The journey to work: exploring commuter mood and stress among cyclists, drivers, and public transport users

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Abstract

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Commuting times and distances between home and work continue to increase in many North American cities with negative impacts to the environment as well as adverse health consequences for the commuters, because of stress from the commuting trip. There are very few empirical studies, however, on the differences between various modes of commute on commuters stress and mood. This study provides a comparison of drivers, public transport users and cyclists in terms of stress and mood elicited by each commute mode. On a sunny day in June 2013, 123 employees of a company rated their mood and stress immediately after they arrived at work. As was expected, those 25 employees who cycled to work on that day arrived at work less stressed than their counterparts who arrived by car. However, there was no difference in mood among the three mode users.

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Contents

1 Introduction

The travel between home and work is a major part of many workers' daily routine and may turn into a source of stress and frustration for many of them. Individuals' overreliance on the automobile as their main mode of transport has resulted in negative impacts to the environment and adverse health consequences for commuters. Congestion and delays among drivers and unreliability of services, as well as long waiting times for users of public transports are major sources of commuting stress. The widening understanding of the environmental consequences of traffic congestion and the pollution associated with widespread use of private cars on one hand, and the increasingly understood problem of the health impacts of sedentary lifestyles on the other hand, have resulted in a growing interest in the role of non-motorized modes of commute such as walking and cycling as alternative modes of transport. Walking and cycling not only are less harmful to the environment and beneficial to individuals' health, but are also perceived as more relaxing and enjoyable modes of commute. Unfortunately, the research on various modes of commute on commuters' affective responses (e.g., stress and mood) is mainly limited to drivers and users of public transport. This paper aims to address this shortcoming by studying the affective consequences of different modes of commute and more specifically compare the immediate mood and stress level of cyclists with that of drivers and public transport users. It is suggested that car drivers and public transport users experience more negative responses to commuting than cyclist. The negative responses are manifested in terms of higher level of commuting stress and more negative mood.

This paper is organized as follows: The first section considers the negative implications associated with car and public transport commuting, both for the environment and for the individuals and their health and wellbeing. Then it considers an alternative to motorized

commute modes, namely cycling as a more positive commuting experience and reviews the potential health benefits associated with it. The subsequent section provides a brief review of the aftereffects of commute and certain workplace outcomes associated with each commute mode. The final section attempts to compare and contrast different modes of commute in terms of the affective responses elicited by each commute mode. The outcome of this research project can be helpful since there is a need to promote healthy and sustainable transport alternatives as a way to prevent the negative impacts of transport systems on human health.

2 Literature review

Transportation is an environmental challenge. It accounts for a significant amount of the world's petrol consumption and is responsible for emitting greenhouse gases that contribute to climate change as well as several pollutants that cause respiratory health problems. In the United States alone, transportation accounts for one third of the country's Greenhouse Gas (GHG) emissions and more than two thirds of the country's carbon monoxide emissions (US Department of Transportation, 2010). Also, according to the national inventory report, transportation is one of the largest sources of GHG emission contributing to 45 per cent of Canada's total GHG emissions in 2010 (Environment Canada, 2010). While the adverse consequences of transportation on the environment such as rising air pollution are major concerns of developed countries such as Canada and United States, the number of cars used for personal transportation is increasing and for a significant number of individuals automobile remains the main mode of transportation. More than seventy-five percent of Americans drive a car to work, while another 10 percent carpool (Pisarski , 2006) and in 2010 almost 82% of Canadian workers traveled to their jobs by car, while only 12% used public transport (Turcotte, 2011). Such excess in the use of personal transportation contributes to devastating climate

change, increases in extreme weather and natural disasters and worse of all has adverse health consequences for travelers.

The Oxford English Dictionary (2010) defines the daily commute as "a regular journey of some distance to and from one's place of work" and the first operational definition of the commuting experience used in applied research was "the time it takes to go from home to work or the distance traversed during this trip" (Koslowsky, 1997, p.158). In this study, commuting was assessed in terms of the duration that took commuters travel between their home and workplace, using three different means of transportation (car commute, public transportation commute and non-motorized commute). Canadian commuters took an average of 26 minutes to travel to work on a typical day in 2010 and for more than a quarter of them the average time was 45 minutes or more (Turcotte, 2011). The time workers spend commuting to and from work, influences their health conditions and exerts several effects on their affective states and behavior. Past studies have linked car commuting to higher levels of self-reported stress (e.g., ; Novaco, Stokols, & Milanesi, 1990; Schaeffer et al., 1988) and more negative mood (e.g., Hennessy & Wiesenthal, 1999; Novaco et al., 1979; Wener & Evans, 2011; Stokols et al., 1978) as well as adverse behavioral aftereffect (e.g., workplace absenteeism) (e.g., Schaeffer et al., 1988; Hennessy, 2008; Ommeren & Gutiérrez-i-Puigarnau, 2011).

Before looking into specific health issues related to commuting and related to the purpose of this study (e.g., stress and mood), the following section reviews more general health issues related to car and public transportation commuting and more specifically, health problems that are a result of exposure to vehicle emissions as well as the physiological and physical health issues related to car and public transportation commuting. Following, is an introduction to non-motorized modes of commute (e.g., cycling and walking) as an alternative mode of commute and

ways that such commute modes have recently become popular due to their contribution to the environment and the human health.

2.1 Health Impacts of Car and Public Transportation Commuting

Cars not only cause harm to the environment but also threaten public health by emitting toxic pollutants into the air humans breathe. Vehicle emissions are responsible for increased risk of respiratory and cardio-vascular diseases due to air pollution and due to time spent in and around road traffic (Novaco, Stokols, Campbell, & Stokols, 1979; Schaeffer, Street, Singer, & Baum, 1988; Stokols, Novaco, Stokols, & Campbell, 1978). In fact, studies (e.g., Gulliver & Briggs, 2004) have shown that in typical urban conditions car occupants are often exposed to higher levels of all the main air pollutants than pedestrians, cyclists and public transport users. The constant exposure to air pollutants may lead to devastating results for human health and in extreme cases may even cause mortality. The results of a ten-year study in Toronto showed significantly higher premature mortality rates in people chronically exposed to traffic-related air pollution (Jerrett et al., 2009).

Besides exposure to air pollutants and respiratory diseases, cars are responsible for many other physical, physiological and mental health problems in individuals. For instance, physiological studies have demonstrated that commuting by car is related to negative physiological outcomes such as increased blood pressure and heart rate (Novaco et al., 1979; Schaeffer et al., 1988; Stokols et al., 1978). Moreover, physical health problems have raised because of the lifestyle imposed on individuals by personal vehicles. People have become dependent on cars, and their lifestyles have become unhealthier and more sedentary. A large number of individuals' health problems in North America are attributed to obesity, the probability of which is found to be correlated to the number of minutes spent in a car (Frank,

Andresen, & Schmid, 2004). A study demonstrated that a one percent decrease in the use of automobiles can reduce the chance of obesity by 0.4 percent (Samimi, Mohammadian, & Madanizadeh, 2009). There are numerous other potential negative health impacts of car commuting which will be more serious as time spent commuting increases. Such impacts are widely reported and include increased aggressive driving (Gulian, Matthews, Glendon, Davies, & Debney, 1989; Hartley & El Hassani, 1994), and increased risk of involvement in traffic accidents (Selzer & Vinokur, 1974).

The next popular commute choice for many travelers is public transport. There are plenty of great aspects to using public transport as a mode for commuting and compared to drivers, public transport users take advantage of this mode in many ways. For instance, rather than focusing on driving, commuters can turn their attention to other activities such as reading, chatting with other passengers, catching up on work or simply relaxing on the way to and from work. Public transportation is more affordable than driving and access to public transportation saves individuals many hours in travel time and a lot of money on fuel consumption and car maintenance. According to American Public Transportation Association (2014), public transportation saves the United States 4.2 billion gallons of gasoline annually. Despite the many benefits of public transport, this mode of commute has its own drawbacks. Even though trains and buses are relatively energy-efficient vehicles compared to personal cars, they still emit greenhouse gases and other pollutants. Like cars, buses can still get stuck in traffic and at times are slower than driving because the bus makes frequent stops for other passengers, or the passengers need to change between multiple routes. Moreover, similar to drivers, public transport commuters are not safe from the negative outcomes of commute, such as increased perceived stress (e.g., Evans, Phillips & Wener, 2002; Wener, Evans & Boately, 2005).

