

Cycling Under Influence: Summarizing the influence of perceptions, attitudes, habits and social environments on cycling for transportation

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

Assistant Professor
Department of Geography
McGill School of Environment
805 Sherbrooke Street West
Montreal, Quebec, Canada H3A 2K6
Tel.: 514-398-3242
Fax: 514-398-7437
E-mail: kevin.manaugh@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

Due to cycling's many environmental and public health benefits, research on factors that could increase this activity has greatly expanded in recent years. Clear connections have been found between elements of the built environment and cycling for transportation. However, social and psychological factors, such as perceptions, attitudes, habits and social environments, have recently been shown to play an important role in affecting travel behaviour and mode choice. This paper reviews 24 previous studies and sets out to summarize the literature concerning the influence of these social and psychological factors on the choice to cycle for transportation. The findings highlight the importance of these factors on bicycle commuting, especially perceptions of benefits and barriers to cycling, perceptions of safety, attitudes towards cycling and other modes of transportation, habits, and the influence of family, friends and the workplace. A consensus shows that social factors clearly affect the decision to commute by bicycle. It is therefore important to think beyond the role of physical and built environment factors when attempting to understand or predict bicycle use. Implications for future research design as well as policy are presented.

1 INTRODUCTION

As cycling has multiple environmental and health benefits (Oja, Titze et al. 2011), many studies have sought to identify factors that affect bicycle use for transportation. Several of these studies have focused on objectively measured elements of the built environment (e.g., design of bicycle routes, connectivity of the road network, population density, land use mix), and socio-economic and demographic factors (e.g., age, gender, income, education). While there is a demonstrated correlation between certain aspects of the built environment and the decision to cycle for transportation (Nelson and Allen 1997; Dill and Carr 2003), improvements to the built environment may not be sufficient to encourage cycling. Further, although gender (Heinen, Maat et al. 2011), income (Timperio, Ball et al. 2006; Xing, Handy et al. 2010), car ownership (Timperio, Ball et al. 2006; Eriksson and Forward 2011) and education level (Xing, Handy et al. 2010) are correlated with bicycle commuting, they are not the only determinants of travel mode choice. There are other factors that influence the decision to cycle. The current work presents a review of the literature about those other factors - including attitudes and perceptions; social norms, work environments and neighbourhoods; attitudes and behaviours of family, friends and colleagues; and habits - and their impact on the decision to cycle for transportation. The next section offers a brief summary of previous review papers on cycling. The goal of this paper is to summarize what is known about the effect of these factors on the decision to cycle for transportation and the methods being used to measure these effects. The following section offers a discussion

of the major theoretical models used in travel behaviour research. Next, we present the methods used for the literature review, followed by the results section, which is divided into four sections: 1) Attitudes, 2) Habits, 3) Social-environment factors and 4) Perceptions. The final section will discuss these findings, the methodologies used, the implications for increasing bicycle mode share, the gaps in the research, and paths for future research.

2 BACKGROUND

2.1 Cycling Review Papers

Several review papers have examined determinants of cycling (Fraser and Lock 2010 for example), although none of them have focused exclusively on the effects of attitudes, habits, social-environment factors, and perceptions on bicycle commuting. Panter and Jones (2010) reviewed peer-reviewed articles written between 1990 and 2009 about environmental and psychological influences on bicycle commuting. The authors did not explicitly distinguish between perceived physical environment and objectively measured physical environment, however. Handy et al. (2002) reviewed the effect that the built environment has on travel behaviour and physical activity. The authors emphasize the importance of changing the built environment and they focus on design, land use and transportation systems to promote active travel.

Pucher et al. (2010) reviewed both peer-reviewed and non-peer reviewed papers on the effect of interventions on bicycling. They conclude with a section of case studies of cities that have implemented various programs and policies to increase cycling. They

note that the methods used for most of the studies were not rigorous and did not involve an ideal research design (e.g., they had no “control” and “treatment” groups and thus were unable to control for other relevant factors). They suggest that public agencies should collect data before and after interventions to facilitate the analysis of the effectiveness of these changes, and should work with academic researchers. They do not consider the importance of attitudes, habits, social environments and perceptions on cycling outcomes.

Heinen et al. (2009) divided their review into five sections: built environment; physical environment; socio-economic variables; psychological factors (including attitudes); and time, cost, effort and safety. Their section on psychological factors included attitudes, social norms and habits and they concluded that while only a limited amount of research has been done on the relationships between attitudes, norms and cycling, it may be the case that attitudes play a significant role in the decision to bicycle.

Review papers have also explored walking and bicycling to school (Sirard and Slater 2008), the effect of transportation infrastructure on bicycling injuries and crashes (Reynolds, Harris et al. 2009), attitudes about walking and cycling among children, young people and parents (Lorenc, Brunton et al. 2008), and environmental correlates of walking and cycling (Saelens, Sallis et al. 2003).

2.2 Theories and Models

Many approaches have been used to understand travel choices (trip frequency, mode, distance). This section will briefly introduce relevant theories in the context of active

transportation with the goal of showing how attitudes and behaviors play a major role in travel behavior research.

2.2.1 Random Utility Maximization

Much work on travel behavior is modeled in random utility maximization frameworks that attempt to quantify the influence of various physical and socio-economic factors on travel choices. However, these approaches have come under criticism in recent years for several reasons. For one, these models often deliberately place most matters related to personal preferences, motivations, and values in the error term. In addition, a common criticism of random utility maximization frameworks is that people do not always act rationally. In recent years, however, these elements have been brought into the research framework and modeled in statistical analysis. For example, the Hybrid Choice Model, developed by Ben-Akiva and colleagues (Ben-Akiva, McFadden et al. 2002), takes into account perceptions and attitudes and uses more flexible error structures to better model the realism of choice models. The models and frameworks described below try to more explicitly account for the complex influences of personal values, family and peers, work environment.

2.2.2 Theory of Planned Behaviour

An often-cited framework used to understand behaviour is the Theory of Planned Behaviour (Ajzen 1991). This theory posits that the most important factor influencing an individual's behaviour is their intention to perform that behaviour. That is to say, how hard they are willing to try. Intention to perform behaviour is itself affected by three factors, conceptually independent of each other: the individual's attitude toward the

behaviour, the subjective norm, and the degree of perceived behavioural control. Their attitude toward the behaviour can be favourable or unfavourable; the subjective norm can be pressure to perform the behaviour or pressure to not perform the behaviour; and the perceived behavioural control refers to the perception of the ease of difficulty to perform the behaviour.

