysis of customer satisfaction. This is often done with structural equation models linking different customer satisfaction measures (e.g. expectations, loyalty, complaints, etc.) with predefined formulas (Johnson and Fornell 1991; Fornell 1995). Other types of satisfaction measurement approaches include statistical and data analysis techniques, the quality approach method, and consumer behavioral analysis (Grigoroudis and Siskos 2009).

While traditional models of customer satisfaction often presume the customer's psychology to be an essentially unknowable element acting on the satisfaction outcome, more involved behavioural models have attempted to go beyond this "black box" formulation. By drawing on key concepts from work on consumer satisfaction in the fields of marketing and psychology, travel behavior researchers have expanded the understanding of how expectation, experience, and habit may influence satisfaction. Notable research, for example, has examined the distinction between positive and negative effect, or the satisfaction with a discrete transaction with some transportation service, and cumulative satisfaction with transportation services over a longer period of time (Friman and Gärling 2001).

2.2 Satisfaction with travel

In the realm of satisfaction with transit service, past research has explored the importance of service reliability, frequency, comfort and short commutes—attributes which adhere to the assumptions of utility maximization of public transit users (Weinstein 2000; Tyrinopoulos and Antoniou 2008; Cantwell, Caulfield et al. 2009). Variables such as cleanliness, privacy, safety, convenience, stress, social interaction and scenery have also been found to contribute to transportation-specific satisfaction (Stradling, Anable et al. 2007). These "non-instrumental" variables have been seen to affect both mode choice and satisfaction levels. While many studies have used aesthetic elements of the cycling environment to predict mode choice, few have attempted to measure cycling satisfaction with the same factors.

Several studies have found that cyclists are more satisfied than motorists and public transit riders with their most recent trip. The Travel in London Report 4 (London 2011) found that cyclists were 78% satisfied, slightly less than walkers (81%), but more than transit riders (76%) and motorists (72%). Meanwhile, cyclists were the least satisfied with the transportation network and road conditions: 67% were satisfied with the operation of the Transport for London Road Network and 49% were satisfied with the streets and pavements. A study in Canada had similar findings. Canada's General Social Survey (Turcotte 2005) found that cyclists were the most numerous in liking or greatly liking their commute (57% as compared to 47% of walkers, 23% of those who use transit and automobile, 28% of transit riders and 38% of drivers). Neither of these studies suggests *why* cyclists may be more satisfied than other road users. Gatersleben and Uzzell (2007) looked at perceptions of daily commutes for different mode users. Building on work by Russell (Russell 1980; Russell 2003) they divided modes according to whether they are arousing (or not arousing) and pleasant (or unpleasant) and categorized cycling as both pleasant and arousing. They found that cyclists perceive the most danger and the least delays, as well as some inconvenience, largely due to other road users. They also found cyclists enjoy the scenery along their commute, the enjoyment of the activity itself and respond in the same numbers as drivers that they value the flexibility of cycling. Further, cyclists had the shortest commute time of all mode users.

2.3 Non-utilitarian benefits of travel

In an important study, Ory and Mokhtarian explore the many needs met by daily travel beyond mobility and access to desired locations. These include adventure and variety-seeking, status, curiosity, exposure to scenery and fresh air, escape, and exercise (Ory and Mokhtarian 2005). In recent years, researchers have begun challenging traditional applications of utility-maximization modeling which tended to assume that distance, time, and slope (for active transportation) are always "disutilities" that rational travelers wish to minimize. Until recently many research approaches based on random utility modeling treated personal values and beliefs as essentially unknowable and deliberately left these aspects in the error term in mode choice and other statistical models. Paez & Whalen (2010) find active users often desire *longer* commutes. Other research explores the idea that "high effort-liked activities" bring more subjective satisfaction than "low-effort-liked activities"(Waterman 2005). How these may relate particularly to cyclists will be explored in the discussion section.

2.4 Types of cyclists

Several studies have tried to distinguish cyclists as mode users. Some studies have divided cyclists into different groups, including recreational cyclists and commuter cyclists, and groups according to their frequency of cycling (occasionally, regularly, frequently) (Larsen and El-Geneidy 2011). Recent papers have discussed types of cyclists based on stereotypes (Gatersleben and Haddad 2010). Larsen et al. (2011) found that different types of cyclists travel longer distances than others and prefer different types of bicycle facilities. For instance, cyclists who ride frequently in all conditions are 69% less likely to use a bicycle facility. Jensen (1999) distinguished three groups of cyclists, combining them with transit users: "The cyclists/public transport users of heart", "The cyclists/public transport users of convenience" and "The cyclists/public transport users of necessity". Cyclists of heart choose not to own a car and prefer the exercise, scenery and experience of cycling while cyclists of convenience cycle because it is simply the most convenient option and cyclists of necessity cycle because they cannot afford to drive. Gatersleben and Haddad (2010) measured how cyclists and non-cyclists perceived a typical cyclist and found four stereotypes of cyclists: the "responsible cyclist", the "commuter cyclist", the "lifestyle cyclist" and the "hippy-go lucky cyclist". Anable (2005) grouped people into different groups according to their transportation habits and attitudes. The two non-car owning groups were "car-less crusaders" and "reluctant riders", although one group of car-owners, "aspiring environmentalists" had the most positive attitudes towards cyclists. Finally, one study grouped cyclists according to their travel season; Bergstrom and Magnusson (2003) proposed four categories of cyclists: winter cyclists, summer-only cyclists, infrequent cyclists and never cyclists.

