



#### Sustainable travel behaviour:

Disentangling individual and contextual determinants of active transportation

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#### Outline

- Why do people use active modes?
  - Physical (Built environment) Factors
  - Psychological Factors
- Empirical Work
  - Neighbourhood Walkability
  - Cyclist Satisfaction
- Conclusion
  - Research and Policy Implications

- Why do people walk and cycle?
  - Quality of infrastructure
  - Connectivity
  - Convenience



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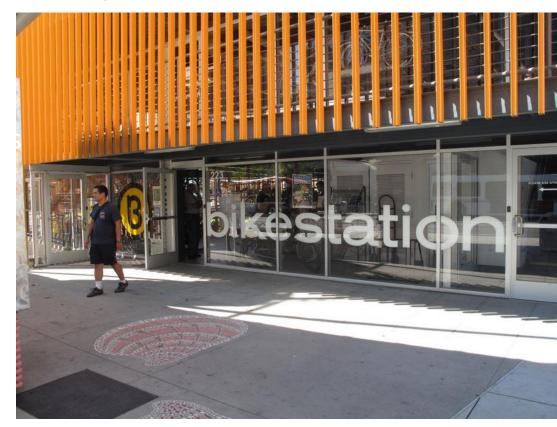
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  - Environmental Awareness



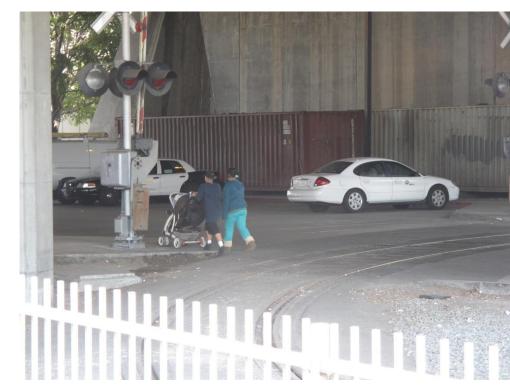
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- Enjoyment
- Exercise



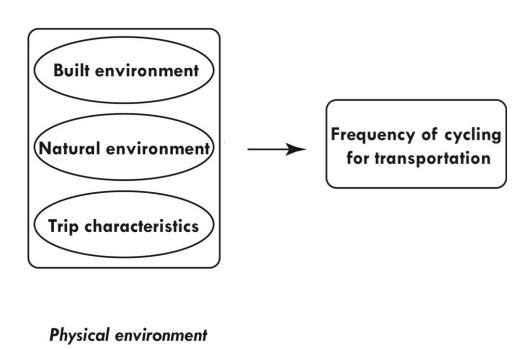
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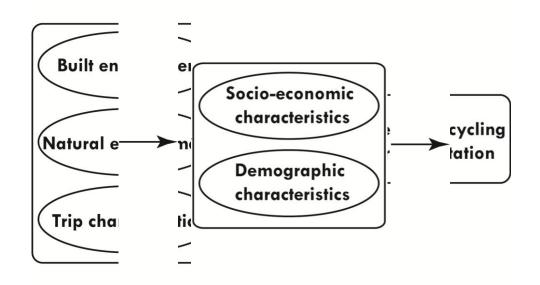
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- Financial Constraints
- Enjoyment
- Exercise
- Social Connections