2.2.3 *Social-Ecological Model*

These dynamic relationships described above are at the core of the social-ecological model (Stokels 1996; Banks-Wallace 2000), which situates an individual in a series of interrelated and nested contexts (Sallis, Cervero et al. 2006). This includes such aspects as cultural and national norms, family obligations and customs, and neighborhood standards, as well as personal expectations and desires. This approach is inherently dynamic and multivariate: that is, the unique assortment of factors ensures that their effects are differentially experienced. An important strength of socio-ecological frameworks is the ease with which attitudes, perceptions, and cultural forces can be incorporated.

Alfonzo (2005) applies the social-ecological model to the decision to walk. The decision has antecedents, mediators, inter-processes and multiple outcomes. Within this model, the built environment is critical in that environmental factors are antecedents to walking. However, they alone do not determine the decision to walk. The decision is also influenced by the *perceived* environmental factors. Thus Alfonzo distinguishes between the built environment objectively measured and subjectively perceived. There are also inter-processes, and this includes the social-environment

("group-level") and individual ("individual-level") factors. Here, Alfonzo also includes regional-level factors such as geography, climate and topography. Together, measured and perceived environmental factors, and inter-processes (moderators), including the individual-level, the group-level and the regional-level, influence the choice of mode.

2.3 Definition of terms

Many terms can have several meanings in the travel behavior research; this section to defines the different terms used in this research paper. This will be useful for readers to better understand the meanings of every term used in the following section of the review.

2.3.1 Perceptions

This section considers perceptions about benefits and barriers, safety, time, and cyclists, using the definition of perceptions offered by Ben-Akiva et al.: "the individual's beliefs or estimation of the attributes of the alternatives" (Ben-Akiva, Walker et al. 1999). Alfonzo (2005) emphasizes the role of individual perceptions in the "Hierarchy of Walking Needs", explaining how different people will experience the same setting or conditions in drastically different ways, depending on their own needs. This emphasizes the difference between the objectively-measured built environment and the perception of the built environment, and conveys the importance of the latter in determining travel choice.

2.3.2 Attitudes

In a recent review paper on attitudes in research on travel behaviour, Bohte et al. (2009) define attitudes according to the definition given by Eagly and Chaiken (1993): “an attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour.”

2.3.3 Habits

In her Theory of Interpersonal Behaviour, Triandis (1977) defines habits as “situation-specific sequences that are or have become automatic, so that they occur without self-instruction”. See Schneider (2013) and Aarts & Dijksterhuis (2000) for more on the role of habit in mode choice.

2.3.4 Social environment

An individual’s social environment is defined by one’s living and working environment and community characteristics and can be, “experienced at multiple scales, often simultaneously, including households, kin networks, neighborhoods, towns and cities, and regions.” (Barnett and Casper 2001)The social environment includes historical and power relations within communities. Person environment fit and residential neighbourhood type “dissonance” are two related concepts that have been used to address social determinants of behaviour. The latter concept has been used to explore mode choice in the context of residential self-selection (Schwanen and Mokhtarian 2005).

3 RESEARCH FRAMEWORK

This paper will review research that considers the effect of social and psychological factors on the decision to cycle for transportation. As mentioned above, many studies have examined associations between built environment, active travel, and personal factors (socio-economic and demographic characteristics). The associations between these factors and the decision to cycle have been established and reviewed and the objective of the present work is to review the papers that associate attitudes, habits, social environment factors and perceptions with bicycle commuting, as in the third diagram in Figure 1. Figure 1 represents the three kinds of empirical studies on cycling behavior: 1) studies that consider only elements of the physical environment as correlates of active travel, 2) Studies that consider both physical environment elements and personal factors as correlates of active travel, and 3) Studies that consider physical environment elements and personal factors as well as social and psychological factors in the decision to cycle for transportation. Only the latter group of studies are reviewed herein.

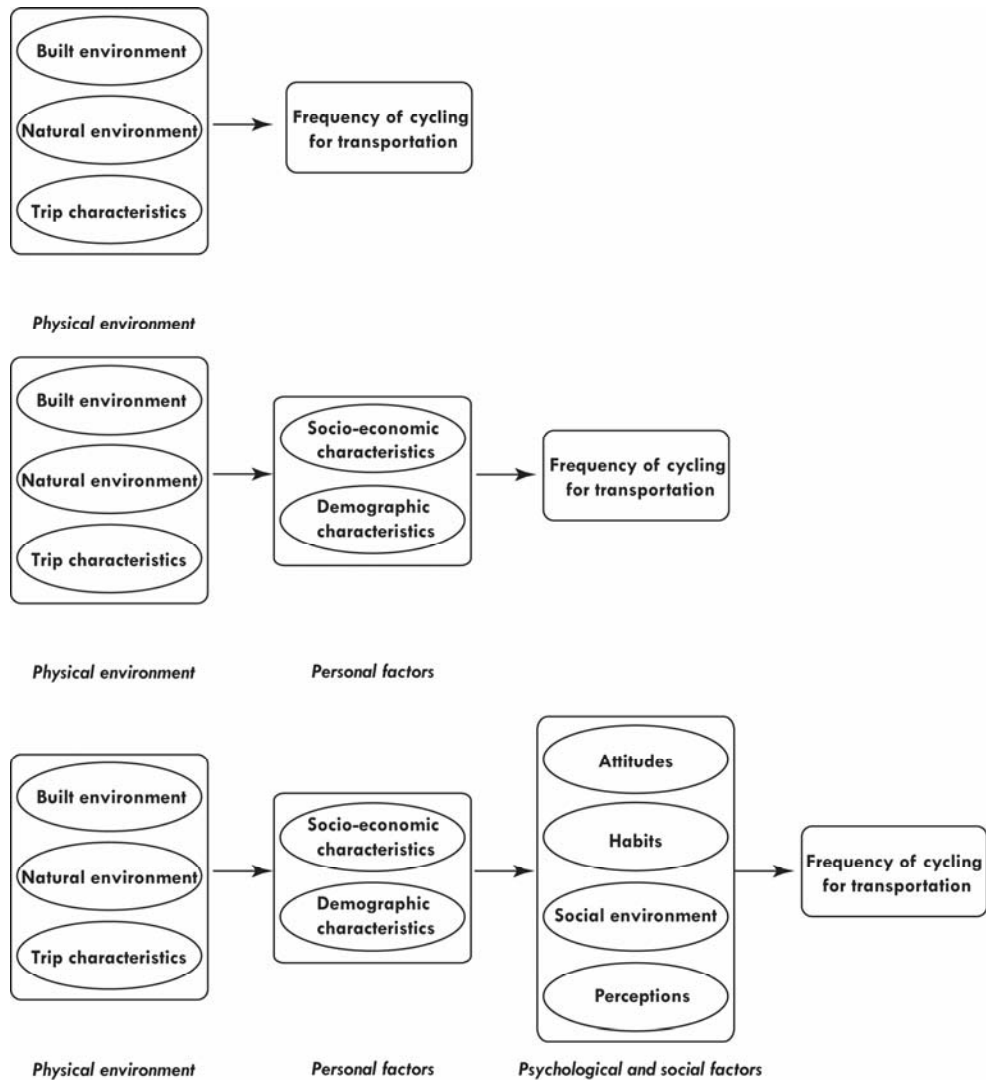


Figure 1: Representation of the different conceptual models regarding correlates of cycling for transportation

4 METHODS

This review examines quantitative, English-language peer-reviewed articles about cycling for transportation (or “active transportation” when it includes cycling and clearly separates findings for walking and cycling) that consider the effect of attitudes, habits, social-environment factors and perceptions on the decision to cycle for transportation.