3 DATA AND METHODS

3.1 Survey Design and Dissemination: The McGill Travel Survey

The data is drawn from the McGill Travel Survey, conducted in March and April 2011 in Montreal, Quebec, Canada. It targeted McGill students, faculty and staff. The survey collected travel information, including home location—via postal code or closest intersection—and McGill campus destination (lower, middle, or upper campus). The survey asked individuals for their primary mode and their first and second reasons for choosing this mode. It further asked participants to describe the details of their last commute to McGill. Since the survey was conducted in the Winter seasonality was taken into consideration through asking the respondents if they would do the same trip on a "nice fall day", and if not, to describe this trip as well. In order to capture trip satisfaction respondents were asked the following question, "How would you rate your satisfaction with this trip to McGill?" They were given the option of very unsatisfied, unsatisfied, neutral, satisfied or very satisfied. The satisfaction question was asked twice for individuals who reported a different mode during the Fall day compared to the winter one so we can capture the commuters satisfaction with both trips. Therefore, the satisfaction attached to each described commute is known[1]. In addition, socio-economic and demographic characteristics, such as age, gender, work or student status, car and bicycle ownership, were collected.

The survey was sent to 19,662 members of the McGill community via e-mail, providing individuals with a link to the online survey. The survey was sent to all faculty and staff with a McGill e-mail address (8,493), and those who did not have a McGill e-mail address were solicited with a postcard sent to their campus work location. Due to concerns with overburdening students with survey requests, the survey could only be sent out to 11,000 students. This resulted in an oversampling of employees. The survey remained active for 35 days. A total of 5,016 responses were received, yielding a response rate of 25.5%. Following a series of data cleaning operations, through which incomplete and nonsensical survey responses were removed, 4,692 survey responses remained. Of the total sample, 268 (under 6%) were cyclists; 58 were year-long cyclists and 210 were seasonal cyclists (meaning they only indicated a fall cycling trip).

The location of the McGill University campus as well as the home location of all cyclists is shown in Figure 2. The McGill campus is centrally-located near Montreal's Central Business District and served by two separated cycling paths. In addition, the campus is well-served by bus and subway service and is a short walk from a commuter train station. Perhaps the two most important natural elements of the city in terms of overall "bikeability" are its notoriously long and snowy winters and the mountain from which the city derives its name. Mont Royal can be seen as the predominantly open area just north of campus. Trips to (and from) campus can be quite steep depending on home location.

[1] Two trips were collected: the respondents' last trip to campus and the trip they would make on a "nice fall day". This additional trip is intended to capture respondents' mode in warm (non-winter) weather. Only "Winter" and "Fall" trips were collected both to limit survey response time and to guarantee greatly consistency among students, faculty, and staff, many of whom would not commute in the summer. In addition, the semesters at McGill are called "Fall" and "Winter". Therefore, it makes more sense to respondents to consider these two seasons for commuting to campus. Further, due to the length of Montreal winters, it is appropriate to refer to the months of March and early April as "winter".