# Where You Are

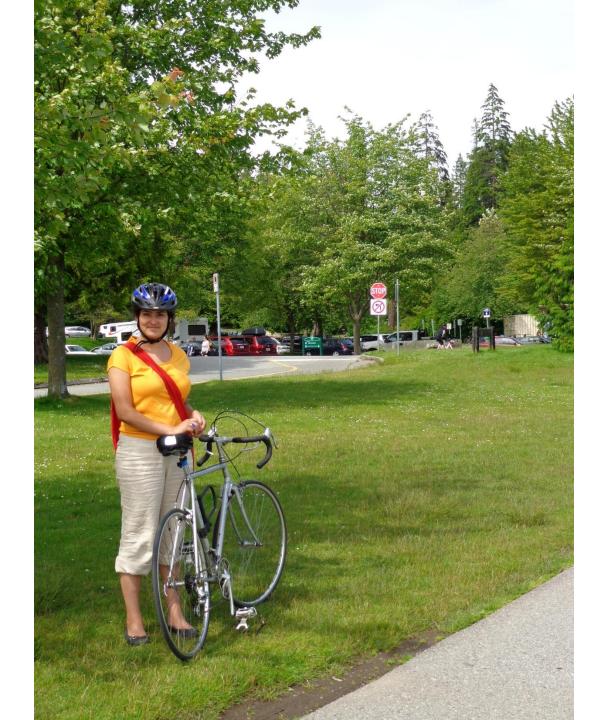


## Where You Are and Who You Are



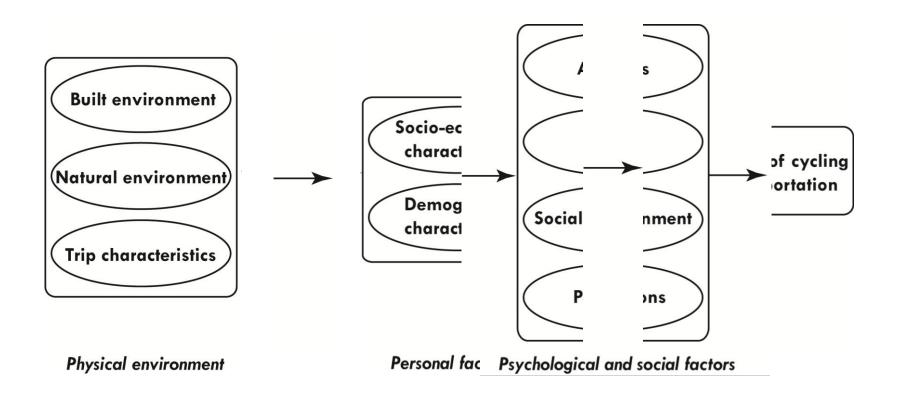
Physical environm Personal factors

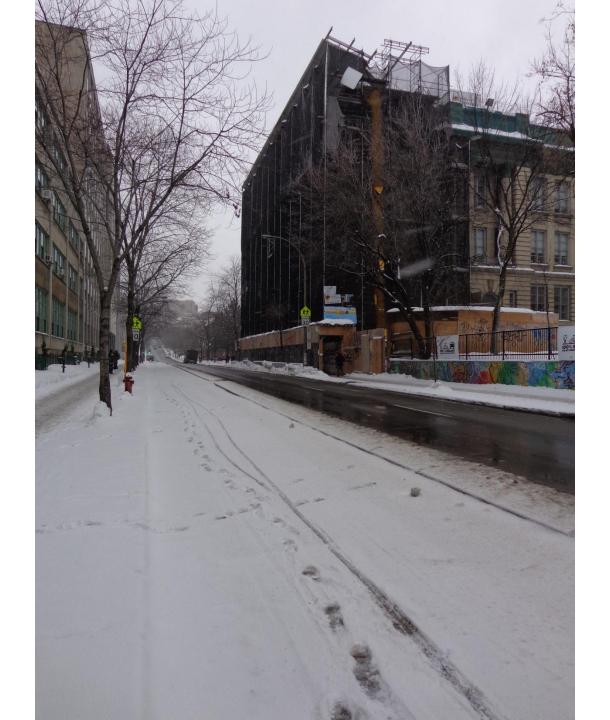






# Where You Are and Who You Are...





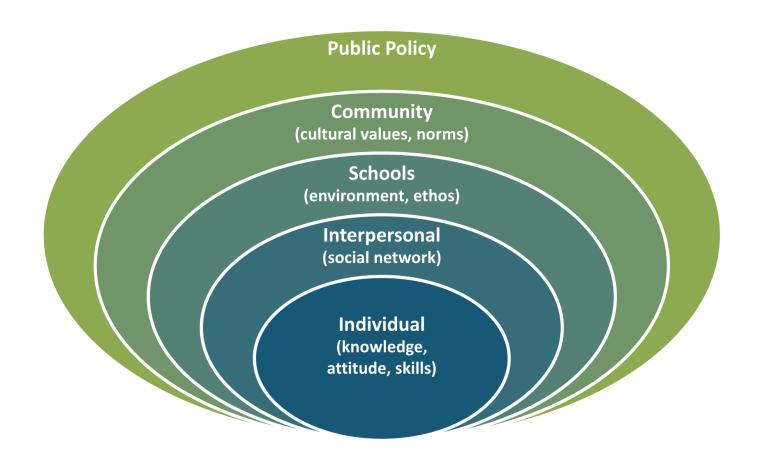


# Propensity to use active modes

 A vast literature explores impacts of built environment on mode choice

 A vast literature also explores mode choice from a behavioural/psychological perspective