In summary, cars damage the environment through the emission of greenhouse gases and other toxic pollutants. They isolate people, impose a sedentary lifestyle upon them, and waste their time in many hours of traffic congestion. The adverse impact of car commute on individuals' health and well-being (e.g., obesity) has also received attention in literature (e.g., Frank et al., 2004). Public transportation, although is ecologically less harmful to the environment and is cheaper and safer than private cars, still has its disadvantages. Public transportation commute can take longer at times and can be less convenient due to multiple stops made by buses or commuters having to take multiple buses or trains.

2.2 Non-Motorized Modes of Commute

Congestion and its adverse effect on environment and individuals' health and well-being have led to the encouragement of alternative modes of commute such as walking and cycling in many North American cities. There is growing interest in the role of non-motorized modes of commute in helping to address several challenges facing transportation managers and public policy makers. On the one hand is the widening understanding of the environmental consequences inherent in traffic congestion and pollution associated with widespread use of cars for personal transportation over even short distances, on the other hand is the increasingly understood problem of the health impacts of increasingly sedentary lifestyles in which car use has replaced more non-motorized travel like walking and cycling. However, research on utilitarian cycling (e.g., cycling as a commute mode) is still in its infancy and more research needs to be developed to examine its individual level as well as organizational level outcomes. This project attempts to contribute to the existing literature by studying the impacts of different modes of commute and more specifically compare the immediate mood and stress level of cyclists with that of drivers and public transport users.

Commuting by bicycle has a number of advantages over other modes of transport both for individuals and society. There are plenty of great benefits of bicycling as a commute choice, including improved health, economic benefits, and environmental sustainability. Cycling benefits the society and the environment because it is the most energy efficient and environmentally friendly means for commuting. Bikes do not emit greenhouse gases, carbon dioxide and other pollutants into the environment and when compared to almost all other modes of transportation, they require the least amount of energy to operate. The US Department of Transportation estimates that increasing bicycling and walking could reduce greenhouse gas emissions by 2 to 5% by 2030 and up to 10% by 2050 (US Department of Transportation, 2010). Moreover, from an economical standpoint, cycling is one of the cheapest forms of transport and it can sometimes prove to be faster than other transport modes (Olde Kalter, 2007).

Beside its many benefits to the society and the environment, cycling also brings about enormous health benefits to individuals. One major advantage of using bicycling as a commute mode is that it builds a fitness routine into individuals' daily schedule without them having to spend time, energy and money to go work out at a gym. The following section sets a context by providing a review of the health enhancing benefits of cycling when chosen as a means of commute to and from work and more specifically, the extent to which cycling helps prevent certain health problems of today's society (e.g., obesity).

2.3 Potential Health Impacts of Cycling

Even though non-motorized modes of commute to work include both walking and cycling, the purpose of this study is to focus only on cycling as the main non-motorized mode of commute to work. Cycling not only is more arousing than walking (Gatersleben & Uzzell, 2007),

but it also provides an excellent opportunity for individuals to incorporate the essential level of physical activity into their daily life. Ainsworth et al. (2000) assigned different activities (e.g., cycling, running, walking) an intensity level based on the rate of energy expenditure expressed as Metabolic Equivalent of Task (MET). The energy expenditure of commuting cycling places it at least in the "moderate intensity" category of activity of around 5-8 METs (5-8 times the energy expenditure at rest) (Ainsworth et al., 2000). This level is almost twice as walking and provides an activity that is continuous, expends sufficient energy, and can be performed by most individuals. In another study by Oja et al. (1991), individuals were subjected to a 10-week program of walking or cycling while commuting to and from work. The findings indicated that while walking and cycling to work improved cardiorespiratory and metabolic fitness, cycling was more effective than walking. Therefore, in order to provide more direct evidence of cycling-specific health benefits, this study separates out and distinguishes between the effects of waking and cycling and measures the effects related only to commute cycling.

The main health benefits of cycling come from its contribution to overall level of physical activity. Daily physical activity can help prevent many health problems related to modern societies. For example, obesity is one of the major health issues in modern societies that not only is devastating to individuals' health, but also is costly to the organizations. The annual cost to employers due to obesity among their full-time employees is greater than $73 billion (Finkelstein, daCosta DiBonaventura, Burgess, & Hale, 2010). Car commute has been a major contributor to the problem of obesity in today's society. According to Palmer (2005), the number of drivers with a Body Mass Index of over 30 (identified as obese) is higher than that of public transport users with the same Body Mass Index. Bicycle commuting, on the other hand has been shown to be related to lower rates of overweight and obesity. A study demonstrated that women

who bicycled for as little as 5 minutes every day gained significantly less weight over a sixteen year period compared to women who did not bicycle and to women who walked slowly (Lusk, Mekary, Feskanich, & Willett, 2010).

There are also a number of studies in the transport literature showing a link between physical activity and health and suggesting that increased levels of cycling and walking can deliver health benefits to the individual. Previous research indicates that cycling to work is an excellent means of health-enhancing physical activity for employees (Oja, Vuori, & Paronen, 1998) and when used as a transportation means can help individuals achieve a healthy level of daily physical activity (Dill, 2009). Besides the favorable effects of cycling on physical health, studies have demonstrated cycling to work has a positive impact on the overall mental state of workers. Ohta, Mizoue, Mishima and Ikeda (2007) showed that a 30 minute or longer round-trip commuting by either walking or cycling is significantly beneficial to mental health. In conclusion, there is no doubt on the value of regular, moderate physical activity. Cycling is an example of an activity with sufficient intensity and hence could be considered as the ideal way to meet the necessary levels of activity and could easily be incorporated into the activities of daily life.

Now that we discussed the environmental and more general health issues related to commuting, we turn to more specific health consequence of commuting related to the purpose of this study. The first section looks into the affective responses following car and public transportation commute and more specifically ways that commuters' stress and mood is affected by their commute choice. Next section offers a review of the few studies that have looked into the affective response (e.g., stress and mood) following cycling.

2.4 Affective Responses Following Car and Public Transportation Commute

Following a commuting journey, individuals experience emotional states and affective responses that are of crucial consequences. Past studies have mainly focused on stress and mood as the affective responses following commuting journey and have linked car and public transportation commuting to self-reported stress (Evans & Wener, 2006; Novaco et al., 1990; Schaeffer et al., 1988) and elevated negative mood (e.g., Hennessy & Wiesenthal, 1999; Novaco et al., 1979; Wener & Evans, 2011; Stokols et al., 1978). It should be mentioned that car commuting features most prominently in the studies of commuting stress and there are only a few studies that have examined commuting stress among public transport users (e.g., Evans & Wener, 2006).

This paper also focuses on the stress level and mood state of commuters and more specifically car commuters following commute journey by first looking into factors in commuting environment that result in perceived stress and elevated negative mood in commuters (e.g., traffic congestion) and then by looking into the behavioral outcomes of such affective responses to commuting experience (e.g., workplace behavior).

2.4.1 Stress

Stress is recognized as one of the main negative affective responses elicited by commuting journey. For instance, drivers show elevated physiological markers of stress like blood pressure and neuroendocrine hormone levels compared to baseline measures (Novaco et al., 1990; Schaeffer et al., 1988). Additional studies on the commuting experience have largely examined factors causing stress among car commuters (Schaeffer et al., 1988; Stokols et al., 1978; White & Rotton, 1998; Evans & Carrere, 1991; Novaco, et al., 1991; Hennessey & Wiesenthal, 1999) and public transport users (Wener, Evans, & Boately, 2005; Evan & Wener,

2006). In case of driving, certain stimuli within the driving environment (e.g., traffic congestion, the duration of commute, the driving behavior of other road users) are shown to be perceived as stressful for commuters. Traffic congestion has been recognized as the primary source of stress and elevated blood pressure among car drivers (Schaeffer et al., 1988; Stokols et al., 1978; White & Rotton, 1998). Driving under more congested conditions leads to feelings of frustration, irritation, and loss of control as well as elevated physiological stress (Evans & Carrere, 1991; Koslowsky et al., 1995; Novaco, et al., 1991; Novaco et al., 1990; Schaeffer et al., 1988). A study by Hennessey and Wiesenthal (1999) who interviewed 60 drivers in Toronto during their commute journey, found that in high-congestion conditions, there is an increase in self-reported driver stress during the journey. Other sources of stress for car users found in these studies are the behavior of other road users (Rasmussen, Knapp, & Garner, 2000) and delays (Koslowsky & Krausz, 1993; Novaco et al., 1990; Schaeffer et al., 1988; Stokols et al., 1978).