Papers were found through an extensive search which made use of four sources: Google

Scholar, Web of Science, PubMed and Science Direct. Search terms included “cycling”, “active transportation”, “active commuting”, “bicycle commuting”, “attitudes”, “perceptions”, “social environment”, “bicycle use” and “preferences”. The authors combed through the references of each paper to find more relevant papers, and used Google Scholar to search papers that cited each relevant paper. The papers reviewed all originate in North American or Western European cities and therefore are most relevant to these cultural contexts. At least two authors read the abstract and methodology section in the original screening process. Through this method 24 relevant papers were found and reviewed in this paper. Papers were deemed relevant if they were on the topic of cycling for transportation and measured at least one variable relating to attitudes, perceptions, habits and social environments and analyzed its correlation with behaviours or attitudes relating to cycling for transport.

5 RESULTS

The 24 relevant papers featured in this review were published between 2005 and 2012. Table 1 summarizes the findings for attitudes, habits, social-environment factors and perceptions, and their association with commuting by bicycle, and the discussion section that follows will present these results, while placing them into the larger context of research on cycling. The last section will address the methodology, future research and policy implications of these findings. For levels of significance and effect sizes please consult Table 1, unless otherwise noted, all effect sizes refer to odds ratios. Refer also to Table 1 for information on study location, sample size and methods used. The following sections will give more information and context for the findings.

5.1 PERCEPTIONS

Twenty-three papers found that perceptions are associated to cycling for transportation, including perceptions of benefits, perceptions of barriers, perceived behavioural control or self-efficacy perceptions of safety, knowledge and perceptions about cycling routes perceptions about cyclists, perceptions of transportation options and parental perceptions. The following sections give more details on these findings (Also see Table 1).

TABLE 1: Summary of Results

5.1.1 PERCEIVED BENEFITS

The perception of benefits to cycling influences the decision to cycle for transportation.

This includes the perceptions of the health benefits from exercise (Gatersleben and Appleton 2007; Akar and Clifton 2009; Bopp, Kaczynski et al. 2012), the economic benefits (De Geus, De Bourdeaudhuij et al. 2008; Heinen, Maat et al. 2011; Bopp, Kaczynski et al. 2012; Sahlqvist and Heesch 2012), the convenience and rapidity of cycling (Titze, Stronegger et al. 2008; Heinen, Maat et al. 2011; Sahlqvist and Heesch 2012), avoiding traffic congestion (Bopp, Kaczynski et al. 2012), environmental benefits (Gatersleben and Appleton 2007; De Geus, De Bourdeaudhuij et al. 2008) and the flexibility of departure time (Akar and Clifton 2009), among several others.

Study and Location	Methods	FINDINGS: Variables associated with bicycle mode choice			
		Perceptions	Attitudes	Habits	Social-environment
1. Akar, G. and K. J. Clifton (2009). College Park, Maryland	Survey (N= 1,500) captured respondents' attitudes towards several transportation characteristics. Principal component analysis.	Positive Perceived benefits: exercise, flexibility of departure time Perceived safety when cycling on campus Negative Perceiving no other option			
2. Bopp, M., Kaczynski, A. T., & Besenyi, G. (2012). Manhattan, KS, U.S.	Online survey (N=375) captured motivators, barriers, self-efficacy, and workplace factors. Logistic regression model.	Positive Economic concerns:1.79*** Health benefits:1.98*** Traffic congestion:1.42*** Negative Concerns about safety from traffic:0.71*** Concerns about safety from crime:0.63***			Positive Co-workers actively commute: 2.54*** Negative Traveling preferences of others traveling with you: 0.68*** Concerns about appearance: 0.54***
3. de Bruijn, G.-J., Kremers, S. P. J., Schaalma, H., van Mechelen, W., & Brug, J. (2005). Netherlands	Questionnaire (N=3859) given to high school students that captured perceived behavioural control, subjective norms, etc. Bivariate correlation and stepwise linear regression analysis.	Positive Perceived behavioural control: Correlation: 0.54 (large size effect) Linear regression: 1.49	Positive Attitudes: Correlation: 0.63 Intention: Linear regression: 1.37		Positive Subjective norm: Correlation: 0.33 (medium size effect)
4. de Bruijn, G.-J., Kremers, S. P. J., Singh, A., van den Putte, B., & van Mechelen, W. (2009). Amsterdam, Netherlands	Amsterdam Growth and Health Longitudinal Study (N=317) captured attitudes, subjective norm, perceived behavioural control, etc. Regression analyses (dependent variable: minutes cycled)	Positive Perceived behavioural control: coefficient=0.28***	Positive Intention to cycle: 0.20* Attitude: coef=0.14*	Positive Habit strength: 0.46***	

Study and Location	Methods	FINDINGS: Variables associated with bicycle mode choice			
		Perceptions	Attitudes	Habits	Social-environment
5. de Geus, B., De Bourdeaudhuij, I., Jannes, C., & Meeusen, R. (2008). Flanders, Belgium	Online and paper questionnaire (N=343) which included questions about psychosocial correlates of cycling for transport (social variables, self-efficacy and perceived benefits and barriers to cycling). Independent t-tests and Chi-squares, binary logistic regression.	<p>Positive</p> <ul style="list-style-type: none"> -Cyclists have stronger external self-efficacy than non-cyclists -Cyclists are more likely to perceive the ecological-economic benefits of cycling (1.71*) <p>Negative</p> <p>Barriers:</p> <ul style="list-style-type: none"> -Non-cyclists are more likely to cite lack of skills, health problems, external obstacles, lack of time (0.26***), lack of interest (0.45**), destinations are far 			<p>Positive</p> <ul style="list-style-type: none"> -Cyclists receive more social support from their surroundings (2.26**) -Relatives cycle (1.83**) -Relatives give social support by cycling with them (2.26**) -Cyclists more often have a cycling partner to stimulate them to cycle with or without them
6. Dill, J., & Voros, K. (2006). Portland, OR	Survey (N=566) captured experience bicycling (e.g. cycling habits of other household members, neighbours, co-workers, barriers to cycling). Compared the number of regular and utilitarian cyclists that agreed with statement to those who disagreed.	<p>Positive</p> <ul style="list-style-type: none"> - Regular and utilitarian cyclists were more likely to agree that bike lanes in their neighbourhood are easy to get to, that bike lanes connect to places they need to go and that quiet streets without bike lanes connect to place they need to go. 	<p>Positive</p> <p>Concern for the environment</p> <ul style="list-style-type: none"> - Regular and utilitarian cyclists were more likely to agree that they like to bike, prefer to bike than drive whenever possible and that biking can sometimes be easier for them than driving -Utilitarian cyclists were more likely to disagree that they like driving. 		