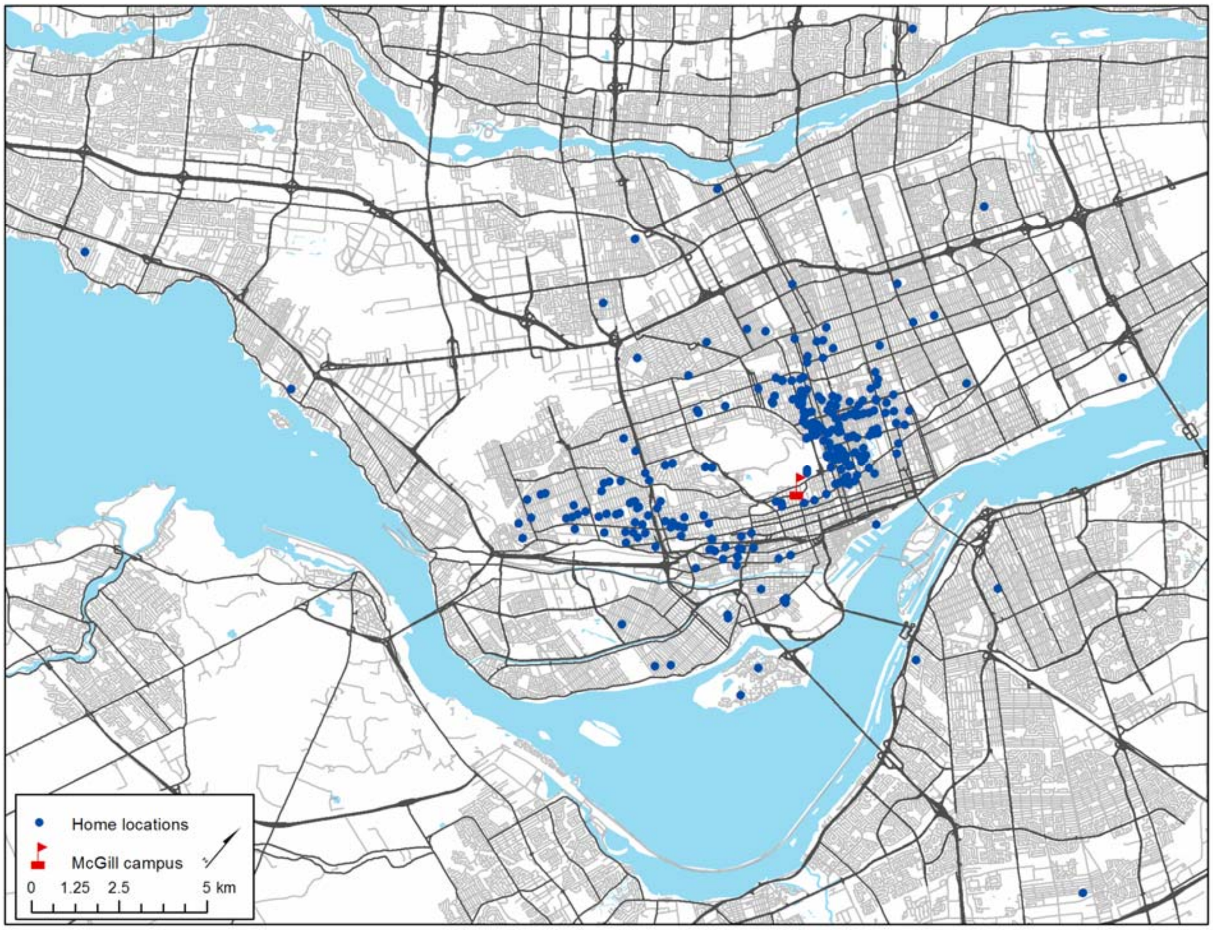


FIGURE 2 Location of campus and home locations of all cyclists.

3.2 Measuring "Bikeability"

The literature on cycling for transportation has found that many elements of the built environment, such as the proportion of local roads and bicycle paths; land uses, including commercial, open area, residential, park and recreation and water; and both population and intersection densities, impact an individual's likelihood to cycle (Cervero and Kockelman 1997; Nelson and Allen 1997; Handy, Boarnet et al. 2002; Cervero and Duncan 2003; Dill and Carr 2003; Cervero, Sarmiento et al. 2009; Dill 2009; Berrigan, Pickle et al. 2010; Dill, Handy et al. 2010; Lee, Jennings et al. 2010; Winters, Brauer et al. 2010; Buehler and Pucher 2011; Forsyth and Krizek 2011). This is sometimes referred to as "bikeability" (Winters and Cooper 2008; McNeil 2011). Thus, the higher the proportion of local roads and bicycle routes, residential, park and recreation and water land use and population and intersection density, the more bikeable a route becomes. The authors hypothesized that if the built environment has an impact on the decision to cycle for transportation, it would also have an impact on trip satisfaction. Therefore, the bikeability of cyclists' routes was measured in order to determine the impact of the built environment on satisfaction.

The measure of bikeability was focused around the route from home locations to campus. Our data contained the postal code or nearest intersection to each respondent's residence but did not contain the actual routes of cyclists. For this reason, the shortest route between cyclists' origin and destination using Network Analyst was used. As cyclists tend to deviate from the shortest path (Aultman-Hall, Hall et al. 1997; Shafizadeh and Niemeier 1997; M.A. and Bhat 2003; Krizek 2006; Tilahun, Levinson et al. 2007; Larsen and El-Geneidy 2011), a 250-meter buffer around each route was created. A similar methodology was adopted by Winters et al. (2010). The 250m was chosen in order to include at least one street on either side of the shortest path. Within each buffer, proportions of different land uses, intersection density, population density and proportion of different types of roads and bicycle paths, were measured, as was the distance of the shortest line. This can be seen in Figure 3, showing the home and campus destination of a respondent (Land use is shown for illustrative purposes).