In the preceding paragraph, we have given some attention to commuting stress involving automobile commuting. As mentioned before, automobile commuting features more prominently in the commuting literature, and there are only a few studies that have looked into commuting stress in public transport users (Evans et al., 2002; Wener et al., 2005). Even though those who ride the bus or train to work can enjoy their time reading, sleeping or interacting with other passengers, there are still several factors (e.g., unpredictability and unreliability services and long waiting times) that will make their journey to work stressful. Wener et al. (2005) conducted an experimental study in order to examine the effects of the introduction of an improved rail service on commuters in New Jersey. They showed that commuters who switched to improved transit system showed a significantly lower level of stress as indicated psychophysiological and self-reported measures compared to commuters who stayed with the previous rail service. Evans et al.

(2002) studied rail commuters in New York and found those who perceived their commute as more unpredictable, experienced higher levels of stress and showed evidence of higher elevations of salivary cortisol as a response to the experienced stress. Evan and Wener (2006) examined the role of commuting duration among suburban train commuters riding into Manhattan, New York and found that the greater the duration of the commute, the more stressful the experience, as indicated by multiple indices of stress, including salivary cortisol and perceived stress. Traffic congestion (Evans & Carrere, 1991) and long waiting times (Cantwell, Caulfield, & O'Mahony, 2009) are other sources of stress among public transport users.

Another dominant factor that leads to car and public transportation commuters experiencing stress following their commute is the distance from one's residence and workplace. Costal, Pickup and Di Martino (1988) compared the stress level and health conditions of industrial Italian workers between commuters (whose journey from home to work usually does not take less than 45 minutes in each direction) and non-commuters (workers whose journey does not take more than 20 minutes). The results showed that commuters reported higher psychological stress scores, and more health complaints than did the non-commuters. The duration of commute is also a source of stress among train commuters such that the longer the duration of the commute among train commuters, the higher is the stress level experienced following the commute (Evan & Wener, 2006). Such stress is indicated by elevations in salivary cortisol, the lower persistence of the commuters on a task at the end of the commute, and the greater levels of perceived stress. Finally, Kageyama, Nishikido, Kobayashi, Kurokawa, Keneko and Kabuto (1998) studied the short-term heart rate variability of 223 male white-collar workers in Tokyo and found those commuting more than 90 minutes one-way had chronic stress and fatigue symptoms.

Taken together, research has consistently found that commuting and more specifically automobile commuting can be a stressor with adverse physiological and affective consequences. Traffic congestion in the case of car commuting, and unreliable and crowded services and long waiting times in the case of public transport along with long commuting distances in both cases are critical ingredients that contribute to experienced stress in commuters.

2.4.2 Mood

Research has identified several key factors (e.g., exercise, personality dispositions, and daily stress) that significantly influence individuals' mood states. For instance, the mood enhancing effect of exercise was shown in a literature review by Yeung (1996) concluded that in terms of mood states, individuals benefit even from a single session of exercise and a more recent study by Lane and Lovejoy (2001) showed that aerobic dance exercise was associated with improved positive mood (e.g., increased vigor) and reduced negative mood (e.g., reduced anger, confusion, depression). With regards to the mechanisms, both physiological and psychological explanations have been proposed to account for the mood enhancing effects of exercise. For instance, studies have shown an increase in endorphin levels following exercise (e.g., Markoff, Ryan, & Young, 1981) and a number of studies have proposed that, it is not a specific action of exercise that enhances mood, but rather the respite or 'time out' that it provides from worrisome thoughts and daily stressors (Bahrke & Morgan, 1978). Another factor that markedly influences mood states is personality dispositions such as extroversion and neuroticism. For example previous research has found that extraversion is consistently related to heightened levels of positive affect and that neuroticism is consistently related to heightened levels of negative affect (e.g., Costa & McCrae, 1980).While the impact of these factors on mood

states is evident, this study focuses on more short-term changes in mood and mainly early morning mood as a result of commute.

In studying the affective experiences of car and public transportation commuting, attention has mostly been drawn to stress as the main affective response related to commuting and research on other affective responses of commuting such as mood is quite limited. Furthermore, there are no studies to the knowledge of the author that have studied mood effects of commuting among public transport users. Commuters' mood and how they feel when they travel to and from work is also an important emotional experience in their daily lives. Past research on mood as an affective response related to car commuting is quite inconsistent. Several studies have found that drivers report more negative affect such as irritability, hostility and other forms of negative affect after commuting than they do before commuting or on days when they do not commute (Hennessy & Wiesenthal, 1999; Novaco et al., 1979; Novaco, Stokols, & Milanesi, 1990; Stokols et al., 1978; Koslowsky, 1997; Koslowsky, Kluger, & Reich, 1995). More negative mood upon arrival at work in the morning or at home in the evening was experienced by car commuters in high congestion roads (Koslowsky et al., 1995). A more recent study showed that for metropolitan New York residents, train commuting created less negative mood than commuting by car (Wener & Evans, 2011). Similar to stress, certain factors in commute environment contribute to commuters' experiencing more negative mood. For instance, longer car commutes have been found to positively correlate with negative mood in the evening hours at work (Kluger, 1998). However, several other studies have reported no changes in mood as a result of commuting. Schaeffer et al. (1988) did not find any effect of commuting on car commuters' mood states. White and Rotton (1998) utilized an experimental manipulation in which students were assigned to either a drive (e.g., drive their vehicle between two designated

locations), ride (e.g., ride a bus over the same route), or control group (e.g., spend time in a psychological laboratory) conditions. The authors did not obtain significant results when they compared the emotional states of students who commuted with those who spent the same amount of time in a psychological laboratory. Finally a study by Van Rooy (2006) used an experimental design to compare two critical aspects of car commuting experience (e.g., trip length and congestion) on emotional states. Mood states were assessed after commute as well as during commute using cell phones while individuals were commuting. Findings indicated that drivers reported negative mood changes only during the commute and not following commute.

Van Rooy (2006) explored the underlying reasons for the discrepancies in the effects of commute mode on mood and came up with two explanations. First, the inconsistences in the findings are partly due to the design of the studies (Van Rooy, 2006). The majority of studies that have found a significant effect on mood have employed correlational and quasi-experimental methods (e.g., Hennessy & Wiesenthal, 1997; Novaco et al., 1979) that fail to control for confounding variables and little research has employed true experimental designs (Van Rooy, 2006). White and Rotton's (1998) and Van Rooy's (2006) negative results are noteworthy because unlike much of the research in this area, participants were randomly assigned to experimental conditions and this might explain the non-significant results for mood. Another explanation for the inconsistencies in the findings is the fact that there has been very little consensus in how commuting should be defined and manipulated (Van Rooy, 2006). For instance Stokols et al. (1978) combined the distance traveled and time spent traveling to define and measure commuting, whereas Hennessy and Wiesenthal (1999) defined commuting in terms of congestion.

Despite the inconsistencies regarding the mood effects of commuting, this study proposes that commuting has a negative impact on mood. The rationale for such a proposition is that whereas previous studies have investigated mood effects only among drivers and public transport users (e.g., Wener & Evans, 2011; Van Rooy, 2006; Koslowsky et al., 1995), this study looks into mood effects among cyclists as well. The only two studies that have included commute cycling as a transportation mode in their data (Gatersleben & Uzzell, 2007; LaJeunesse & Rodríguez, 2012) have obtained significant results for mood. This study like these two prior studies includes cycling as a commute mode and therefore proposes that mood effects exist with cyclists feeling less negative mood upon arrival at work compared to other mode users.