Study and Location	Methods	FINDINGS: Variables associated with bicycle mode choice			
		Perceptions	Attitudes	Habits	Social-environment
7. Ducheyne, F., De Bourdeauhuj, I., Spittaels, H., & Cardon, G. (2012). Flanders, Belgium	Survey of parents of primary school children age 10-12 (N=850). Parental attitudes, social environment, perceived behavioural control, habits, etc. captured. Multivariate logistic regression.	<p>Positive</p> <ul style="list-style-type: none"> -Parents perceived biking skills of child are good are more likely to always cycle to school 1.08* - Traffic safety (safe), children more likely to always cycle to school 1.18*** -Parents think children have high independent mobility with the bicycle more likely to always cycle to school (1.06*) <p>Negative</p> <ul style="list-style-type: none"> - Perception that there are routes along the roads with walking and cycling facilities, children are 8% less likely to always cycle (0.92*) 		<p>Positive</p> <ul style="list-style-type: none"> -Strong habit of cycling to school, children 18% more likely to always cycle to school (1.18***) 	<p>Positive</p> <ul style="list-style-type: none"> - Friends encourage my child to actively commute to campus, children 8% more likely to cycle to school (1.09*) <p>Negative</p> <ul style="list-style-type: none"> -Parents walk or bike alongside their children to school, children 9% less likely to always cycle (0.91***)
8. Emond, C. R., & Handy, S. L. (2012). Davis, CA	In-class survey at high school (N=494). Survey measured attitudes and preferences towards modes, self-efficacy, environmental concern, preference for physical activity, social environment. T-tests and chi-square tests Binary Logistic Regression.	<p>Positive</p> <ul style="list-style-type: none"> Self-efficacy (Bicycle ability confidence): 1.24,* <p>Negative</p> <ul style="list-style-type: none"> -Non-bicyclists say more often they need a car to do the things they like to do and cite clothes are an impediment. 	<p>Positive</p> <ul style="list-style-type: none"> - Bicyclists like being physically active, care about protecting the environment more than non-cyclists. 	<p>Positive</p> <ul style="list-style-type: none"> -Parents encourage bicycling: 2.04*** -Bicyclists more likely to agree that their friends also bicycle and disagree that driving is the coolest way to get to school. <p>Negative</p> <ul style="list-style-type: none"> - Can rely on parents chauffeuring them:: 0.81** 	

Study and Location	Methods	FINDINGS: Variables associated with bicycle mode choice			
		Perceptions	Attitudes	Habits	Social-environment
9. Eriksson, L. and S. E. Forward (2011). Falö, Sweden	Questionnaire (N=620) captured attitudes towards travel modes. Bivariate correlation.	Positive -Perceived ability to cycle/perceived behavioural control (0.60***)	Positive -Positive attitudes towards cycling (coef:0.49, p=0.001)		Positive -Subjective norm (0.39***) - Descriptive norm (0.57***)
10. Gatersleben, B. and K. M. Appleton (2007). Surrey, UK	Online questionnaire (N=389) which included questions about cycling attitudes. Summary Statistics.	Positive - 100% maintenance cyclists say it is good for the environment and healthy Negative -Barriers such as not fit, uncomfortable or uncharacteristic were reported significantly more for cyclists at the pre-contemplation phase.	- -34% "pre-contemplation" cyclists say they do not want to cycle		
11. Gatersleben, B. and D. Uzzell (2007). Surrey, UK	Online questionnaire (N=389) asking to what extent their journey to work is stressful, exciting, boring, relaxing, pleasant, depressing. Summary Statistics	Positive Cyclists perceive their commutes as relaxing and exciting.			
12. Gatersleben, B., & Haddad, H. (2010). Norfolk and Surrey, UK.	Questionnaire (N=244) distributed to employees of two organisations in two towns: Norfolk and Surrey. It measured bicycling stereotypes (52 attributes). Factor analysis and regression analysis.	Positive -Cycling frequency is statistically correlated with perception of other cyclists (0.19,*) and slightly less likely to indicate that the typical bicyclist is a lifestyle bicyclist (r=-0.20*).		Positive -Strong relationship between past bicycling behaviour and intentions to bicycle (t=15.06***)	

Study and Location	Methods	FINDINGS: Variables associated with bicycle mode choice			
		Perceptions	Attitudes	Habits	Social-environment
13. Heinen, E., Maat, K., & van Wee, B. (2011). Netherlands	Internet survey (N=1666) which asked about benefits, behavioural control, attitudes habits, etc. Binary Logit Models.	<p>Positive Direct benefits: 1.747*** (<5km), 1.984*** (5-10km), 1.681*** (>10km)</p> <p>Perceived behavioural control: 2.293*** (<5km), 2.497*** (5-10km), 2.925*** (>10km)</p> <p>Cyclists more likely to perceive cycling as providing status, as mentally relaxing, as comfortable, as time-saving, as flexible, as cheap, as pleasant, as offering privacy, as being good for health, as being safe from traffic, as socially safe and as a part of their lifestyle.</p>	<p>Positive Cycling to work is pleasant.</p>	<p>Positive Habit: 1.154*** (<5km), 1.077** (5-10km), 1.106** (>10km)</p>	<p>Positive Subjective norm: 1.102* (<5km)</p>
14. Heinen, E., Maat, K., & van Wee, B. (2012). The Netherlands	Survey (N=1370) about work environment (work attire, expected mode of travel by colleagues, etc.) Binary logit models.				<p>Positive -Bicycle contribution from work: 0.314*** -Clothes changing facility: 0.294*** - -Colleagues expect one to drive: -0.682*** Colleagues expect other mode of transportation: -1.452***</p>