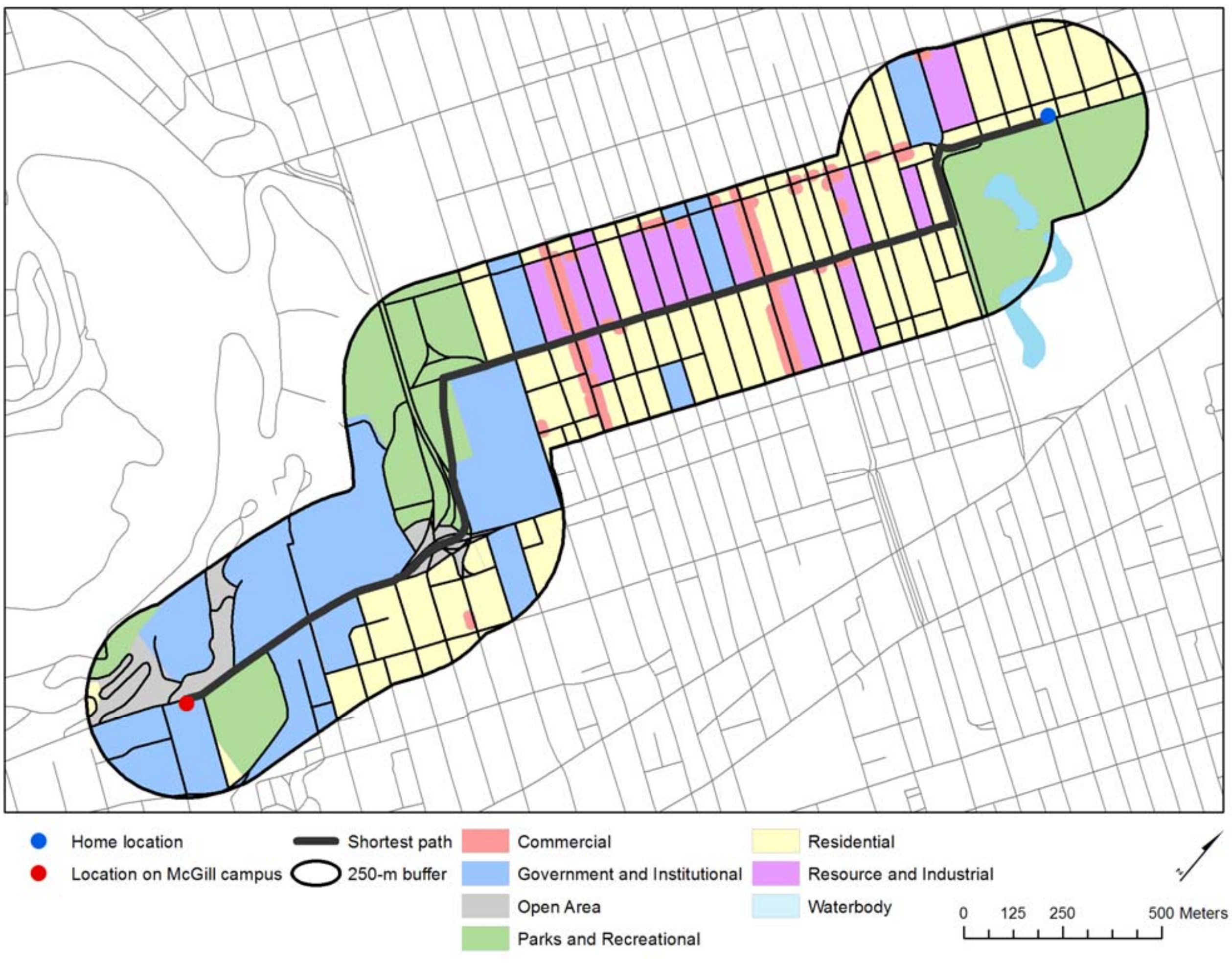


FIGURE 3 Illustration of shortest path and 250m buffer.

The slope of each cyclist's route was measured using the RunningSlope Script, which divides each route into 100-m segments and outputs the slope. The measure of slope was the proportion of 100-m line segments with slope greater than 5%.

4 FINDINGS

4.1 Preliminary Analysis: Cyclists are uniquely satisfied

Cyclists in the McGill Travel Survey were significantly more satisfied (combination of "satisfied" and "very satisfied" responses) than other mode users (88%), with a chi square p-value of less than 0.01. While their satisfaction dropped in the winter months, it did not drop as much as other modes (83%). Only walkers were more satisfied than cyclists in the fall (91%). However, this difference is not statistically significant. Table 1 reports the overall satisfaction of every mode as well as the seasonal satisfaction with trips. It is clear from this table that cyclists form a uniquely satisfied group of commuters.