Summarizing the argument, the adverse affective consequences of car and public transportation commuting are not just limited to commuting stress. Besides stress, commuters may also experience more negative mood as a result of long and time-consuming commute journeys and even if in some cases changes in mood are not observed following the commute (e.g., Van Rooy), they may be experienced during commute.

2.5 Affective Responses Following Cycling

The benefits of cycling do not stop at improving physical and mental health but also extend to benefit individuals' emotional state and behavior, by reducing the adverse impacts associated with motorized commute modes. The following section provides a review of the emotional states and affective responses as well as behavioral outcomes related to cycling mode of commute. There are only a few studies that have examined the affective responses (e.g., stress and mood) associated with cycling. For instance Pretty, Peacock, Hine, Sellens, South and Griffin (2007) examined the extent to which different green activities (e.g. walking, cycling, and horse-riding) have effects on the mental and psychological well-being of individuals. Participants

were measured on their general physical health, psychological health, their level of physical fitness, as well as their self-esteem and mood status. Pretty et al. (2007) states that from an affective appraisal perspective, consistent physical activity such as walking and bicycling results in significant improvement in self-esteem and positive moods. Gatersleben and Uzzell (2007) conducted a survey among university employees to examine how people feel when they travel to and from work. Respondents were asked to provide information on their travel such as travel mode, time and distance, and were then asked to indicate their affect following a journey (e.g., the extent to which their journey was pleasant, stressful, boring, exciting, and relaxing). The study revealed that excitement, pleasure, and joy are the affective response most related to walking and cycling modes of commute to university. Finally a recent study by LaJeunesse and Rodríguez (2012) examined the ways in which users of different travel modes perceive their journey to work from an affective standpoint. After indicating their mode of travel and commute duration, participants provided information on their commute-related stress, psychological experience of contentment and relaxation while commuting to work (e.g., feeling at ease and relaxed when traveling to work) as well as feelings of competence (e.g., having complete control when traveling to work). The authors found that walkers and bicyclists report relatively lower levels of stress and greater competence. Moreover, compared to drivers and public transport users, they feel more relaxed and content with their commute and are better able to cope with commuting stress. The findings of the study were consistent with that of Gatersleben and Uzzell (2007) who claimed that compared to other mode users, cyclists perceived their work commute as relatively relaxing and exciting. Both studies conclude that given the positive affective consequences of non-motorized commuting, it is likely that walking and bicycling to work provide a more positive transition between home and work environments than driving or using

public transportation and hence from an affective standpoint, they should be promoted as optimum mode choices. The preceding paragraph reviewed the few studies that have looked into affective responses of cycling as a mode of commute. There is no doubt that cycling to work can have significant psychological (e.g., enhanced self-esteem) and affective (e.g., lowered stress and feelings of pleasure and joy) consequences.

2.6 Workplace Consequences of Commuting

The previous section focused on commute environment and factors that elicit negative physiological and affective responses as immediate reactions to commuting. However, the affective responses related to commuting experience could extend beyond the journey and affect commuters' behavior after the commute. The studies on behavioral effects of commuting have mainly studied individuals' behavior in workplace and the majority of these studies have employed data from existing employee records such as absenteeism, turnover, and lateness. It is found that traffic congestion is related to increased absenteeism at work (Novaco et al., 1990), reduced job satisfaction (Koslowsky et al., 1995; Koslowsky & Krausz, 1993), as well as more negative affect such as feelings of irritation, frustration, and anxiety (Stokols et al., 1978; Evans & Carrere, 1991). A more recent study by Ommeren and Gutiérrez-i-Puigarnau (2011) demonstrated that lower productivity and increased absenteeism resulted from long commuting distance. They argued that, on average absenteeism would be about 15% to 20% less if all employees in an organization had a negligible commute. The following section concentrates on the organizational level consequences of commuting stress and negative mood by describing the ways that such affective responses following commute can affect and interact with subsequent domains (e.g., work environment).

2.6.1 Workplace Outcomes of Commuting Stress

There is growing evidence to suggest that stress experienced while driving affects and interacts with environments outside driving environment such as home or work (Novaco et al., 1990). The adverse effects of commuting stress are manifested in tasks known to measure motivation or persistence. For instance the study by White and Rotton (1998) provided support for finding task performance effects of commuting stress. It was found that those who drove had a significantly lower frustration tolerance and persistence in completing puzzles compared to controls. Wener, et al. (2005) found that commuters who switched to an improved rail service showed reduced level of stress and as a result, a significantly reduced level of job strain. Schaeffer et al. (1988) examined the behavioral outcomes following participants' actual commute to work. Those who experienced greater impedance in traffic had more errors on a subsequent proofreading task which demonstrated that a difficult or demanding commute can adversely impact subsequent performance. Finally, commuting stress was related to greater workplace hostility and obstructionism (Hennessy, 2008). All these provide evidence that workplace behavior and performance can be influenced by factors outside work such as commuting stress due to previous commute.

2.6.2 Workplace Outcomes of Mood State

Just like commuting stress can affect subsequent environments and affect individuals' behaviors, the emotional states (e.g., mood) that follow commute journey can also accumulate and carry forward to the work environment and affect work performance. There are fewer studies that have examined the organizational level consequences of commuters' mood experienced following commute. In the second part of the study by Van Rooy (2006), the effects of commuting on decision-making behavior were assessed. Specifically, the study examined the

effects of commuting on subsequent work behavior as measured by commuters' evaluations of unqualified job candidates. It was found that it was only during commute that drivers reported negative mood, and little spillover effect appears to exist. However, longer commute and higher traffic congestion led to more negative evaluations of unqualified job candidates. Hence, they argued that even if mood states are unaffected after a commute, behaviors may be affected in part by commuting experience, indicating that commuting can influence subsequent work behavior. Their findings parallels the findings from White and Rotton (1998), who also found that commuting experience, does not reveal changes in mood, but it brings about behavioral effects, namely, reduced frustration tolerance.

Related to the affective experiences following commuting journey and their impact on workplace environment, is a recent study by Rothbard and Wilk (2011) who have examined how start-of workday mood influences work performance through employees' perception of work events. The study emphasizes on the role of start-of-workday mood as a new construct which may play an important role on how employees feel following an event at work, and how this feeling influences their work performance. The study was conducted among employees in a call center whose mood at the start of working day and feelings subsequent to calls were measured using self-report. Productivity measures such as percentage of time available for answering calls, transfers, and calls per hour as well as verbal fluency were used as measures of objective work performance. The findings indicated that work performance is related to start-of-day work mood through affect subsequent to a work event, such that positive affect subsequent to work events leads to a better performance whereas negative affect subsequent to work events leads to decreased work performance. The authors argue that start-of-workday mood is a result of variety of experiences happening before one arrives at work (Rothbard & Wilk, 2011). Since journey to

work is one such experience that affects start-of-workday mood, a negative commute experience can negatively predict start-of-workday mood which in turn can adversely impact work performance.

2.7 Workplace Outcomes of Cycling

Despite the fast growing literature on cycling as a transportation mode, and the health benefits associated with non-motorized modes of transport, there has been surprisingly little research on workplace outcomes of cycling as commute mode. An exception is a recent study by Hendriksen, Simons, Garre and Hildebrandt (2010) who investigated the association between commuter cycling and sickness absence among Dutch employees and found that non-cyclists were absent from work more than cyclists by over one day a year. Even though the research on workplace outcomes of cycling is limited, there is ample evidence of the effectiveness of physical activity on employees' mental health and certain workplace outcomes such as absenteeism, performance and turnover (e.g., Coulson, McKenna, & Field 2008; Lechner, de Vries, Adriaansen, & Drabbels, 1997; Aldana, Merrill, Price, Hardy, & Hager, 2005). Most of these studies have reported on the effectiveness of workplace health promotion programs on long term increases in levels of physical activity and reduced rate of absenteeism among participants in such activities compared to non-participants. Aldana et al. (2005) documented the impact of a wellness program on employee health care costs and rates of absenteeism over a two year period. There was a significant difference after two years in absenteeism among those who participated in the wellness program as opposed to those who did not participate. Findings indicate that participants had a significant reduction in the number of days absent from work such that individuals who participated in wellness program in the long term (24 months) had a 20% (3-day) difference in absenteeism compared with those who did not participate in the programs.