Study and Location	Methods	FINDINGS: Variables associated with bicycle mode choice			
		Perceptions	Attitudes	Habits	Social-environment
15. Panter, J. R., A. P. Jones, et al. (2010). Cambridge, UK	SPEEDY study (Sport, Physical activity and Eating behaviour: Environmental determinants in young people) (N= 2012) Measured parental and children's attitudes and social environment. Independent associations.	Negative -Parental concern about dangerous traffic en route to school (1-2km, 0.f05**) -Parent thinks it is convenient to drive their child to school by car (<1km, 0.04**)			Positive -Friend encouragement (4.48**) -Parental encouragement (4.63**) Negative -Parent can usually take child to school (<1km, 0.40**)
16. Panter, J., Griffin, S., Jones, A., Mackett, R., & Ogilvie, D. (2011). Cambridge, UK.	Commuting and Health in Cambridge study (N=1164). Participants were asked to state their level of agreement with 7 statements that could be used to describe the environment along their route to and from work using a 5-point Likert scale. Independent associations	Positive -There are convenient routes for cycling (4.60***)	Negative -Stronger attitudes in favour of car use (0.28***)		
17. Sahlqvist, S. L., & Heesch, K. C. (2012). 9(1), 818-828. Queensland, Australia	Online survey (N=1813) captured motivators and constraints. Logistic regression analysis.	Positive - Cycling is convenient (8.93*) - cycling is a cheap mode of transport (1.50*) -Concerns about cycling in traffic increased the likelihood of utility cycling (1.57**)			

Study and Location	Methods	FINDINGS: Variables associated with bicycle mode choice			
		Perceptions	Attitudes	Habits	Social-environment
18. Titze, S., Giles-Corti, B., Knuiaman, M. W., Pikora, T. J., Timperio, A., Bill, F.C. and van Niel, K. (2010) Perth, Australia	Survey (N=1813) RESIDE, a quasi-experimental 5-year longitudinal study. Measured attitudes, perceived behavioural control, self-efficacy, enjoyment, behavioural skills, family support and friend support. Multivariate logistic regression.	Positive -Perceived behavioural control (6.28***)	Positive - Positive attitude towards cycling (3.07***).		
19. Titze, S., Stronegger, W. J., Janschitz, S., & Oja, P. (2007). Graz, Austria	Questionnaire (N=634) assessing social environment, attitudes. Factor analysis (principal components analysis) and multi-nominal regression analyses.	Positive Regular cyclists (>3 times per week) perceive high safety from bicycle theft (2.330***), high emotional satisfaction (1.989**), little physical effort (2.086**) and high mobility (3.401***)-and perceive low traffic safety (0.552*)			Positive Regular cyclists (>3 times for week): many friends cycle (2.210**)
20. Titze, S., Stronegger, W. J., Janschitz, S., & Oja, P. (2008). Graz, Austria	Survey using a computer-assisted telephone interview (N=896) captures cycling behavior and associated personal, social and environmental factors. Factor analysis and logistic regression analyses.	Positive Perceived benefit of “rapidity” 2.38 Negative Barriers: -Physical discomfort 0.49 -Impractical mode of transportation 0.33			Positive -Social support/modeling (1.62)

Study and Location	Methods	FINDINGS: Variables associated with bicycle mode choice			
		Perceptions	Attitudes	Habits	Social-environment
21. Trapp, G. S. A., Giles-Corti, B., Christian, H. E., Bulsara, M., Timperio, A. F., McCormack, G. R., & Villanueva, K. P. (2011). Perth, Australia	Self-reported travel diaries, self-completed questionnaires (N=1197) anthropometric measures and GIS. Multivariate logistic regression analyses. *Results divided according to gender*	Positive - Parents think neighbourhood is safe enough for children to cycle to school with friends (<i>BOYS</i> : 2.39***; <i>GIRLS</i> : 2.21**) -Parent is confident in child's ability to cycle without an adult (<i>BOYS</i> : 10.60,***; <i>GIRLS</i> : 3.63***) - Child is confident in ability to cycle without an adult (<i>BOYS</i> : 3.42*, <i>GIRLS</i> : 2.13*). Negative - My child would have to cross a busy road (<i>BOYS</i> :0.51***, <i>GIRLS</i> :0.32***) -Driving child to school more convenient (<i>BOYS</i> : 0.51*; <i>GIRLS</i> : -0.44**)	Positive - Cycling is child's preference (<i>BOYS</i> : model 4: 5.68*** <i>GIRLS</i> : model 4: 3.73***)		Positive -Cycling to school is cool (<i>BOYS</i> - model 4: 1.85**) Negative -Adult home after school on most days (<i>GIRLS</i> - model 4: 0.41**)
22. Whannell, P., Whannell, R., & White, R. (2011). Australia	Questionnaire (N=270) about confidence cycling, perceived benefits, knowledge of the route, etc. Correlation	Positive -Perceived benefits of riding a bicycle (0.338***) -Knowledge of route between home and university (0.159**)			
23. Winter Winters, M., Davidson, G., Kao, D., & Teschke, K. (2011). Vancouver, Canada.	Survey (N=1402) about motivators and deterrents to cycling. Means scores and factor analysis.	Positive Route: route away from traffic noise and air pollution; beautiful scenery along route; route has bike paths separated from traffic the entire distance; Negative Safety: risk from motorists who don't know how to drive safely near bicycles; risk of injury from car-bike collisions; risk of bike theft; risk of violent crime.			

Study and Location	Methods	FINDINGS: Variables associated with bicycle mode choice			
		Perceptions	Attitudes	Habits	Social-environment
24. Xing, Y., Handy, S., & Mokhtarian, P. (2010). Davis, Chico, Woodland, Turlock, Eugene, Boulder	Questionnaire about comfort, self-efficacy, etc. (N=520) Binary logit model.	Positive -Bicycling comfort: 0.817** Negative -Perception that children bike: -0.229	-Liking driving: -0.258** -Limit driving: 0.304*** -Biking community preference (chose their community because It is bike-friendly): 0.179**		Positive -Biking is normal, 0.206*

5.1.2 PERCEIVED BARRIERS

Non-cyclists are more likely to mention barriers to cycling such as lack of skills, health problems, external obstacles, lack of time, lack of interest and destinations that are far (De Geus, De Bourdeaudhuij et al. 2008). In fact, individuals who have never contemplated cycling are more likely to perceive personal or physical barriers (e.g. fitness) whereas regular cyclists are more likely to cite specific facility barriers (e.g. change facilities at work) (Gatersleben and Appleton 2007). Barriers such as physical discomfort and perceiving cycling to be impractical decrease the likelihood to cycle (Titze, Stronegger et al. 2008) as does having to wear a certain kind of clothing to work (Emond and Handy 2012).

5.1.3 PERCEIVED ABILITY TO COMMUTE BY BICYCLE: *Self-efficacy, perceived behavioural control and comfort on a bicycle*

An individual's perceived ability to cycle for transportation has been found by a number of studies to be significant in the decision to use active transportation. It appears in both Ajzen's Theory of Planned Behaviour (1991) and Alfonzo's Hierarchy of Walking Needs. Ajzen refers to it as perceived behavioural control, one's perceived ability to perform a behaviour, while Alfonzo (2005) includes it in the base of her pyramid as "feasibility".