TABLE 1 Satisfaction rates by mode

	Overall Satisfaction	Fall Satisfaction	Winter Satisfaction
Bicycled	88%	89%	83%
Walked	76%	91%	72%
Took transit	64%	81%	63%
Drove	60%	69%	59%

4.2 The Effect of Personal and Environmental Characteristics on Satisfaction

As previously mentioned the literature on cycling for transportation has found that certain socio-economic, demographic and built environment characteristics affect the decision to cycle. To test this, an independent samples t-test was performed to determine whether a significant difference between the means of cyclists who were "very satisfied" and other cyclists who were less satisfied. Built environment characteristics, such as proportion of local roads and bicycle paths, proportion of open area, parks and recreation, water and residential land uses, and intersection density were not significantly different between groups. However, slope and population density were significantly different between those who said they were very satisfied and those who were not very satisfied. The full findings are reported in **Table 2.** These findings show how remarkably similar the cycling environment is for cyclists regardless of their satisfaction levels.

When season was considered, those who cycled in the fall were significantly more satisfied than those who cycled in the winter, with a chi square p-value of less than 0.01. While there is no strong relationship between satisfaction and the built environment, there is a strong relationship between satisfaction and season. The next step was to consider how personal characteristics of cyclists influence their levels of satisfaction. We found that age, gender, status at the university (e.g. Faculty, Student, Staff) and car ownership were not significant in explaining the variance in satisfaction levels. However, cyclists who stated the environment as their first reason for cycling were significantly less "very satisfied" (40% as compared to 64%, chi-square p-value of less than 0.05). Cyclists who cycled only in the fall, and took transit in the winter, were significantly more "very satisfied" (69.7% as compared to 52.9% chi-square p-value less than 0.05).

TABLE 2: Characteristics of the built environment on the commute of very satisfied and not very satisfied cyclists

	"Very satisfied"	Not "very satisfied"
Distance (km)	4.2	4.3
% Local roads	62.7%	62.2%
% Bike paths	21.2%	21.2%
% Open Area	3.1%	3.3%
% Parks and recreation	12.4%	13.0%
% Water	0.4%	0.4%
% Residential	47.9%	48.2%
Slope (% 100-m line segments with slope greater than 5%)*	12.0%	10.3%
Population density*	446.6	377.6
Intersection density	95.3	94.3
N	167	101

*=t-test significance <0.01

4.3 Who are the cyclists?

The inconclusive findings in regards to built environment factors led us to more deeply explore the differences among cyclists. The intention was to uncover relationships among reasons for cycling and expressed satisfaction. To better understand cyclists, respondents were grouped using a Two-Step Cluster analysis. Two variables, one that combines first and second reasons for choosing cycling as a mode of transportation and one variable expressing a cyclist's alternate (winter) mode, were inputted. The alternate mode was examined as most cyclists in the sample (78%) cycled only in the fall and therefore used another mode in the winter months.

There are two broad categories of cyclists: "fair-weather cyclists" who predominantly (or exclusively) cycle during warm months and "year-round cyclists" who cycle in the winter as well. Within these two broad categories, cyclists are split up according to their alternate mode (transit, driving or walking) and by their reasons for choosing cycling as a mode of transportation (e.g. convenience, exercise).

FAIR-WEATHER CYCLISTS

Fair-weather cyclists refer to all cyclists who responded that they do not cycle in the winter. These cyclists were more satisfied from their cycling trip than their alternate mode of transportation (transit, walking or driving) during the winter months. Among fair-weather cyclists, there are transit riders and non-transit riders. This section briefly describes each of the six clusters.

Transit riders

All cyclists in the "transit riders" category stated that they took transit in the winter. In general, they were less satisfied with their transit trip than with their fall bicycle trip. The first group identified are *Cycling enthusiasts* (n=41). A majority (80%) state that they chose to cycle because it is good exercise, nearly half state they cycle because it is good for the environment (49%) and 41% say they cycle because it is a pleasant ride. They are the most satisfied overall

(95%) and the most very satisfied (76%). Curiously, they cycle on average the longest distances (6.08km) and the largest percentage of their trip towards campus is uphill (61%).

All *Active, convenience-motivated transit-riders* (n=42) state that they cycle for exercise and convenience/because it is "faster than other modes", and all cyclists in this group use transit as their alternate form of transportation. Overall, 71% are very satisfied and 86% are satisfied overall. They cycle an average of 4.6km. All *Convenience-motivated transit-riders* (n=65) stated convenience or speed as their reason for choosing to cycle and everyone took transit on an alternate trip. 65% are very satisfied and 89% are satisfied overall. They cycle just below 4km on average.