Lechner et al. (1997) conducted a longitudinal study by collecting data on absenteeism in the prior and during the first year of introducing a fitness program in different industries in the Netherlands. It was reported that in a physical activity intervention with low exercise participation rate (less than once a week) and a no participation group, there was hardly any decline in sick days. On the other hand, the group with high exercise participation rate (more than once a week) on average showed a decline of 4.8 sick days. The authors reported that the results emphasize the belief that high exercise activity (i.e., an average of at least once a week) can indeed have a positive effect on reduced absenteeism. Other studies have reported significant reductions in staff turnover. For example, the Canadian Assurance program reported a turnover rate drop from 18% to 1.8% per annum in program adherents in the first year (Song, Shephard, & Cox, 1982; Shephard, 1992b). And finally with regards to work program, a recent study by Coulson et al. (2008) asked employees to complete questionnaires about their job performance and mood on days when they exercised at work versus days they didn't. It was found that exercise is associated with enhanced self-reported work performance, improved time management, higher job concentration and increased tolerance of work-based relationships. According to the authors, the strong mood effect of physical activity is such that exercising leads to increased work performance through improved mood. Hence, the evidence of the effectiveness of physical activity on employees' mental health and certain workplace outcomes such as absenteeism, performance and turnover is an indication of the importance of implementation and promotion of wellness programs within organizations as a means to improve employees' mood and ultimately their work performance.

This section set a context by providing some key facts and findings which outlined the environmental (e.g. rising air pollution), individual (e.g. a long and time-consuming commute

has adverse physical, physiological and affective consequences for commuters), and organizational (e.g., a stressful commute journey affects an individual‘s level of productivity once they reach work) consequences of car and public transport commuting. Existing research confirms the widespread belief that car and public transport commuting is stressful and may lead to commuters' experiencing higher stress level and more negative mood. The potential impact of the traffic congestion and long commuting distances can extend beyond the commuting environment and carry forward to subsequent domains (e.g., the workplace). The organizational consequences of car and public transport commuting stress are manifested in behavioral outcomes such as poor task performance (Schaeffer et al., 1988), work place hostility (Hennessy, 2008) lower productivity and absenteeism (Ommeren & Gutiérrez-i-Puigarnau, 2011). Moreover, we looked at the ways that cycling commute contributes not only to the environment but also to the betterment of individuals' emotional state (e.g., stress and mood) as well as its positive behavioral aftereffects. Cycling is considered to be the ideal way to meet the necessary levels of physical activity with sufficient intensity and it could be incorporated into individuals' daily life. Cycling to work will not only have a great impact on improving public health, but it will also have positive workplace outcomes. One of the benefits to organizations can be achieved through increased physical activity arising from encouraging people to walk or cycle more often as part of their journey to work. If more people walked or cycled to work, it would cut rush hour traffic congestion, and result in a healthier, fitter and happier workforce with all the associated benefits of increased work performance and reduced absenteeism that entails.

2.8 Comparing Stress and Mood across Modalities

The environmental consequences associated with excessive use of private cars on the one hand, and the increasingly understood problem of car commute on individuals' physical and

mental health on the other hand, have led transport policy makers to encourage people to commute less with their cars and use public transport or cycle to work more. Comparisons between different commute modes provides a good insight into the reasons why people prefer certain travel modes over others and how they can be encouraged to change their choice of commute mode. Individuals' commuting experience can affect their choices of commute mode to a great extent. According to Gatersleben and Uzzell (2007), people prefer a positive commuting experience and are more likely to choose a commute mode that provides them with that experience. From such stand point, it seems crucial to examine individuals' perceived stress and mood states related to different commute modes in order to find out the commute mode that elicits the most positive affective responses (Gatersleben & Uzzell, 2007). The other reason for comparing the affective responses across different modalities is that as mentioned above, the affective responses related o commuting experience can carry forward to and affect commuter's behavior and productivity in subsequent environment. Therefore, finding a commute choice that elicit the most positive affective state, enables employers to consider transport policies that promote and encourage that mode of commute over others.

Unfortunately, there are few studies that have compared commuters across commute modes on stress and mood measures. The few studies that did so, have been mostly limited to comparing private car use and public transport only and no comparisons have been made between these groups and commuters who cycle or walk to work. These studies mostly argue that car drivers experience more negative responses to commuting as indicated by higher level of stress and more negative mood than users of public transport (e.g., Koslowsky, Kluger, & Reich, 1995; Wener & Evans, 2011). This difference is partly because car drivers experience the commute as more effortful and unpredictable than do train commuters (Wener & Evans, 2011).

For example in major metropolitan cities, the duration of commute to and from work becomes unpredictable mainly due to the sudden onset of accidents on the road or traffic congestions and in addition driving requires constant attention and effort while train commute tends to be more predictable and requires less attention (Wener & Evans, 2011).

As mentioned above, there has been comparatively little research comparing the affective experiences of cyclist and walkers to car and public transport users. There are only two studies that, to the knowledge of the author, have examined and compared the affective responses of all mode users (drivers, public transport users, cyclist, and walkers). Gatersleben and Uzzell (2007) compared the affective responses to commuting of car users, public transport users, cyclists and walkers. The study revealed that each commute mode elicits a different affective response. They demonstrated that car commuters perceived their work commute as stressful and bus users frequently characterized their commute as boring. Cyclists, on the other hand, perceive their commutes as most enjoyable and exciting, and walkers report their journey as most relaxing. A recent study by LaJeunesse and Rodríguez (2012) investigated the affect associated with journey to work and argued that one's dominant commuting mode may influences their journey-based affect. The authors found that walkers and bicyclists report relatively lower levels of stress, feel more relaxed and content with their commute, and are better able to cope with commuting stress as compared with drivers and bus users. Both studies are novel in that they are the only studies that employed all mode users in studying the affective responses related to commuting, however a limitation of the studies is that they employ data that come from retrospective self-report measures such that participants have to rely on their memories to indicate their feelings of past commute. Such measure of emotions may interfere with the validity of data, because according to Thomas and Diener (1990), individuals tend to overestimate the intensity of past emotions.

This study attempts to overcome the mentioned shortcoming by measuring the mood state and stress level of employees following their commute, on a specific day, rather than relying on past memories. Also, while the two studies mentioned above, are conducted among a population of university employees, this study, employs a population of workers in a company.

3 Hypotheses

A rationale for undertaking this project is to test whether certain benefits of cycling such as enhanced mood and reduced level of commuting stress are proven in order to convince employers to integrate a non-motorized travel plan which encourages the b non-motorized commute modes among their employees. There have been studies of non-motorized commuting and health, but there is little evidence studying the specific role of cycling in influencing perceived stress and mood in employees. The purpose of this project is to address this shortcoming by examining whether the journey to work undermines stress and mood level of the employees upon arrival at work. Commuting by car or public transport negatively impacts individual's emotional state and stress level (e.g., Schaeffer et al., 1988; Stokols et al., 1978). The spillover of commuter stress into work place leads to less productivity and reduced work performance for car drivers and users of public transport (e.g., Wener et al., 2005; White & Rotton, 1998; Ommeren & Gutiérrez-i-Puigarnau, 2011). There is no doubt that physical activity helps relieve stress and lift mood and positively impact employees' work performance (e.g. Coulson et al., 2008; Lechner et al., 1997; Aldana et al., 2005). As many can find limited time for any physical activity, every day cycling to work could be an achievable way for people to build regular physical activity into their lifestyles, reduced their stress, and increase their mood prior to starting work.