Using a mail-out questionnaire filled out by 343 Dutch workers, De Geus et al. (2008) found that respondents reporting high levels of external self-efficacy, meaning their confidence cycling is not affected by external obstacles such as bad weather or having to carrying items from shopping trips, are more likely to take their bicycle for transportation. Perceived behavioural control, confidence in one's ability to cycle, is

significantly correlated to cycling for transportation in several studies (De Bruijn, Kremers et al. 2005; de Bruijn, Kremers et al. 2009; Titze, Giles-Corti et al. 2010; Eriksson and Forward 2011; Heinen, Maat et al. 2011; Emond and Handy 2012), as is comfort cycling (Handy, Xing et al. 2010). This also applies to children. Children who are confident in their own ability to cycle without an adult are more likely to cycle to school (Trapp, Giles-Corti et al. 2011).

The inability to imagine oneself as a cyclist and the idea that cycling is something that other people do are barriers to cycling (Gatersleben and Appleton 2007). However, one study at a university in Australia found no correlation between the likelihood to cycle and confidence in relation to riding a bicycle (Whannell, Whannell et al. 2011). Nonetheless, this was an in-class survey of just 270 students in a Science, Technology and Society class and is probably not representative of a wider population.

5.1.4 PERCEIVED SAFETY

Perceptions of safety fall into two main categories: safety from traffic and safety from crime. Usually concerns about traffic safety discourage cycling (Titze, Stronegger et al. 2007; Bopp, Kaczynski et al. 2012), although concerns about traffic safety increased likelihood to cycle in a study done in Queensland, Australia (Sahlqvist and Heesch 2012). The authors suggest this is because cyclists have a heightened awareness of traffic risks as they more often travel in traffic. In a stated preference survey of motivators and deterrents of bicycling, Winters et al. (2011) found that cycling was significantly deterred by safety risks, especially motorists who do not know how to drive safely around bicycles, bicycle-car collisions, bicycle theft and violent crime when cycling. Two

other papers found that fear for personal safety negatively affects the choice to cycle. In a web-based transport survey at the University of Maryland College Park, Akar and Clifton (2008) found that people who feel safe walking and biking on campus after dark were significantly more likely to cycle and perceived safety from bicycle theft increases likelihood to cycle (Titze, Stronegger et al. 2007).

5.1.5. PERCEPTION OF CYCLING ROUTES

The perception of the quality of routes available for cycling has an effect on the decision to cycle. For instance, people who agree that there are bicycle lanes that are easy to get to, that connect to places that they need to go and that there are quiet streets without bicycle lanes that connect to places that they need to go are more likely to be regular or utilitarian cyclists (Dill and Voros 2006). Further, those who consider there are convenient routes for cycling (Panter, Griffin et al. 2011) and those who know the routes for cycling between their origin and destination are more likely to cycle (Whannell et al. 2011). Finally, survey respondents who perceived that their route was away from traffic noise and air pollution, that the route has beautiful scenery and that the route has bicycle paths separated from traffic for the entire distance were much more likely to cycle (Winters, Davidson et al. 2011).

5.1.6 PERCEPTION OF CYCLISTS

The way that a person perceives cyclists has an effect on her likelihood to cycle. Gatersleben and Haddad (2010) examined the stereotypes held by individuals about cyclists and assessed respondents' intentions to cycle. Their study consisted of a

questionnaire exploring views that cyclists and non-cyclists have about the typical bicyclist and the effect that these views have on bicycling behaviour and intentions in the United Kingdom. They found that there were four stereotypes: responsible cyclists, lifestyle cyclists, commuting cyclists and hippy-go-lucky cyclists. They found no correlation between stereotypes and general bicycle use. However, cyclists who indicated that they bicycled more frequently in the past two months were more likely to indicate that the typical bicyclist is a hippy-go-lucky cyclist, that is to say a person who uses their bicycle for everyday activities such as shopping, wears normal clothing and owns no special equipment. Also, those who indicated they bicycle more frequently were slightly less likely to indicate that the typical bicyclist is a lifestyle bicyclist, who cycles to stay fit, has expensive equipment and wears specialized clothing. This is to be expected as individuals who cycle more often, to get to work, shopping or other activities, see other non-lifestyle cyclists on the road. Further, respondents were more likely to say they intend to bicycle in the future if they perceived the typical bicyclist as a hippy-go-lucky cyclist or a commuter cyclist. The authors define a commute cyclist as a young professional, often male, who is likely to be assertive, good looking and well-educated, and who commutes to work on the cycle in all kinds of weather. In another study, Handy et al. (2010) found that individuals who agreed that “cyclists are too poor to own a car” were less likely to cycle regularly.

Finally, Handy et al. (2010) found that people who agreed that “Kids often ride their bikes around my neighbourhood for fun” were less likely to bike for transportation.

This is perhaps because they associate bicycling with a children's activity, to be done within the residential area for fun and not for transportation.

5.1.7 THE PERCEPTION THAT THERE ARE NO ALTERNATIVES

The perception that one does not have many transportation options means a lower likelihood to bicycle and a higher likelihood to drive (Akar and Clifton 2009). Similarly, those who perceive the need of a car to do things they enjoy doing are less likely to cycle (Emond and Handy 2012).

5.1.8 PARENTAL PERCEPTIONS

The literature on parental perceptions is vast and suggests that parental perceptions play a significant role in cycling among children. Parental perceptions that one's child's bike skills are good, that children are safe from traffic and that children have high independent mobility are associated with always cycling to school (Ducheyne, De Bourdeauhuij et al. 2012). The perception that the routes children take have cycling and walking facilities increases the likelihood that children never cycle to school. The authors explain this paradox by explaining that roads equipped for cyclists and pedestrians in Belgium are usually busy roads and that this traffic deters cycling. Further studies found that traffic en route to school (Panter, Griffin et al. 2011; Trapp, Giles-Corti et al. 2011), the need to cross a busy road to get to school (Trapp, Giles-Corti et al. 2011) and the parental perception that it is convenient to drive one's child to school (Trapp, Giles-Corti et al. 2011) are negatively associated with cycling to school, while parental perceptions

that the neighbourhood is safe enough for children to cycle to school with their friends and parental confidence in a child's ability to cycle without an adult are positively associated with cycling to school (Trapp, Giles-Corti et al. 2011).