# Socio-Ecological Model



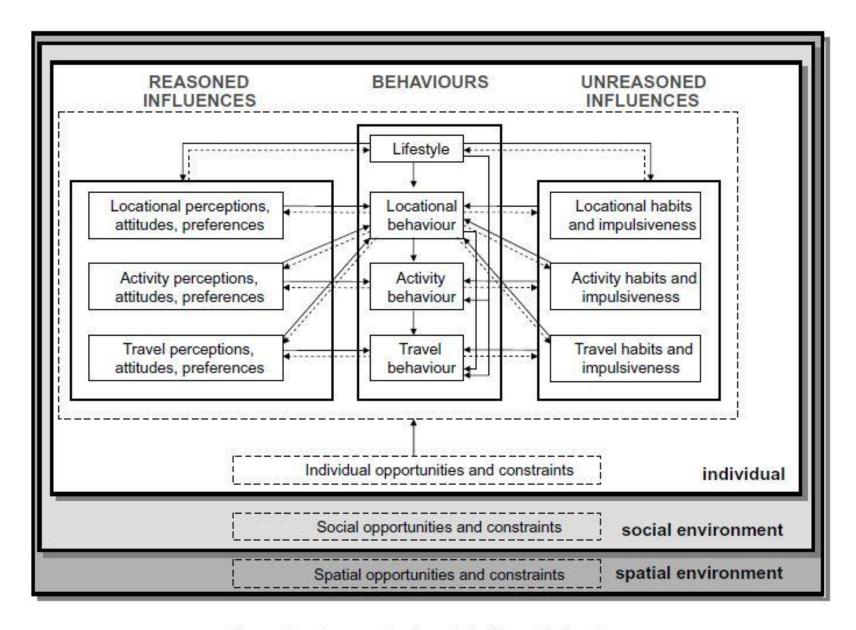
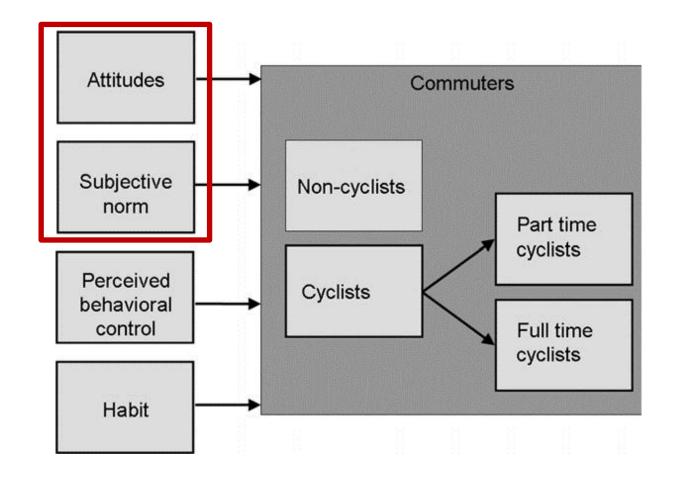


Figure 1. A conceptual model of travel behaviour.



Conceptual model from Heinen, E., Maat, K., and van Wee, B. "The role of attitudes toward characteristics of bicycle commuting on the choice to cycle to work over various distances" *Transportation Research Part D* 16 (2011) 103.

## **Attitudes**

 "An attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour" (Eagly and Chaiken, 1993).

 "The degree to which performance of the behaviour is positively or negatively valued" (Ajzen, 1991).

# Subjective Norm

"Perceived social expectation to follow a

certain behaviour"

(Heinen 2011)





"Many of my friends use the bicycle for transportation".

"My friends and acquaintances encourage me to use a bicycle for transportation".

Titze *et al* (2008)

# EXPLORING NEIGHBOURHOOD WALKABILITY

Is this the "same" activity?





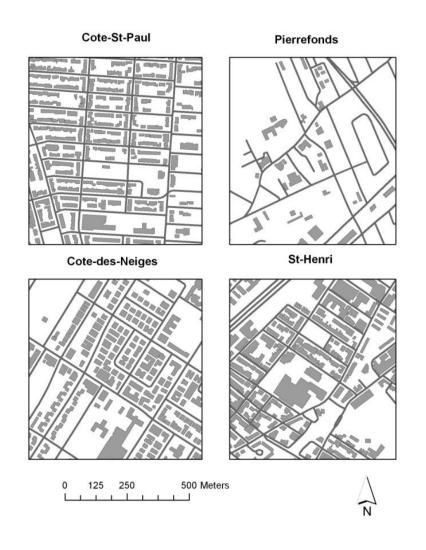
# Walkability

What is "walkability"?

"[...]a measure of the extent to which the public realm provides for movement and other activity on foot in ways that are both efficient and enjoyable."

(Transport London, 2005)

# Form



### Content



### Walkability

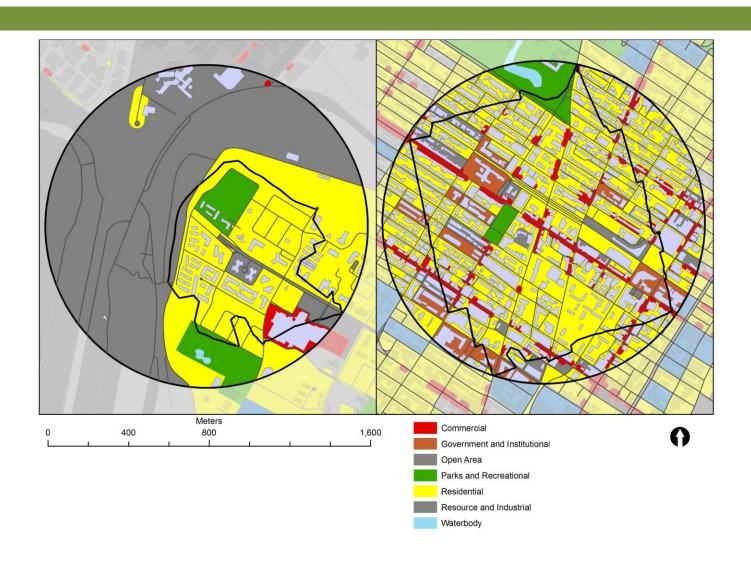
- Frank et al. (2005) "Walkability Index"
  - Population density, Intersection density and land use mix entropy measure.
- Kuzmyak et al. (2006)"Walk Opportunities"
  - Weights types of intersections and destinations.
- Walkscore
  - Gravity based measures to a set of destinations. e.g. retail, libraries, cafes.
- "Pedshed"
  - Ratio of straight-line buffer to pedestrian network buffer.