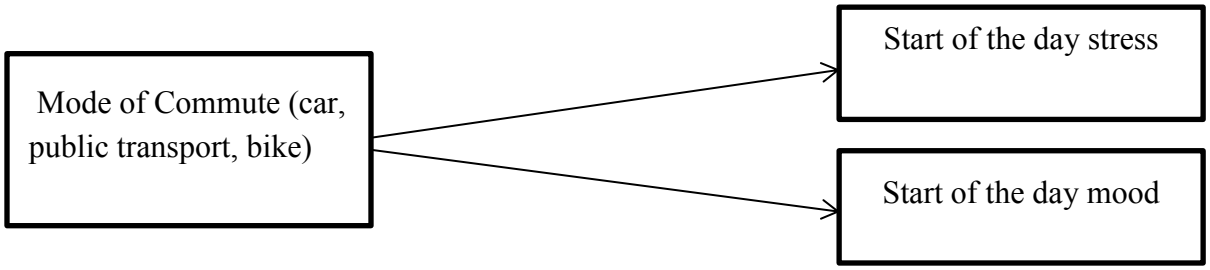
This study proposes two mechanisms through which employees' mood and stress level is elevated by cycling. First, biking is a physical activity and leads to reduced level of stress at least during the first hours of work. Second, biking is a mood enhancing activity and it especially elevates one's start-of-workday mood. Most studies on health consequences of commuting stress do not look at non-motorized mode of commute such as cycling. This project however, is a cross-sectional study, comparing employees who cycle to work and those who drive or use public transport as their commute mode. We look into how commuters' level of mood and stress varies as a function of their commuting mode.

Hence, building on the prior studies of stress and commuting, it is hypothesized that:

H1: The stress experienced upon arrival at work differs among the three mode users such that employees who cycle to work, report lower levels of stress compared to those who use public transport who also report lower levels of stress compared to drivers.

H2: The mood experienced upon arrival at work differs among the three mode users such that employees who cycle to work, report elevated mood upon arrival at work compared to those who use public transport, who in turn feel they are in a better mood compared to drivers.

Figure1. Theoretical Model for the Study



4 Methods

4.1 Procedure

Participants were recruited from an international software development company located in Montreal, which had demonstrated willingness to corporate with the researchers and had asked their employees to participate in the study. A few weeks before the questionnaire was sent out, a bilingual invitation email was sent out by the Human Resources director of the company (see Appendix A). This e-mail invited employees to participate in the study and contained a brief message stating the purpose of the project, and the persons responsible for the research**.**

Once the questionnaire was designed and translated into French, the researcher sent out another invitation email which contained a link to the survey and gave the participants the option to fill in the questionnaire in both languages (see Appendix B). The study was meant to be conducted on a sunny day in summer to allow for the maximum number of cyclists, therefore it was sent out on June 14, 2013. This email further explained the purpose of the research, the name of the researchers and the time required to complete the survey. Participants were instructed to follow a link to a survey designed for the purpose of the study and respond to questions concerning mood, perceived commuting stress and mode of travel to work on that day. Employees were also asked to provide their names, however it was emphasized to them that this information will not compromise their individual anonymity and the results will be kept anonymous, and this is only for the purpose of compensating them. Since participation in the study consumed part of the employees' actual work time, there was a need to compensate for the time they spent responding to the survey. Hence, the participation of individuals was tracked by the researcher, who a week later provided participants with a $10 i-tune gift card. In the questionnaire, the employees were encouraged to contact the principal researcher at any time if they had any questions or concerns.

Time verification

The mood states and stress level of individuals fluctuate throughout the day, mainly due to events occurring during a working day. Hence, in order to measure the mood state and stress level related only to commuting and avoid the effects of other daily stressors, this study measured mood and stress upon arrival at work and not later in the day. This procedure is in line with many other studies on commuting stress where stress measures are collected at the end of commute (e.g., Wener et al., 2005, Wener & Evans, 2011; Schaeffer et al., 1988). For instance, Wener et al. (2005) collected salivary cortisol and self-reported stress measures at the end of the commute as the commuters disembarked from the commuter train. And in a study by Schaeffer et al. (1988), commuters reported directly to the experimental room immediately upon arrival at work in order to have their blood pressure and heart rate readings taken. Therefore, in order to measure employees' mood and stress immediately upon arrival at work, participants were asked to mark the time of their arrival at work. The time of filling in the questionnaire was also recorded automatically, allowing the researcher the ability to differentiate between those who completed the survey within a certain time period of arriving at work and those who did not.

4.2 Participants

Out of 634 employees who received the invitation e-mail, 159 employees participated in the study by filling in the questionnaire, resulting in a response rate of 25.1%. The researcher discarded the data of those 16 participants who completed the survey more than 45 minutes after arriving at work, resulting in 143 participants. Also, since walking mode of commute was not a part of the study, those 20 employees who walked on that day to get to work were not included in the analysis. Therefore, the sample consisted of 123 employees (61 female, 61 male) who were a population of regular home-to-work commuters with a mean age of 40 years (SD = 7.30).

Commuting by car was the most dominant mode of commute on that day, chosen by almost 38% employees (n = 54). Public transport commute was the second main mode of commute (n = 42). The number of employees who used bicycle as their main mode of commute was 25 and finally a small number of people used motorcycle as their main mode of commute (n = 2).

4.3 Measures

A 31-item questionnaire instrument was designed to measure perceived commuting stress, early morning mood, and subjective vitality at the end commute mode and demographic variables. The scales used in this questionnaire are detailed in the following section.

Control Variables

Basic socio demographic information was collected of all participants for use as statistical controls when necessary in the analysis of the relation between commute mode and stress and mood. Information on gender and age was collected.

Length of commute

The duration of the commuting journey to work is among the most important determinants of commuting stress (Costa et al., 1988; Kluger, 1998). Although the individuals were also asked to report the distance between their home and their work place, only the duration of commute was used since it is a more accurate variable than commuting distance. Distance between work and home was divided into four categories: less than 5 k, between 5 and 10, between 10 and 20 and over 20. Duration of commute was measured in terms of time taken to travel to work and was divided into four categories of less than 15 minutes, between 15 minutes and 30 minutes, between 30 minutes and one hour, and over one hour.

Subjective Vitality

Subjective vitality is conceptualized as an indication of one's "health of spirit," and it is expected to be affected by both physical health and psychological well-being (Ryan & Frederick, 1997). It is related not only to the individual's experience of physical health, conscious experience of possessing energy and aliveness, but also associated with personality dispositions of extraversion and conscientiousness (Ryan & Frederick, 1997). The underlying explanation for choosing subjective vitality as a control variable in the study is that it is highly likely that one's level of energy, physical health, and affect might impact their commute choice. For instance it is likely that one chooses to cycle to work because in the first place she possesses higher level of energy, positive affect and is extraverted. Subjective vitality was measured using a seven item scale developed by Ryan and Frederick (1997). Employees were asked to respond to subjective vitality items in terms of how they "apply to you and your life at the present time." Sample items include: "I feel alive and vital"; "Sometimes I feel so alive I just want to burst"; and "I nearly always feel alert and awake." The response scale ranges from 1 ('not at all true') to 7 ('very true') with a higher score indicating a more vitality and a lower score indicating less vitality. The estimated reliability of this scale was $\alpha = 0.89$.

Start-of-workday Mood

We measured a person's start-of-workday mood at the point at which she or he first sits down to work, prior to engaging in any work activity. We ask employees to report their mood at the start of each day, using the following phrasing: "Before you begin your day, tell us how you feel. Using the scale below, please indicate to what extent you feel this way right now." A revised version of the brief momentary mood checklist (Thomas & Diener, 1990) was used to assess emotional states. The original scale consists of nine adjectives that describe affective states. Four of these are positive (happy, joyful, pleased, and fun) and five are negative

(depressed, frustrated, angry, anxious, and unhappy). The scale in this experiment was reduced to five items and modified to include three adjectives relevant to emotions that drivers might experience (stressed, overwhelmed, and confused). The negative adjectives were reverse coded during the analysis therefore making a higher score indicate a better mood and a lower score indicate a worse mood. The estimated reliability of this scale was $\alpha = 0.80$.

Indices of Perceived Commuting Stress

Perceived stress was assessed by commuters filling out perceived stress items using a five point Likert scale (e.g., "Commuting to work takes effort"; "Overall commuting is stressful for me"). The scales used are those developed and field tested in previous studies of commuting to measure perceived commuting stress (e.g., Novaco et al, 1990; Kluger, 1998). Certain items were reverse coded, resulting in an estimated reliability of $\alpha = 0.82$ for this scale.