Non-Transit Riders

All cyclists in the "non-transit riders" category state that they took other modes than transit (driving, walking) when responding to the survey. In general, they are less satisfied with this alternate mode than with their bicycle trip on a "Nice Fall Day". 96% of *Convenience-motivated walkers* (n=48) state that they cycle because it is convenient or "faster than other modes" and when they are not cycling, 83% of them walk while 17% of them drive. On average, they commute 2.78km. Around 52% were very satisfied from their cycling trip and 88% were satisfied overall. All *Active-environmentalists* (n=25) stated that they cycled because it is a good form of exercise and over half state that it is good for the environment (52%). When they are not cycling, 24% drive, and 28% walk, although 48% of the group cycle year-round. They were least satisfied with their cycling trip; only 38% were very satisfied and 80% were satisfied overall. They cycle on average 5.52km.

YEAR-ROUND CYCLISTS

94% of the *Year-round cyclists* (n=47) state they cycle because it is convenient or "faster than other modes" and one third of the cluster state that cycling is a good form of exercise. 69% are very satisfied and 87% satisfied or very satisfied. They cycle an average of 3.5km.

4.4 DIFFERENCES BETWEEN CLUSTERS

Cycling Enthusiasts travel significantly longer distances than *Convenience-motivated transit-riders, Year-round cyclists* and *Convenience-motivated walkers.* In general, cyclists motivated by convenience cycled shorter distances than those motivated by exercise or the environment.

These findings are presented in Figure 4 and Table 3. Table 3 presents each cluster's average distance and trip satisfaction rates with significance tests. Only *Cycling enthusiasts* have a significantly higher rate of satisfaction than the other groups. Interestingly, this group also displays a significantly longer average cycling distance. *Convenience-motivated transit riders, Convenience-motivated walkers,* and *Year-round cyclists* on the other hand, have significantly shorter cycling distances.

To better visualize the relationship among trip satisfaction, motivations to cycle, and distance, the radial graphs in Figure 4 were generated. The motivations that people cite for cycling were plotted on five axes (as percentages). To make this more clear, the two responses that deal with cycling as a response to constraints ('I do not have access to a car' and 'other forms of transportation are too expensive') were grouped under "constraints". Similarly for the two responses that cite proximity and convenience, which were aggregated into "convenience". The remaining 3 axes plot the percentage of people who are "satisfied" with their cycling trip, the percentage that cycle year-round, and the distance cycled. Distance was standardized as a percentage of the longest cluster; therefore cycling enthusiasts have a value of ”1” while all other groups show the proportion of their average trip relative to this group.

TABLE 3: Satisfaction and Distance by Cluster

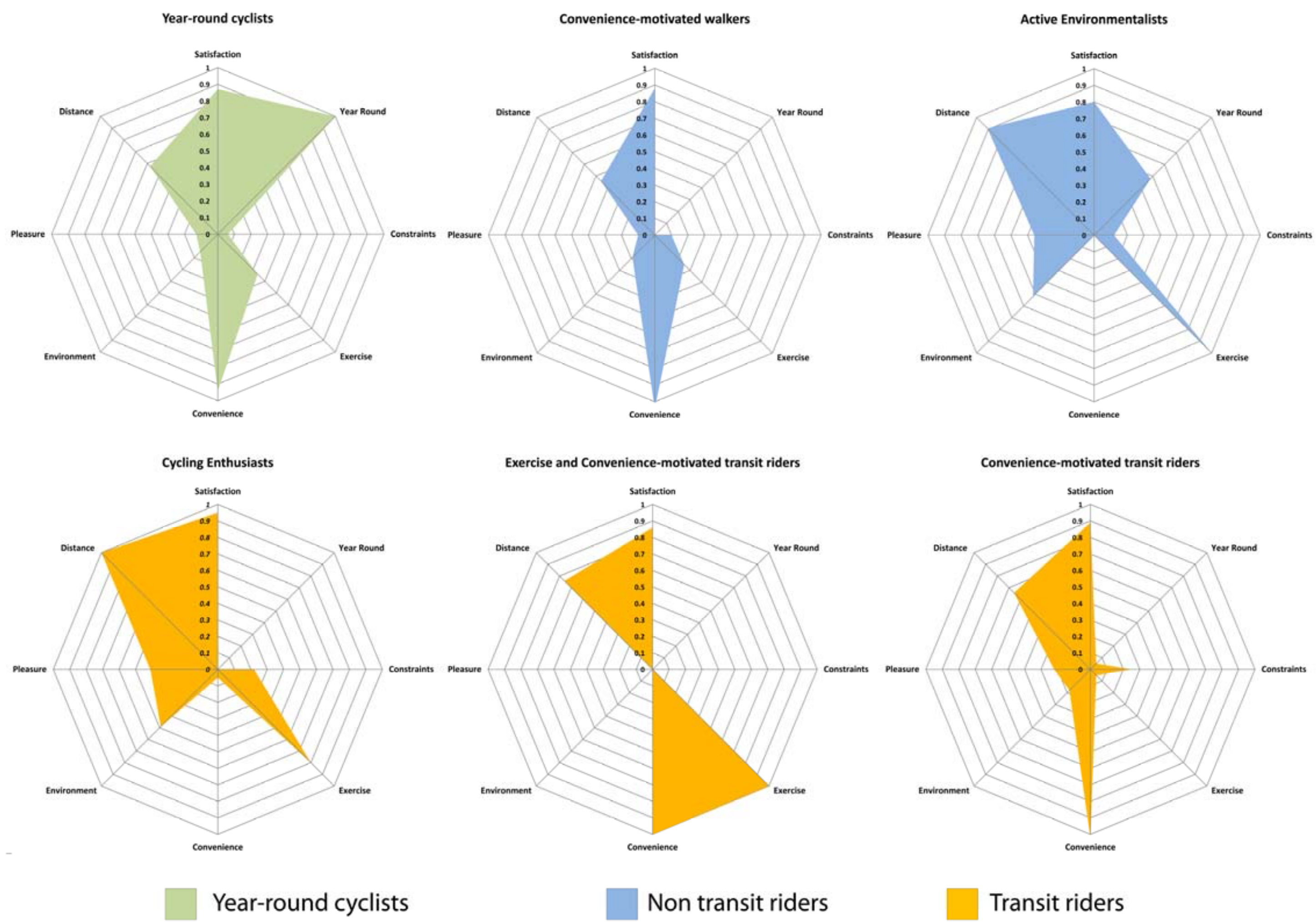
	Satisfaction	Distance cycled (km)
Cycling Enthusiasts	95% *	6.08 [1]
Exercise and Convenience-motivated transit riders	86%	4.61
Convenience-motivated transit riders	89%	3.99 [2]
Convenience-motivated walkers	88%	2.78 [2]
Active Environmentalists	80%	5.52
Year-round cyclists	87%	3.51 [2]