### Research Question #1

 How well do existing walkability indices explain the variance in pedestrian behaviour?

(Manaugh & El-Geneidy, 2012)

# Walkability



#### Percentage of shopping trips by walking by decile



#### Percentage of School trips by walking by decile



### **Index Comparison**

Shopping						
Index	OR	LL				
Walk Score	1.78***	-1608.1				
Walk Opportunities	1.50***	-1618.2				
WI 800 buffer	1.64***	-1621.4				
WI 400 buffer	1.61***	-1622				
WI 1200 buffer	1.58***	-1626.5				
WI Census Tract	1.48***	-1630.9				
Pedshed 800	1.35***	-1649.7				
Pedshed 1200	1.33***	-1652				
Pedshed 400	1.30***	-1652.4				

School					
Index	OR	LL			
Pedshed 400	1.29***	-1525.65			
Pedshed 800	1.298***	-1525.69			
Pedshed 1200	1.23***	-1530.39			
WI 800 buffer	1.08***	-1532.69			
WI 1200 buffer	1.07***	-1534.22			
WI 400 buffer	1.11	-1536 55			
Walk Score	1.09**	-1536.77			
WI Census Tract	1.059	-1537.87			
Walk Opportunities	1.052	-1537.96			

*Note*: Each walkability measure was inputted into a separate model controlling for age, gender, income, car ownership and length of trip. Minimum pseudo R square (McFadden) = 0.445. p< .01, \*\*\* p< .05, \*\*p<0.1. \*

# Findings

 The examined walkability measures explain much of the variance in behaviour.

There are important differences by trip purpose.

#### Research Question #2

 How does the walkability of a neighbourhood affect different types of people/households?

(Manaugh & El-Geneidy, 2012)

### **Stratified Models**

	Walk		
Household Type	OR	R <sup>2</sup>	N
Low income	1.11	0.42	638
Retired	2.41***	0.45	1,329
	2 62444	0.44	504
Wealthy no children	2.68***	0.41	581
Cinalo	1.93	0.46	732
Single	1.95	0.40	732
Middle Class	1.21	0.47	373
Wilder Class	_,	J. 1.	
Large Families	1.62***	0.43	714
Young Families	1.54*	0.42	583
Wealthy	3.46***	0.53	531

Note: Each walkability measure was inputted into a separate model controlling for age, gender, and length of trip. The reported pseudo r-square (McFadden) is for the fully specified model. p< .01, \*\*\* p< .05, \*\*p<0.1, \*

# Findings

Probabilities calculated at the mean* by walking by walkscore deciles										
	Low income			Retired	Wealthy no	Middle age no	Middle Class	Large	Young	Wealthy
					children	children		Families	Families	
First Decile		72.1%		36.1%	12.6%	21.4%	30.6%	29.7%	18.5%	3.3%
Fifth Decile		74.8%		65.2%	38.4%	43.6%	43.6%	49.7%	35.8%	16.2%
Tenth Decile		78.0%		89.4%	79.5%	74.1%	61.0%	74.10%	63.1%	63.2%

<sup>\*36</sup> year old female making a 734 meter (average length) shopping trip

#### Walkability is not "one size fits all" but depends on:

- Trip Purpose
- Socio-economic factors

### Research Question #3

 How do people perceive their trip and how do values and motivations relate to satisfaction with walking trips?

(Manaugh & El-Geneidy, 2013)