4.4 Results

The means, *SD*s, and correlations of the variables used in the study are presented in Table 1. Results show that there was no significant relationship between mode of commute and either of commuting stress or mood. With regards to socio demographic variables, gender and age were unrelated to commuting mode, neither were they related to commuting stress and mood early in the morning.

Table 1

Mean, standard deviations (SDs), and correlations between the variations in the study

Variable	Mean	*SD*	1	2	3	4	5	6	7	8
1.CommuteMode			1	-.14	-.13	.02	-.23*	-.22*	0.13	-.07
2.Mood	3.54	.86		1	-.10	.67**	.-06	.24**	.00	.01
3.Stress	2.37	.80			1	.26**	.58**	.47**	.19*	.02
4 Vitality	4.81	1.11				1	-.06	.15	.08	-.08
5.LengthofCommute	2.58	.89					1	.67**	.10	.04
6.Distance	2.81	1.06						1	.10	-.05
7.Gender									1	-.15

8.Age	40	7.30	1

4.4.1 Effects on Stress

Self-ratings of stress were collected at the point at which individuals first sat down to work, prior to engaging in any work activity. A one-way analysis of covariance (ANCOVA) was conducted to test the hypothesis that cyclist experience lower level of stress compared to car and public transport commuters. The independent variable, commute mode, included three groups of commuters (car drivers, public transport users, and cyclists) and the dependent variable was early morning stress. Because of the importance of length of commute, given its correlation with stress, all analyses comparing the three commuting modes incorporate statistical controls for length of commuting. Vitality was also included as an additional control in the analysis. Table 2 shows, the result of the analysis of covariance (ANCOVA) was significant F (2, 118) = 4.13, $p <$ .05, indicating that after controlling for the effects of covariates (length of commute and vitality), there was a significant difference in stress among the three groups of commuters. Additionally, length of commute and vitality were significantly related to stress with F (1, 118) = 65.39, $p <$ .05 and F (1, 118) = 10.03, $p < .05$ respectively.

Table 2

Analysis of covariance for Commuting Stress by Commute Mode

Source	*SS*	*df*	*MS*	*F*
Length of commute	24.13	1	24.13	65.39***
Vitality	3.70	1	3.70	10.03*
Commute Mode	3.05	2	1.52	4.13*
Error	43.54	118	.37	
Total	76.76	123		

Note. *SS*= Sum of squares; *df*= Degrees of freedom; *MS*=Mean square; *F*= *F* distribution
* = $p < .05$, *** = $p < .001$

The differences among the adjusted means for the three groups of commuters are reported as 2.18 for cyclists, 2.25 for public transport users, and 2.54 for car drivers (see Table 3). Follow-up tests were conducted to evaluate pairwise differences among the adjusted means for the three groups of commute mode (see Table 5). The Bonferroni pairwise comparison of the difference between "bike" and "car" ($d = 0.35$) approached significant. Moreover, the Bonferroni pairwise comparison of the difference between "bike" and "public transport" ($d = 0.06$) was not statistically significant and neither was the Bonferroni pairwise comparison of the difference between "car" and "public transport" ($d = 0.29$) significant.

For the first hypothesis, it could be stated that based on the mean stress adjusted by length of commute and vitality, individuals who cycled to work, had lower stress level ($M = 2.18$, $SE = 0.12$) compared to those who drove to work ($M = 2.54$, $SE = 0.08$) or who commuted to work by public transport ($M = 2.25$, $SE = 0.09$) and individuals who commuted to work by public transport experienced a lower stress level ($M = 2.25$, $SE = 0.09$) compared to those who drove to work ($M = 2.54$, $SE = 0.08$). However, since the Bonferroni pairwise comparisons between drivers and public transport users or between public transport users and cyclist were not significant, it cannot be said where the differences come from. It should be noted that the non-significant result of the Bonferroni pairwise comparisons is probably due to a small sample size and an almost significant p-value of .05 for the difference between cyclists and drivers means that cyclists experience less level of stress compared to drivers. Therefore, controlling for length of commute and vitality, there is a statistically significant difference between the stress levels of commuters as a function of their commute mode, but this difference is only observed between cyclist and drivers. Hence, the hypothesis that different commuter mode users experience

different stress level is partially supported with cyclist experiencing less stress compared to drivers.

Table 3

Pairwise Comparisons and effect sizes of commuting Stress by commute mode

		Adjusted mean differences		
	Adjusted mean	1.	2.	3.
1.PublicTransport	2.25	…		
2.Car	2.54	.29	…	…
3.Bike	2.18	.06	.02	…

4.4.2 Effects on Mood

Self-ratings of mood were collected at the point at which individuals first sat down to work, prior to engaging in any work activity. A one-way analysis of covariance (ANCOVA) was conducted to test the hypothesis that cyclist experience elevated mood compared to car and public transport commuters. The independent variable, commute mode, included three groups of commuters (drivers, public transport users, and cyclists) and the dependent variable was early morning mood. Because of the importance of length of commute, given its correlation with mood, all analyses comparing the three commuting modes incorporate statistical controls for length of commuting. Vitality was also included as an additional control in the analysis given its significant relationship with mood. As Table 4 shows, the result of the analysis of covariance (ANCOVA) was not significant $F(2, 118) = 2.31$, $p = .10$, indicating that after controlling for the effects of covariates (length of commute and vitality), there was no significant difference in mood among the three groups of commuters. Moreover, there was no relationship between length of commute and mood $F(1, 118) = .81$, $p = .37$. Vitality, however, was significantly related to mood $F(1, 118) = 102.00$, $p < .05$.

Table 4

Analysis of covariance for Commuting Mood by Commute Mode

Source	*SS*	*df*	*MS*	*F*
Length of commute	.32	1	.32	.81
Vitality	40.80	1	40.80	102.00***
Commute Mode	1.85	2	.93	2.31
Error	47.20	118	.40	
Total	90.25	122		

Note. *SS*= Sum of squares; *df*= Degrees of freedom; *MS*=Mean square; *F*= *F* distribution
* = $p < .05$, *** = $p < .001$

For the second hypothesis, it could be stated that controlling for vitality and length of commute, there is no significant difference between the mood levels of commuters as a function of their commute mode. Hence, the hypothesis that cyclists experience elevated mood compared to car and public transport commuters or public transport commuters experience elevated mood compared to drivers is not supported.

5 Exploratory Study

An exploratory study was conducted for two reasons. First, it was expected that, compared to drivers and public transport users, the number of those who cycle to work would be lower in the study. Therefore, it seemed reasonable that studying another population of bike commuters would enable the researcher to have access to a more number of cyclists. Therefore, since a large number of students at Concordia University bike to school, the exploratory study was conducted among this population of cyclists. Second, this further investigation would enable the researcher to explore the results in a deeper level and tap into the reasons for changes in stress obtained in the study. In other words, the study was conducted to gain a better control over

some of the independent variables by examining if the change in variables (mood and stress) is a result of commute mode or other factors (e.g., individuals who are less stressed choose to cycle). Therefore, it is expected that if biking results in better mood participants should score higher on mood upon arrival at school (once they disembark their bikes) compared to a few hours later in the day. Also, if biking to school results in lower stress, participants should score lower on measures of stress upon arrival at school compared to a few hours later in the day.

6 Methods

6.1 Procedure, Participants, and Measures

This study is a longitudinal study where mood and stress were measured at two points in time. During the last two weeks of September and the month of October, students at Concordia University were approached by the researcher in the morning once they arrived at school. They were asked if they were willing to participate in a study concerning individuals' moods, feelings and motivation. After agreeing to participate in the study, individuals were given a hard copy of the questionnaire which included 23 items to measure perceived commuting stress, mood upon arrival at school, subjective vitality and demographic variables of age and gender. The scales used in this questionnaire were the same scales used in the main study. The participants were told that they will receive a $10 i-tune gift card, if they agree to meet with the researcher a few hours later and respond to the same questionnaire. While participants were asked to provide their names, they were informed that this is only for the purposes of compensating them and the researcher's ability to follow up with them a few hours later. The sample included 17 students (10 female, 7 male) with a mean age of 26 years.