* Statistically significant ($p<0.01$) chi square test
[1] Statistically significant (above average) independent sample t-test
[2] Statistically significant (below average) independent sample t-test

Cycling enthusiasts, who take transit in winter months and are motivated by a desire to exercise and engage in environmentally-friendly behavior, both cycle much longer than average and are more satisfied. *Convenience-motivated transit riders*, on the other hand, who cite convenience and neither exercise nor environmentalism, cycle on average much shorter than the enthusiasts but are much less satisfied. The relationship between satisfaction and the desire to exercise and concern for the environment does not hold for *Active environmentalists*, who are significantly less satisfied. This may be attributable to the fact that 48% of this group cycled during the winter months. Interestingly, though not necessarily a surprise, we see clearly that year-round cyclists cycle shorter distances and cite convenience as their main motivation for cycling much more than other groups.

Cycling enthusiasts are significantly more satisfied than other groups although they cycle on average further than other groups. This lends tentative support of the underlying hypothesis that personal values (as captured by the reason to cycle) are more important than objectively measured physical trip characteristics in predicting satisfaction levels.

FIGURE 4: Relationship among satisfaction, distance, and reasons for cycling.



5 DISCUSSION

Our original hypothesis that cyclist trip satisfaction is affected by the built environment, the natural environment and trip characteristics was inconclusive. The only elements of the physical environment that seem to affect satisfaction in our study were slope and population density, with no effect from land use, connectivity or street types. The slope finding was surprising, as more satisfied cyclists experienced greater slope. Season was the most significant indicator of satisfaction, with cyclists taking fall trips more satisfied than cyclists taking winter trips. It is interesting that while the built environment (land use, connectivity, and street network), safety, distance and slope may influence the likelihood to cycle; they do not predict levels of satisfaction in our sample. Further, while certain groups are more likely to cycle (young men, for instance) they are not necessarily more satisfied. Overall, cyclists are very satisfied with their commute to work or school. It is interesting to explore why cyclists may be much more satisfied with their commute than other mode users even in cases where they are least satisfied with the road network (London 2011). While the evidence is only slight, the higher (and statistically significant) satisfaction rates of *Cycling enthusiasts* do lend support to the theoretical framework presented in Figure 1. The following section will explore some ideas of how and why cyclists may be more satisfied than other mode users and how observed and unobserved personal traits may moderate the relationship between physical factors, internal factors and trip satisfaction.

5.1 Independence

In many ways, cycling offers the independence of driving without the inconveniences; a cyclist can leave when they choose, without the stress of being caught in traffic. One survey respondent stated that their primary motivation for cycling was independence and empowerment: "I think that bicycling is generally the most empowering way to travel. I can fix my bicycle myself, I do not have to rely on [transit] schedules". In fact, in research conducted by Gatersleben and Uzzel (2007) cyclists stated in the same numbers as motorists (14%) that the most pleasant part of their commute was the flexibility. Cycling was considered arousing, like driving, whereas transit and walking were considered not arousing. Sometimes driving is too arousing however, resulting in stress (Gatersleben and Uzzell 2007).

