



Bicycle ridership and intention in a northern, low-cycling city

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ABSTRACT

Cycling as a mode of transportation (i.e. utility cycling) has been given heavy attention and investment in North America over the last decade. It is perceived as an environmentally friendly way to travel, leading to benefits for health and traffic alleviation. This study examines the determinants of utility cycling behaviour and intent, and more broadly, active transportation (i.e. cycling and walking) behaviour in Edmonton, Canada – the northernmost North American city with a metropolitan population over one million. With harsh winter weather and low cycling rates, the city presents a unique case study for cycling behavior. In this research, we analyzed 646 responses to a bike ridership survey conducted in 2014 by the City of Edmonton. Borrowing concepts from behaviour theory, public health and transportation engineering we seek to quantify the effects of infrastructure density, traffic attitude, perceived control over time and distance, and traffic stress tolerance perception on cycling for utility purposes, the intention to cycle more frequently, and the use of an active mode of transportation, specifically for a northern and low-cycling city. Three empirical models were developed to describe cycling behaviour using binary logistic regression. Most variables were significant and in line with other study findings in the current literature. Results point at the importance of perceived safety in deciding or intending to cycle, as well as perceived time and distance of travel. Broad policy implications and suggestions for future research are discussed.

1. Introduction

Cycling, particularly for commuting and transport purposes, has been an object of increasing interest in North America over the last two decades. The degree and intensity of uptake and investment has been varied; cities like Montreal, Vancouver, and Portland have all witnessed sharp increases since 1990, but they are the exception and not the rule (Pucher et al., 2011). Nonetheless, city planners, health officials, and academics alike largely agree that greater levels of cycling can contribute to mitigating ever-increasing congestion in urban environments, reduce transportation-related greenhouse gas emissions and pollution, and offer a remedy to inactivity-related health problems (Guttenplan et al., 2003; Oja et al., 2011; Lindsay et al., 2011). Researchers from diverse disciplines have taken interest in the subject; a central focus has been to identify the correlates and determinants of non-recreational (i.e. utility) cycling and, more broadly, of active transportation.

The objective of this work is to gain insight into cycling behavior, the intent to cycle more often, and the use of active modes of

transportation specifically in Edmonton, Alberta, Canada. As a northern city with long winters and heavy snowfall, this locale constitutes an interesting case study of cycling behaviour. Indeed, many North American studies on cycling activity focus on cities such as Portland, Seattle, Washington, D.C., Vancouver, etc. – cities with milder climates and urban infrastructures that are more conducive to year-round cycling. Yet, research shows that sub-zero temperatures, wind, precipitation, and poor winter maintenance are associated with lower levels of cycling in winter months (Miranda-Moreno et al., 2013; Flynn et al., 2012; Helbich et al., 2014). Given the northern context, the drivers of the use of active modes and of intent to cycle or to walk could conceivably differ from other, warmer cities. Therefore, we seek to quantify the effects of infrastructure density, traffic attitude, perceived control over time and distance, and traffic stress tolerance perception on cycling for utility purposes, the intention to cycle more frequently, and the use of an active mode of transportation, specifically for a northern and low-cycling city. Incorporating a typology of traffic stress proposed by Mekuria et al. (2012), we test this typology empirically

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and propose modifications based on findings from this study.

This work makes use of a publicly-available secondary dataset from the City of Edmonton, drawn from a regular survey panel called the Edmonton Insight Community. Research regarding correlates and determinants of cycling, the intention to cycle, and the use of an active mode of transportation will be reviewed in turn. This is followed by a discussion of safety perception and concludes with a review of distinctions between intent and behavior.

2. Literature review

Research regarding cycling for transportation is inherently multidisciplinary. The themes below are reviewed with respect to the literature from social sciences, public health, and transportation engineering.

2.1. Intention to cycle

The Theory of Planned Behaviour (TPB) is one of the most highly applied frameworks to assess the intention to cycle (see Eriksson and Forward, 2011; Kaplan et al., 2015; Milković and Štambuk, 2015; Lois et al., 2015). The theory was developed by Ajzen (1991); briefly, it is based on the premise that intentions are a good predictor of actual behaviour. Intentions are theorized to stem from three elements: attitude towards the behaviour, subjective norms (i.e. the “perceived social pressure to perform or not perform the behaviour” (Ajzen, 1987)), and perceived behavioural control, although some researchers of mode choice also suggest the use of descriptive norms (see Eriksson and Forward, 2011). In their study of car and transit commuters, Lois et al. (2015) found that a positive attitude and the presence of subjective norms regarding cycling explained increased intention to cycle. Their study also included a measurement of habit where a positive influence on cycling intention was also observed.