# Cluster membership

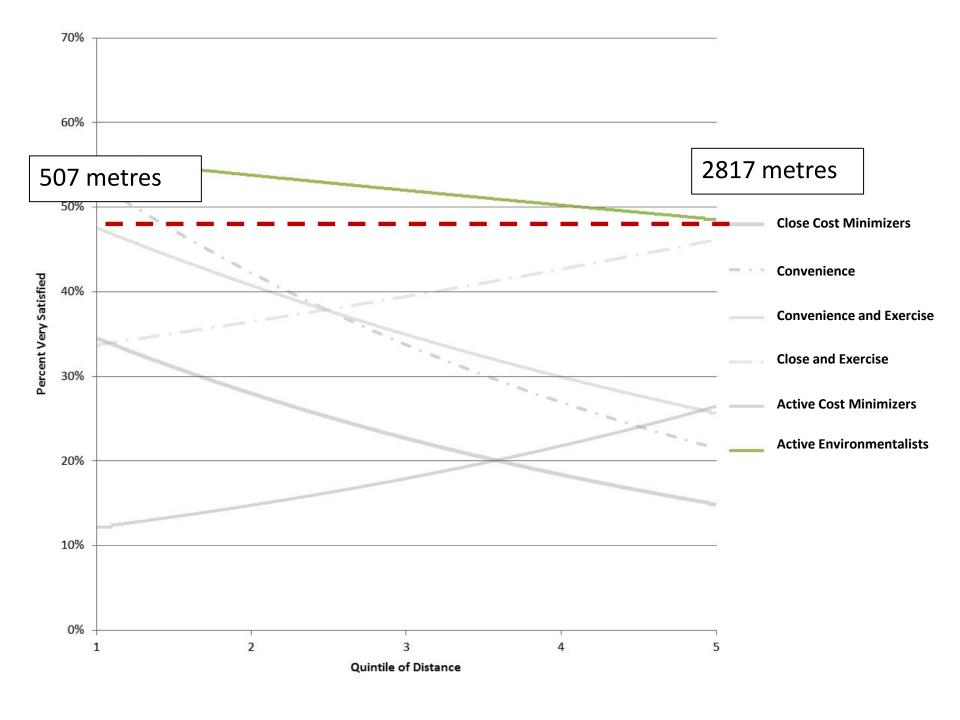
		Elevation				
		change	Very		Min (m)	Max (m)
Cluster	Count	(m)	satisfied (%)	Distance (m)		
Active cost Minimizers	134	61.0**	19.4%****	2034.2*	335.5	6068.6
Close Cost Minimizers	88	29.7	25.0%****	958.3	337.0	2354.3
Active Environmentalists	53	57.0**	52.8%***	1801.3*	327.0	4020.9
Convenience	224	24.6	35.7%	846.3	194.5	3267.4
Close and exercise	106	30.9	40.6%***	963.7	26.5	2862.5
Convenience and exercise	66	51.7**	39.4%***	1675.6*	431.6	3561.6

<sup>\*</sup>Statistically significant (ANOVA) F(5,671) = 61.18, p < .01(in relation to non-asterisks)

<sup>\*\* (</sup>ANOVA) F(5,671) = 37.926, p < .01(in relation to non-asterisks)

<sup>\*\*\*</sup>Chi-square (5, N = 671) = 27.58, p = .0001, higher than expected value

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**Urban Form** 

Streets
Intersections
Sidewalks
Trails

**Content** 

**Destinations** 

Parks

**Transit** 

Schools

Resident

Needs

Desires

**Expectations** 

Values

**Urban Form** Content

Streets Destinations

Intersections Parks

Sidewalks Transit

Trails Schools

Resident

Needs

**Desires** 

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**Expectations** 

Values

Urban Form Content Sidew Walkability

#### **CYCLIST SATISFACTION**

#### Literature

- Cyclists are the most satisfied commuters (Transport for London, 2011; Turcotte, 2005)
- The reason for this high level of satisfaction is rarely explored
- Existing literature:
  - Satisfaction of other mode users (e.g. transit)
  - Likelihood to cycle
    - 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.

### Hypothesis

- People cycle for many diverse reasons
- Different types of cyclists will respond differently to distance, slope and elements of the built environment such as bike lanes and land use mix
- Motivations for cycling will affect cyclist trip satisfaction
  - Cyclists motivated by exercise will be more satisfied than those motivated by convenience or by lack of options

### Research questions

 What types of cyclists can be identified based on motivations and alternate (winter) mode?

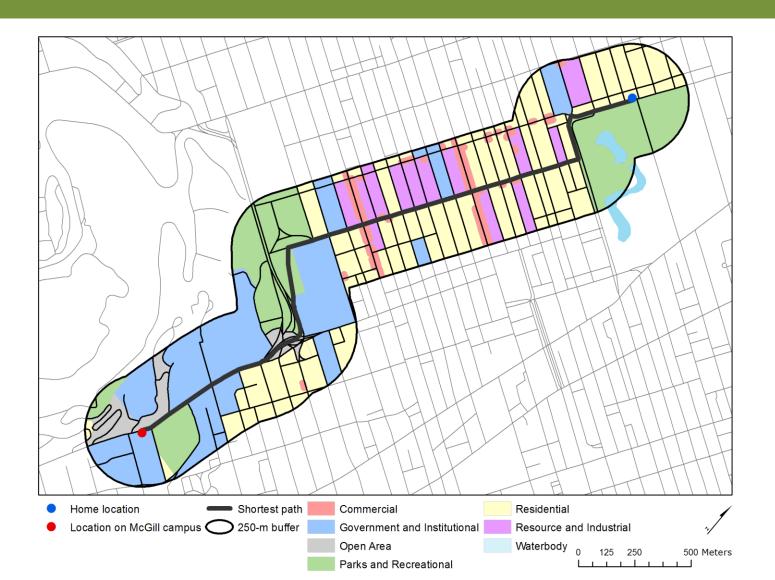
 How do physical elements of the commute and cyclists' personal characteristics affect trip satisfaction?

How does this vary by cyclist type?