5.2 Economical

Cyclists may be satisfied because they save money by not purchasing and maintaining a personal vehicle or buying a transit pass. A transit pass in Montreal can cost over $100 per month, and the Canadian Automobile Association estimates that owning a car costs $6,239 per year (for a compact car), or approximately $17 per day and this cost does not include gas or parking (Canadian Automobile Association).

5.3 Pleasure

Cyclists may enjoy the activity of traveling itself more than other mode users. Gatersleben and Uzzel (2007) found that for 21% of cyclists the most pleasant aspect of their daily commute was enjoyment of the activity itself, and 37% stated the scenery. In our study, nearly half (47.7%) of cyclists stated exercise as their first or second reason for cycling, and another 20% stated the pleasant ride. Therefore, the ride itself is enjoyable. Further, if cyclists are choosing this mode for exercise they may be less affected by increased distance or slope, or actually positively affected. In another sense, commuting by bicycle is like multi-tasking; just as transit riders can read, listen to music and make phone calls while commuting, cyclists are able to both exercise and commute at the same time.

5.4 Identity

Cyclists may self-identify as "cyclists" more frequently than other mode users self-identity as "drivers" or "transit riders". Satisfaction levels may simply be a reflection of engaging in activity that one identifies with as either socially desirable or fitting with one's values. Abou-Zeid and colleagues (Abou-Zeid and Ben-Akiva 2011; Abou-Zeid and Ben-Akiva 2012; Abou-Zeid, Witter et al. 2012) have explored the power of "social comparisons". This is especially relevant in Montreal which has a strong "cycling culture".

5.5 Distance

On the other hand, cyclists may be more satisfied simply because they have a shorter commute than other mode users (Gatersleben and Uzzell 2007). In this study, cyclists commute on average shorter distances than drivers and transit riders, but slightly longer distances, on average, than walkers. However, in terms of time, they have the fastest commute; the average time a cyclist commuted was 16 minutes, compared to 20 minutes for walkers, 38 minutes for transit users and 36 minutes for drivers.

6 CONCLUSION

We initially hypothesized that trip characteristics and the natural environment and built environment affect trip satisfaction and that this effect is mediated by personal characteristics such as socio-economic and demographic characteristics and motivations (Figure 1). While this initial hypothesis was somewhat inconclusive, this study has several noteworthy findings. First, we found there are several kinds of cyclists on the roads in Montreal. The most satisfied were *Cycling Enthusiasts*, who cycle the longest distances on the least objectively measured bikeable roads and with the greatest uphill commute, using transit during the winter months. Cyclists who use this mode year-round are most often motivated by convenience (*Year-round cyclists*). The least satisfied cyclists were those who both cycled year-round and were motivated by exercise or the environment (*Active-environmentalists*). Second, slope and population density along the route are significantly different between "very satisfied" cyclists and all other cyclists. Lastly, season has an important effect on cyclist satisfaction. Just 22% of cyclists in our survey cycled during winter. These winter cyclists also reported lower satisfaction rates than fall cyclists. This means that a large portion of cyclists are using a different mode in the winter months (walk, transit or drive), suggesting that winter cycling in Montreal is difficult. This is probably attributable to the harsh weather and challenging cycling network conditions during this period.

Other studies have similarly found cyclists to be the most satisfied commuters, even when they are dissatisfied with the transportation network (London 2011). This may be attributable to the relative short commute that cyclists have (just 16 minutes in this study), the cost savings, the exercise benefits or the relative independence afforded by having a bicycle. Cyclists are able to use the road network like a car, go longer distances than walkers and with more flexibility transit users, carry small to medium-sized loads and park next to their destination. Research should seek to further explain these high levels of satisfaction and understand what makes cyclists such enthusiastic commuters overall.

6.1 Limitations and Future Research

While the survey is representative of the McGill community, the authors make no claim that this sample is representative of the city of Montreal. Future research could explore cyclist satisfaction more widely by surveying cyclists outside of a university setting. Future research should examine the multi-faceted nature of satisfaction, such as satisfaction with individual elements of the commute (e.g. distance, slope, safety) and could seek to attribute satisfaction to particular characteristics of the commute. Examining these individual components will allow a more nuanced look at satisfaction.

In the present study, we see that many factors that may lead to—or dissuade from—the decision to cycle for transportation do not have the expected effect on derived satisfaction. Ettema et al. (2010) and Middleton (2009) argue that "experienced utility" is a much more appropriate measure in understanding how individuals experience and perceive their travel choices than "decision-utility" (Kahneman and Sugden 2005). This distinction could be a welcome and much-needed addition to travel behavior research. Echoing recommendations made by Ory and Mokhtarian (2005), further refinement of both attitudinal questions and measurement of satisfaction with travel is necessary to address many of the concerns mentioned herein.

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