Without measuring intent itself, other researchers have studied factors influencing the progression of stages prior to actual behaviour change; that is, adopting cycling for utilitarian purposes. For example, Gatersleben and Appleton (2007) utilized the framework of the transactional model of behaviour change (also known as the Transtheoretical model, TTM) developed by Prochaska and DiClemente (1984) and related the five progression stages to more or less positive attitudes and perceptions regarding cycling.

We expect our modeling results to indicate that higher perceived behavioral control and a more positive attitude towards cycling will be associated with a greater intent to cycle.

2.2. Active mode use

Public health researchers have extensively studied active transportation use (mainly walking and cycling) and its correlates. Much of this research follows Saelens et al. (2003), where features critical in urban transportation design – such as population density, network connectivity, and land use mix – were correlated to activity levels resulting from the choice of active transportation. In particular, Panter and Jones’ review (2010) is helpful in identifying a list of active travel correlates. The environmental correlates are very similar to those related to cycling only and will be discussed in the next section. The review also identifies cognitive theoretical models that have been used in active transportation research. In addition to TPB, which has a rich history in the assessment of cycling and walking behaviors (Dill et al., 2014), the Theory of Interpersonal Behaviour (TIB), the Norm Activation Model and the Theory of Trying have all been applied (Panter and Jones, 2010). Burbidge and Goulias (2013) also created a conceptual behavioural analysis framework to analyse active travel behaviour. Like many other studies, TPB is included in their model, although the framework distinguishes itself through the inclusion of elements of Decision Field Theory (Busemeyer and Townsend, 1993).

Rather than a behavior, the use of active travel modes can also be studied from the point of view of mode choice theory. Recent mode choice models used in travel demand forecasting are increasingly integrating behavioral aspects, as is the case of the Generalized Random Utility Model (Walker and Ben-Akiva, 2002). Theoretical mode choice frameworks aimed specifically at active travel also exist. One such example is the Theory of Routine Mode Choice Decisions, which integrates variables of awareness and availability, basic safety and security, convenience and cost, enjoyment, and habit (Schneider, 2013).

2.3. Cycling for transportation

Heinen et al. (2010) offer an excellent overview of concepts that have been associated with the use of cycling as a travel mode in transportation research, identifying five categories. The *built environment* includes aspects describing urban form (such as network connectivity), infrastructure, and facilities (bicycle parking, etc.). There is evidence that the presence of dedicated infrastructure induces higher levels of cycling (Dill and Carr, 2014; Burk, 2017). Bicycle infrastructure density is a metric that has also been used to assess bikeability (Winters et al., 2013). The *natural environment* refers to external factors such as hilliness and weather. As in all behavioural research, *socio-economic factors* are also considered. For example, it has been found that men tend to cycle more in countries with low cycling rates, although the relationships between age, income, and cycling are unclear. The *utility* category includes cost, travel time, effort, and safety. The latter often plays a central role in the choice to cycle as both objective and subjective safety assessments are associated with lower levels of cycling (Dill and Voros, 2007; Winters et al., 2011). In fact, an increasingly popular method of cyclist classification is by cyclists’ traffic stress tolerance. This concept will be explored in detail in Section 2.4. Finally, the *psychological factors* reviewed bring up the behavioural models presented earlier (TPB, TIB, as well as habit). For example, de Bruijn et al. (2009) found that habit is strongly linked to actual behaviour and acts as a mediator in the intention-behaviour relationship, as measured by the constructs of TPB. The mode choice models discussed in the previous section are also applicable to cycling.

2.4. Traffic stress tolerance and safety perception

Traffic stress tolerance is a means of categorizing cyclists into four groups based primarily on how comfortable they are mingling with motorized vehicles while cycling. The typology was developed by City of Portland bicycle coordinator Roger Geller (c. 2007) and gradually gained widespread adoption. The four cyclist categories are: “Strong and fearless” – the stereotypical male performance road cyclist or bike courier; “Enthusied and confident” – avid cyclists who do not mind mixing with moderate traffic, but avoid high-risk situations or high vehicular speeds; “Interested but concerned” – the vast majority of cyclists or potential cyclists, who fear motorized vehicle traffic and feel most comfortable on segregated facilities; and “No way no how” – the portion of the population for whom travelling by bicycle is not an option. It should be noted that this typology, although adopted by many researchers and practitioners, is not based on empirical evidence, but rather from Roger Geller’s experience as a planner; it has been critiqued for this reason (Damant-Sirois and El-Geneidy, 2015). However, the typology was tested on a sample of adult Portland residents by Dill and McNeil (2013), who found it to be accurate for classifying the adult population into the four categories.

Mekuria et al. (2012) also created a framework to evaluate different types of road infrastructure based on this typology. They assign specific design and operations criteria to four levels of traffic stress which are briefly described here. LTS4 designates facilities that are only adequate for the “Strong and fearless” – generally important roads with vehicle speeds over 55 km/h, without bicycle lanes. LTS 3 corresponds to conditions the “Enthusied and confident” would tolerate, with bicycle

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