# Preliminary results

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

# Methodology



### **Cluster Analysis**

 Cluster Analysis identified 6 distinct groups based on reasons for cycling and 'other' mode

	Clusters	Distance cycled (km)	Built environment measure	% fall cycling trips	% with uphill commute	% 100-m segments with slope > 5%	n
	Cycling Enthusiasts	6.08	51.44	100%	61%	11%	41
Transit riders	Exercise and Convenience- motivated transit riders	4.61	52.24	100%	48%	10%	42
	Convenience-motivated transit riders	3.99	55.57	100%	49%	11%	65
Non-Transit riders	Convenience-motivated walkers	2.78	58.75	100%	48%	12%	48
	Active Environmentalists	5.52	52.68	52%	52%	13%	25
Year-round	Year-round cyclists	3.50	56.98	2%	45%	12%	47

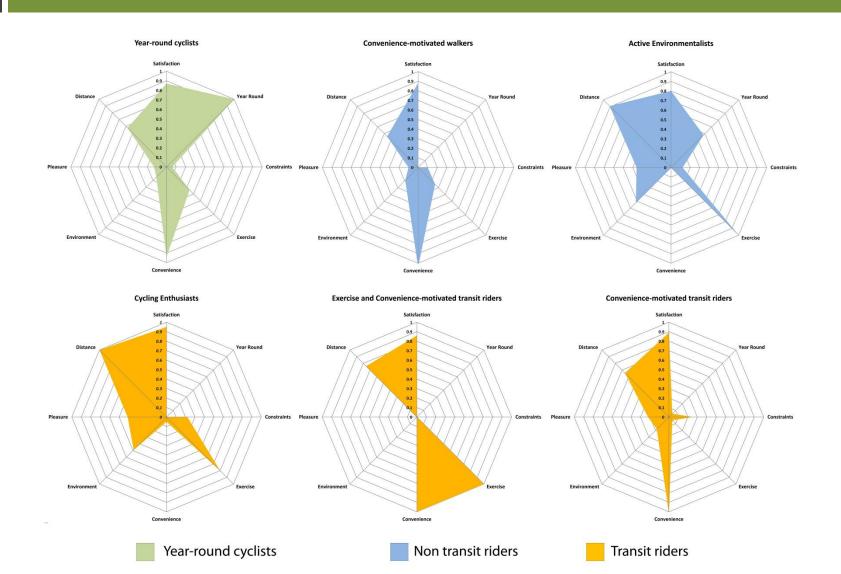
#### Internal factors: Personal characteristics

- Age, gender, status at the university and car ownership were not significant in predicting satisfaction
- Cyclists who stated the environment as their primary reason for cycling were significantly less "very satisfied" than average
- Cyclists who cycled only in the fall and took transit in the winter were significantly more "very satisfied"

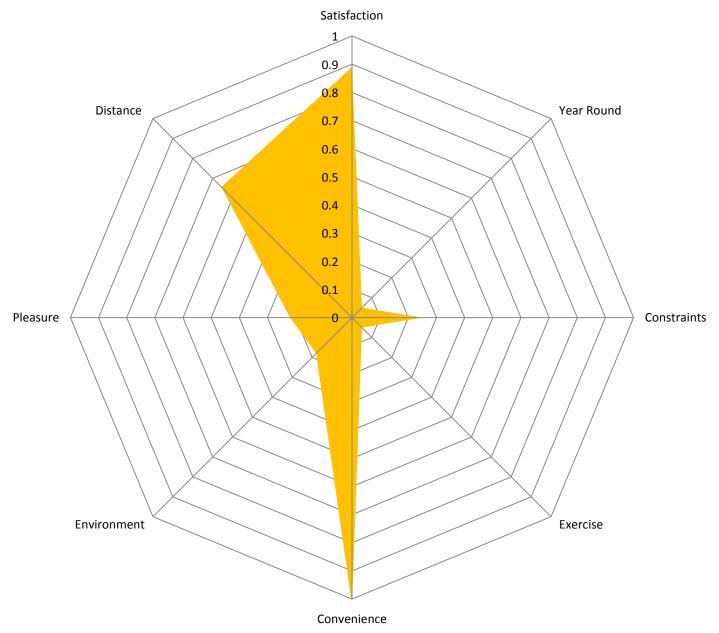
# External factors: built environment, distance & slope

- No clear relationship between level of satisfaction and distance, slope or built environment measure
- Strong relationship between satisfaction and season