5.2 ATTITUDES

Eleven articles cited attitudes as correlates of bicycling for transportation. Attitudes positively correlated to bicycle use included concern for the environment, enjoyment of cycling, enjoyment of physical activity, intention to cycle, bicycle community preference and dislike for driving or an attempt to drive less. Stronger attitudes in favour of car use were negatively correlated to cycling for transportation. The following section will elaborate on these attitudinal effects (Also see Table 1).

5.2.1 CONCERN FOR THE ENVIRONMENT

Dill and Voros (2006) found a relationship between environmental values and cycling. Individuals in their random phone survey in Portland, Oregon who thought air quality was a problem, those who tried to limit their driving to improve the air quality, and those who thought that the region did not need to build more highways were more likely to be regular or utilitarian cyclists. Emond and Handy (2012) found that bicyclists care about the environment more than non-cyclists and Handy et al. (2010) also found that those with higher levels of environmental concern are more likely to bike regularly for transportation.

5.2.2 ATTITUDE TOWARDS CYCLING

Intuitively, respondents who enjoy cycling are more likely to cycle for transportation. In the above-mentioned survey, Dill and Voros (2006) found that the more individuals like to ride a bicycle and the more positive their views about bicycling are, the more likely they are to be regular or utilitarian cyclists. In another online survey, Xing et al. (2010) found that respondents who stated that they like to cycle were more likely to cycle for transportation and that enjoyment levels were positively related to distance cycled. Heinen et al. (2011) found that cyclists were significantly more likely to describe cycling as pleasant than non-cyclists.

General positive attitudes towards cycling have a positive effect on decision to cycle (De Bruijn, Kremers et al. 2005; de Bruijn, Kremers et al. 2009; Titze, Giles-Corti et al. 2010; Eriksson and Forward 2011). Gatersleben and Appleton (2007) grouped respondents to their online survey of members of the University of Surrey, United Kingdom, into phases of cycling, from “pre-contemplation” to “maintenance”, based on how often they used a bicycle to get to work and whether they had contemplating cycling to work. They found that regular cyclists (“maintenance”) had the most positive attitudes towards cycling, followed by occasional cyclists, and that those who had never contemplated cycling had the least positive attitudes towards cycling and were more likely to not want to cycle. Again, this applies to children. When cycling is a child’s preference, he or she is more likely to cycle to school (Trapp, Giles-Corti et al. 2011) and those who express a preference for bicycle friendly communities are more likely to cycle (Xing, Handy et al. 2010).

5.2.3 ATTITUDES TOWARDS OTHER MODES

Just as enjoying cycling has a positive effect on cycling for transportation, not enjoying driving (Dill and Voros 2006) and limiting driving (Xing, Handy et al. 2010) are correlated to cycling for transportation, while enjoying driving decreases the likelihood of cycling for transportation (Dill and Voros 2006; Xing, Handy et al. 2010).

5.3 HABITS

Four papers discuss the effect of habits on the decision to cycle for transportation. Individuals who have a habit of cycling are more likely to cycle in the future. Gatersleben and Appleton (2007) found that individuals who had never contemplated cycling have the least positive attitudes towards cycling. De Bruijn et al (2009) found that habit strength was in fact the strongest predictor of total minutes of bicycle use. Ducheyne et al. (2012) examined the role of child and parental opinions about cycling and found that a strong habit, based on an index measuring habit strength developed by Verplancken and Orbell (2003), is associated with 18% more cycling. Finally, Gatersleben and Haddad (2010) found a strong relationship between past bicycling behaviour and intentions to cycle.

5.4 SOCIAL-ENVIRONMENT

Thirteen papers referred to social-environmental factors, such as the subjective norm, descriptive norm, the influence of parents on children, the community opinion on

cycling and the effect of the workplace environment on the decision to cycle for transportation. The following section will elaborate on these social-environment correlates of cycling for transportation (Also see Table 1).

5.4.1 SUBJECTIVE NORM

Subjective norm is one part of the Theory of Planned Behaviour and refers to “the perceived social pressure to perform or not to perform a behaviour” (Ajzen 1991). Three papers referred directly to subjective norm, but many papers examined the effect of encouragement from family or friends on cycling behaviour.

Heinen et al. (2011) found that subjective norm was only important for short bicycle trips. Using a mail-out questionnaire completed by 620 people in Sweden, Eriksson and Forward (2011) found that while many respondents had strong *subjective* norms of cycling (i.e., that they believe their friends and family would support them cycling), they did not have strong *descriptive* norms for cycling (i.e., their friends and family do not themselves cycle for transportation). De Bruijn also found that those who if respondents’ thought that people important to them think they should use a bicycle for transportation as often as possible, they had a stronger intention to use a bicycle for transportation (De Bruijn, Kremers et al. 2005).

The encouragement of people around a person has an influence of their behaviour. For schoolchildren, friends who encourage cycling has a positive effect on their likelihood to cycle to school (Panter, Jones et al. 2010; Ducheyne, De Bourdeauhuij et al. 2012), as does parental encouragement to cycle (Panter, Jones et al. 2010; Emond and Handy 2012). Finally, social support more generally was also found positively

correlated to cycling (De Geus, De Bourdeaudhuij et al. 2008; Titze, Stronegger et al. 2008).

5.4.2 DESCRIPTIVE NORM

Descriptive norm refers to the typical or normal behaviour of those around a person and in this case refers to the actual cycling behaviour of one's family and friends (Eriksson and Forward 2011). Eriksson found that descriptive norm was a significant predictor of intention to use a bicycle. In other studies, parents who walk or bike along with their children to school was associated to always cycling to school among 10-12 year olds (Ducheyne, De Bourdeaudhuij et al. 2012) and bicyclists are more likely to agree that their friends cycle (Emond and Handy 2012). Cyclists more often have a cycling partner and relatives who cycle (De Geus, De Bourdeaudhuij et al. 2008) and those who have many friends who cycle were more likely to be regular or irregular cyclists (Titze, Stronegger et al. 2007).

5.4.3. INFLUENCE OF PARENTAL BEHAVIOUR ON CHILDREN

The presence and availability of a parent to chauffeur their children to school was negatively correlated to cycling to school among children in three studies. Panter found that when parents are around to take their children to school by car, their children were less likely to bike to school (Panter, Jones et al. 2010), and children who stated that they could rely on their parents to chauffeur them were less likely to be a bicyclist (Emond and

Handy 2012) and that when an adult is home after school most days, children are less likely to cycle to and from school (Trapp, Giles-Corti et al. 2011).

5.4.4 SOCIETAL ACCEPTANCE OF CYCLING AS A MODE OF TRANSPORTATION

More generally, the perception of the acceptance of cycling by one's community is important. Perceiving that cycling is cool (Trapp, Giles-Corti et al. 2011), normal (Xing, Handy et al. 2010) or disagreeing that driving is the coolest way to get to school (Emond and Handy 2012) are positively correlated to cycling for transportation. Concerns about appearance and the traveling preference of others traveling with a person had a negative effect on the decision to bike among adults in Bopp (2012).