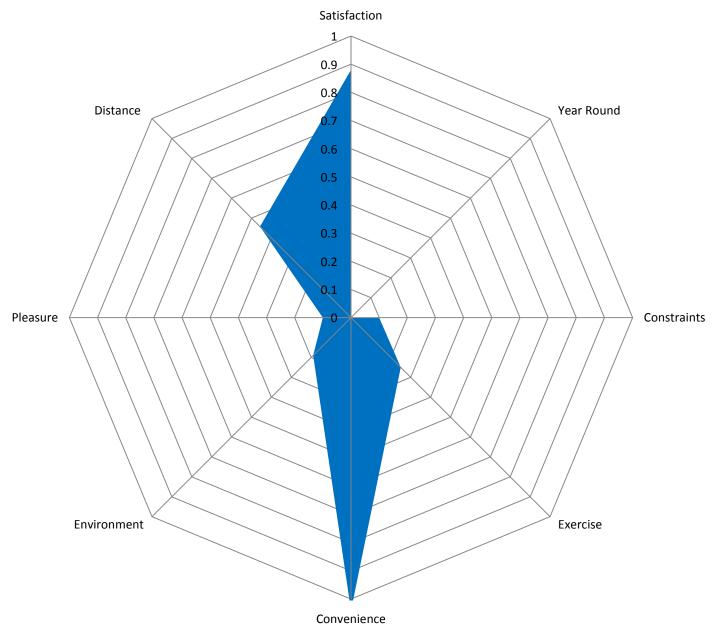
#### **CLUSTER ANALYSIS**



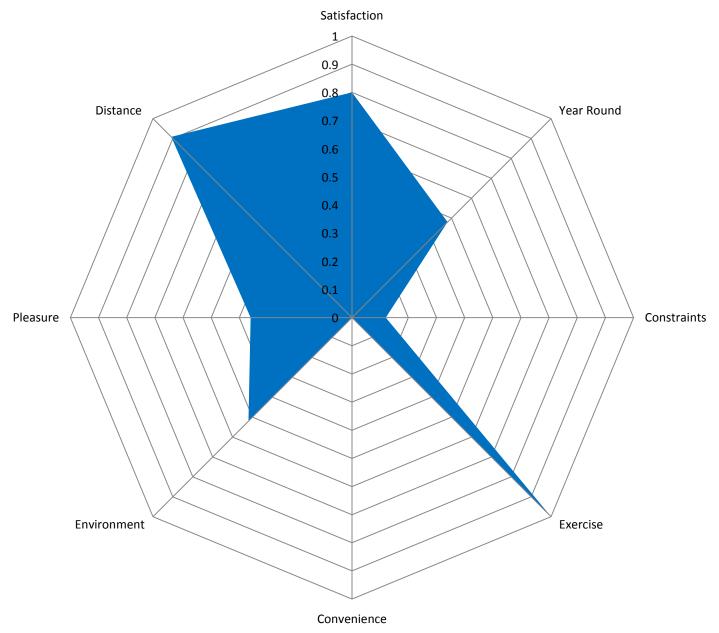
#### **Convenience-motivated transit riders**