5.4.5 WORK ENVIRONMENT

Cycling for transportation largely entails cycling to work. The work environment, responsibilities of the job and the influence of colleagues are all therefore important factors in the decision to cycle. Two articles found that an individual's work and work culture influence the decision to cycle (Bopp, Kaczynski et al. 2012; Heinen, Maat et al. 2012).

Having co-workers who actively commute positively influenced bicycling to work at least once per week in Bopp (2012). Having a work environment favourable to cycling is also important, including a bike contribution from work, a clothes-changing facility at

work and having colleagues who expect one to drive or use another mode that is not a bicycle (Heinen, Maat et al. 2012).

6 DISCUSSION AND CONCLUSION

This section discusses the implications of the findings of articles reviewed in this paper and suggests some ways of increasing bicycle mode share based on what is known about how perceptions, attitudes, habits and social-environment factors influence the decision to commute by bicycle. Planners and engineers are continually searching for effective policy and design mechanisms to influence behaviour. Developing a deeper understanding of how attitudes, habits, social environments, and perceptions interact with built form increases the effectiveness of these mechanisms. Further, Engbers and Hendriksen (2010) found that in environments that are already well-suited to travel by bicycle, such as the Netherlands, the effect of these determinants exceeds that of environmental factors. Further, for places that are not yet bicycle friendly, while the focus may remain on improving facilities and infrastructure in the city for cycling, it must be understood that an individual may still choose not to cycle if they are not confident in their ability to perform the behaviour. Similarly, the influence of the attitudes and behaviours of friends, family and co-workers cannot be understated.

Perhaps the most important lesson from this review is the fact that attitudes, habits, social environment factors and perceptions are integral aspects of travel behaviour. While there has been a recent increase in these elements in research, two issues remain:

- What are the most effective methodologies to capture and analyse these factors? and,
- How can these findings be turned into effective public policy?

While this research has not conclusively answered these questions, it is hoped that the importance of asking these questions has been highlighted.

6.1 POLICY IMPLICATIONS

6.1.1 THE BUILT ENVIRONMENT IS STILL IMPORTANT

While this paper emphasizes that city planners and engineers must look beyond improvements to the built environment to increase bicycle mode share, the authors do not wish to claim that the built environment cannot influence perceptions, especially perceptions of safety, convenience and speed of cycling. The presence of bike paths can be correlated with perceptions of safety from traffic, for instance. Creating a network of bicycle lanes, applying traffic calming measures across various roads and giving cyclists priority at some intersections, for example, may very well lead to changes in perception and behaviour.

6.1.2 PARENTAL EFFECT

There is an abundance of literature showing that parental perceptions and behaviour affects the travel behaviour of their children. Therefore, working alongside parents to address their safety concerns or create safe routes to schools is a potential way of increasing cycling among children. Also, simply increasing cycling among adults can lead

them to pass these habits along to their children. Also early adoption of a mode is well known to carry on with the person in adulthood more, unless external factors such as family responsibilities and/or work changes (Grimsrud and El-Geneidy, 2013).

6.1.3 BICYCLE-FRIENDLY WORK PLACES

Bicycle-friendly workplaces encourage cycling, whether it is with a cycling-friendly work culture, flexible work schedules or work clothing rules. Possible interventions by employers include encouraging cycling by offering incentives to cycle, facilities for cyclists such as secure bicycle parking and showers, as well as eliminating free automobile parking for employees or offering employees the choice between free parking or a parking cash out so that they may put the value of their parking space towards other purchases (such as a bicycle).

6.1.4 COMMUNICATE THE BENEFITS

Given the sheer number of benefits of cycling, including cost-savings, health benefits and rapidity in congestion-prone city centers, simply informing people of these benefits could increase the number of people who opt to cycle for transportation. This can be accomplished through organized campaigns in collaboration with city planners and activist groups.

6.1.5 EVERYONE CYCLES

Finally, it is important that cycling be a form of transportation for everyone. Gatersleben and Haddad (2010) emphasized the importance of this by showing that those who cycle more see cyclists are regular people who are going to work (“commuter cyclist”) or

running errands (“hippy-go-lucky cyclist”) whereas non-cyclists see cyclists as athletic, spandex-clad young men (“lifestyle cyclists”). In North America, cycling is still seen much more as a form of physical activity than a mode of transportation and this is reflected in the infrastructure available for cycling, which is often indirect and off-road and thus not optimal for getting people safely and quickly from home to work or school.

6.2 FUTURE RESEARCH

An array of methods has been used to capture social and psychological factors. As this review limited its scope to quantitative studies, the methods used to collect data were limited to questionnaires and survey, either in person, over the phone or online. In other studies, in-depth interviews (Jensen 1999; Handy and Heinen 2012) and travel diaries (Gatersleben and Appleton 2007) have been used. Often combinations of quantitative and qualitative methods are employed (Jensen 1999; Gatersleben and Appleton 2007). At times, sample sizes are quite small and possibly unrepresentative (Whannell, Whannell et al. 2011), although this is more of a concern with qualitative studies not mentioned herein (Handy and Heinen 2012). Since the factors to be measured are social and psychological, it is advisable that large scale studies include components that properly capture differences between individuals. To date, it could be argued that the quality of survey and research design in the realm of the social and psychological components of travel have room for improvement in relation to more commonly studied elements of the built environment and socio-economic characteristics.

Many studies about cycling behaviour group cyclists with pedestrians (Shannon, Giles-Corti et al. 2006; Timperio, Ball et al. 2006; Robertson-Wilson, Leatherdale et al. 2008) or public transit users (Jensen 1999). In the future, studies should separate walking and cycling as there are significant differences between these two active modes, as illustrated by Forsyth and Krizek (2011).

Future research should examine the effect of social and psychological factors in cities with varying degrees of bicycle-friendly infrastructure and facilities. Further, data should be collected before and after the implementation of policies, campaigns, programs and infrastructural changes, in order to measure the change in attitudes over time and how these factors interact with built environment, socio-economic and demographic characteristics. It is also important to note that the studies examined here took place within a relatively consistent cultural context. Additional work could examine active transportation in other parts of the world where social and cultural norms concerning cycling are likely to vary significantly.

This paper emphasizes the sheer number of factors that influence the decision to cycle for transportation. It is evident that not all factors influence all people, but it is important to note that while the built environment plays a role, the social environment, individual perceptions and attitudes, and habits influence the decision to cycle as well. Knowledge and understanding of how these factors affect cycling is crucial when devising and implementing policies and programs to encourage cycling as a mode of transportation.

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