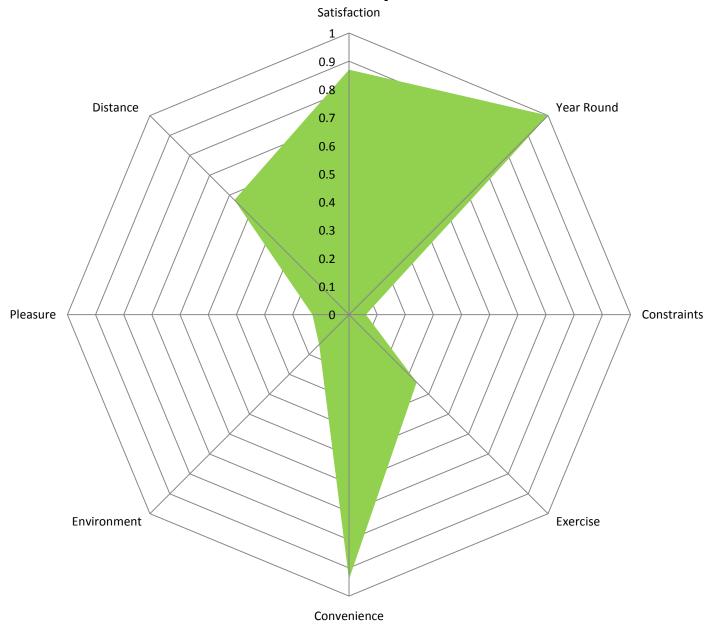
#### **Convenience-motivated walkers**



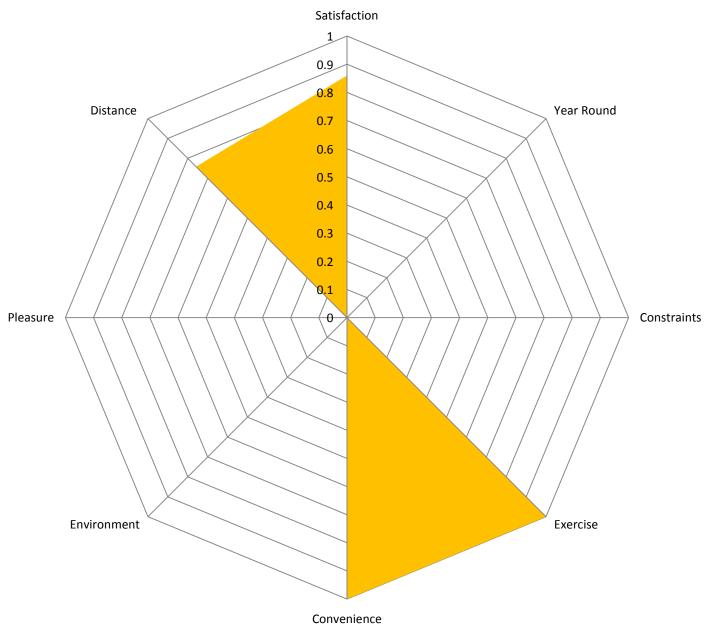
#### **Active Environmentalists**



#### **Year-round cyclists**



#### **Exercise and Convenience-motivated transit riders**



#### **Cycling Enthusiasts**



#### WHY ARE CYCLISTS SO SATISFIED?

- Independence afforded by having a bicycle
- Flexibility of travel times and routes
  - "I think that bicycling is generally the most *empowering* way to travel. I can fix my bike *myself*. I do not have to rely on [transit] schedules"

### WHY ARE CYCLISTS SO SATISFIED?

- Identity
  - Strong sense of identity, socially desirable activity.

## WHY ARE CYCLISTS SO SATISFIED?

#### Exercise

 Just as transit users may value the "multi-tasking" aspect of some transit travel, cyclists may value the chance to exercise while commuting

## WHY ARE CYCLISTS SO SATISFIED?

#### Cost savings

- A transit pass in Montreal can cost as much as \$100.
- The CAA estimates the average cost of owning a car at \$6,239 (not including parking)

## WHY ARE CYCLISTS SO SATISFIED?

#### Short commute times

	Average Commuting
	Time (min)
Cycled	16
Walked	20
Took Transit	38
Drove	36

### Conclusion

- The higher (and statistically significant) satisfaction rates of Cycling Enthusiasts lends support to the research framework
- Elements that have been found to affect likelihood to cycle, such as built environment, distance, slope, socio-economic status and gender were not found to affect levels of satisfaction in this study

# Why is this Important?

Policy Implications

Methodological concerns

### Future research

 Understand what makes cyclists so uniquely satisfied, as satisfaction from daily travel surely affects future travel habits

 Understand the barriers to winter cycling as only 22% of cyclists in our survey cycled in winter, how to increase cycling mode share in colder climates

Further refinement of attitudinal questions and measurement of satisfaction

# **Policy Implications**

- Is the goal to:
  - Increase active mode share (GHG and CC)
  - Increase total activity (Population Health)
  - Improve satisfaction and comfort of those already walking and cycling (Equity)
  - Ensure that those who are forced to walk can do so in safety and comfort (Equity)

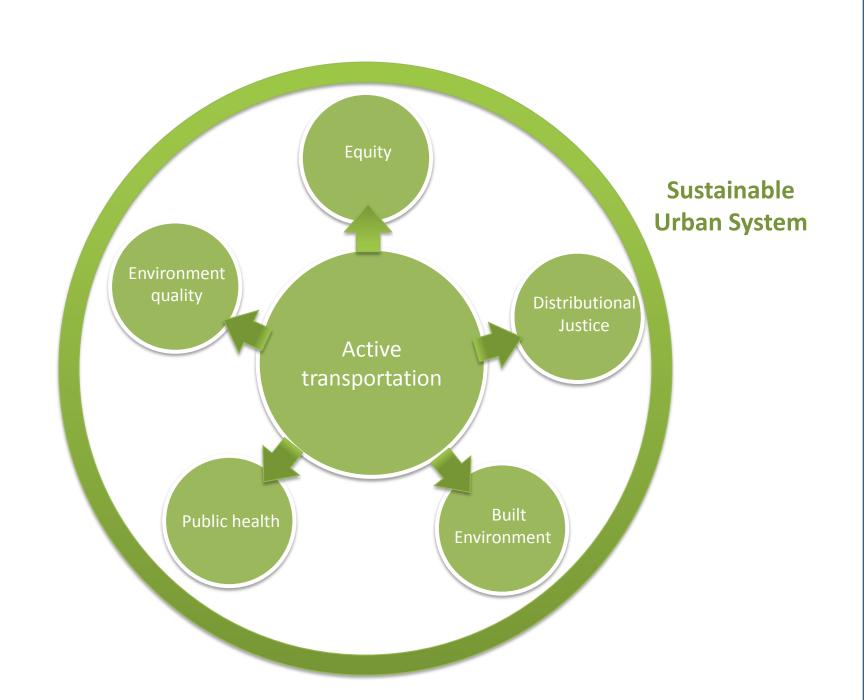
## Methodological Concerns

Measurement issues

- Are we asking the "right" questions?
  - Conflation of attitudes, perceptions, beliefs
  - Stated versus revealed preferences
  - Self-selection, feedback loops

## Methodological Concerns

- Modeling
  - Under or over-estimation of built environment effects
  - How to better incorporate these concerns into mode-choice modeling
    - Mixed logit etc.
  - Integrate theoretical frameworks with utilitymaximizing modeling frameworks



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