6.2 Results

The means, SDs, and correlations of the variables used in the study are presented in Table 5. Results show that there was a significant relationship between mood upon arrival at school (mood1) and mood a few hours later (mood 2) as well as between stress upon arrival at school (stress1) and stress a few hours later (stress2). Both mood1 and mood 2 were related to Vitality.

Table 5

Mean, standard deviations (SDs), and correlations between the variations in the study

Variable	Mean	SD	1	2	3	4	5	6	7
1.Mood1	4.24	.51	1	.87**	-.21	-.07	.92**	.85**	-.27
2.Mood2	4.15	.42		1	-.04	.08	.85**	.71**	-.15
3.Stress1	1.88	.39			1	-.84**	.00	.01	.11
4.Stress2	1.92	.36				1	.11	.15	.27
5.Vitality1	5.79	.77					1	.92**	-.02
6.Vitality2	5.71	.53						1	.04
7.Age	26	4.42							1
8.Gender	10 female 7 male								

Using a repeated measures t-test, participants' rating of their mood (Mood1) and stress (Stress1) upon arrival at school were compared to their ratings of mood (Mood2) and stress (Stress2) a few hours later. The findings as shown in Table 6 indicate that there was no significant difference between Mood1 ratings and Mood2 ratings t (16)=1.40, p>.05. Neither was there any significant difference between Stress1 ratings and Stress2 ratings t (16)= -.86, p>.05.

Table 6

Paired Sample t-test

	Mean	*SS*	*T*	*df*	*P*
Mood1	4.20	.50			
Mood2	4.15	.42			
Mood1_Mood2	.09	.25	1.40	16	.17
Stress1	1.88	.39			
Stress2	1.92	.36			
Strees1_Stress2	-.04	.21	-.86	16	.40

7 Discussion

One's mode of commute to work significantly affects their stress level upon arrival at work. Employees who biked to work showed significantly lower levels of stress compared to those who commuted by car. These findings support previous research by Gatersleben and Uzzell (2007) and LaJeunesse and Rodríguez (2012) who found that car commuters perceived their work commute as more stressful than other mode users and cyclists perceived their commute to work as less stressful and more relaxing. However, the study did not find any significant difference between the stress level of cyclists and that of public transport users. This research project extends earlier research on commuting by Gatersleben and Uzzell (2007) and LaJeunesse and Rodríguez (2012), particularly by investigating the effects of commuting modes on stress and mood in a different population of commuters (e.g., employees in a company), and by assessing data not based on individuals' memories of past commute, but obtained measurements shortly after commute. While the significant result on stress implies that cyclists experience lower level of stress, the results of the exploratory study did not find if cycling to school leads to less level of stress in students. Possible explanations for not obtaining significant results in the exploratory study are a small sample size or a population of cyclists different from that of the main study. It is possible that students are younger, are generally in a better mood and their work is less stressful. As one of the participants quoted "I'm always in a good mood."

That the study did not find any significant effect on stress between cyclists and public transport users, is inconsistent with previous findings (e.g., Gatersleben & Uzzell, 2007; LaJeunesse & Rodríguez, 2012). One explanation could be that this is the first study on affective responses of commuting (e.g., stress and mood) that was carried out in Montreal. The discrepancies between the findings of this study and the other two studies (Gatersleben & Uzzell,

2007; LaJeunesse & Rodríguez, 2012) might be the result of the differences in public transport systems in Montreal and where the other two studies were undertaken. It is possible that the sources of stress (e.g., delays and crowded services) exist to a lesser amount in public transport system in Montreal. The other possible explanation for not finding a difference between cyclists and public transport users is that biking in Montreal is more dangerous compared to where the other two studies were conducted. Even though Montreal is said to be Canada's most bike friendly city (Ogden, 2014), according to Pucher and Buehler (2012), the city ranks fourth on the list with 2.0 annual fatalities per 10,000 daily cyclists followed by Paris 8.2, London 11.0 and New York 37.6 (all 2010 except Paris, London and New York, 2009).Moreover, a comparison of the data on bike accidents in Montreal and the cities where the other two studies were conducted (Orange County, NC and Surrey, Great Britain) shows that biking in Montreal is at least more dangerous compared to biking in Orange County where LaJeunesse and Rodríguez's (2012) study took place. Data collected by The University of North Carolina Highway Safety Research Center shows that the number of bicycle accidents that occurred from 2008 to 2012 in Orange County totaled 128 (The North Carolina Department of Transportation, 2012). In Surrey, Guilford in 2011 there were 8 fatalities and 599 seriously injuries (Keep, 2013). In Montreal in 2012, 1,954 cyclists were victims of a road accident involving a motor vehicle with 13 people killed and 88 seriously injured (Societé d'assurance automobile du Québec, 2014). Safety was also one of the issues repeatedly mentioned by student cyclists in the exploratory study as one of the students mentioned "I had an accident and broke my hand once when I was biking. As much as biking to school is fun, you have to always be careful about your surroundings, the parked cars next to you that might open their doors without looking, the broken glasses to not have a flat tire and of course the street holes" and another student mentioned "I had an accident with an

oncoming cyclist and I was taken to the urgency. Even though I didn't have major injuries, I started wearing helmets afterwards." Moreover, cycling in Montreal is probably not less stressful than using public transportation, because according to a report by La Presse, the growing rate of cyclists in Montreal has led to congestion cycling, and has created friction between cyclists, motorists and pedestrians (Fortier, 2012). Another explanation for the non-significant results between cyclists and public transport users is that public transport more than driving, allows for engagement in activities such as talking to others, as well as working or reading and listening to music and it is possible that such social and entertainment activities counteract stress and boredom in public transport users.

Findings that commute to work by bicycle is less stressful than driving to work have important implications, especially in relation to the promotion of cycling to work. It is well documented that commuting stress can lead to negative emotional and behavioral consequences upon arriving at home or at work (e.g., Cohen, 1980; Novaco et al., 1991).Therefore, bicycling should be promoted as commute mode choice because not only it is a source of physical activity but also from an affective standpoint it can lead to employees starting their day feeling less stressed. As mentioned by LaJeunesse and Rodríguez (2012), given the positive affective consequences of non-motorized commuting, it is likely that bicycling to work has greater potential to engender a more positive transition between home and work environments than driving or riding the bus do.

Moreover, there was a significant effect of length of commute on stress. Those commuters who had to commute longer distances reported a higher level of stress. The findings that commute distance affects commuting stress is in line with previous studies (e.g., Evan & Wener, 2006; Costal et al., 1988) that reported higher stress scores among commuters with

longer duration of the commute. Hence it seems that short commute counteracts commuting stress.

Contrary to expectations, the findings did not reveal elevated mood in cyclists compared to car or public transport commuters. This is in contrast with the findings from Gatersleben and Uzzell (2007) and LaJeunesse and Rodríguez (2012) who showed more elevated mood among cyclists compared to other mode users. The findings, however, parallels the findings from Van rooy (2006) and White and Rotton (1998) who did not show any changes in mood following a commute between drivers and public transport users. According to Van Rooy (2006) what is affected by negative commute is mood only during the commute and performance following commute, and not mood following commute. Therefore, it is possible that even though participants' mood following commute is not affected, their mood during commute or their post-commute performance is affected. However, the study did not measure either mood during commute or post-commute performance and a more comprehensive study could provide a better insight into commuting effect on mood. Moreover, the non-significant results of mood among the three commute mode users could be the result of dispositional factors. As mentioned before the dispositional factors influence the extent to which an individual experiences positive or negative mood (e.g., Costa & McCrae, 1980). Therefore, it is possible that those who biked to work or to school are generally in a better mood compared to their counterparts due to their personalities. As a student cyclist mentioned, "I'm always in good mood."

This paper provided insights into the commuting experience across different commute mode users, by finding that commuters' stress could vary as a function of their commuting mode such that compared to drivers, cyclists will experience reduced level of stress. This finding suggests that one element that might be taken into account by transportation managers and

organization in making transportation related decisions is the impact of commuting mode on stress.

Practical Implications

In 2011, 6% of Canadians biked to work (Turcotte, 2011) and even though this number is increasing every year, Canada still falls behind many European countries such as Germany, the Netherlands, and Denmark with respect to the number of people who travel by bike (Pucher & Dijkstra, 2003). Obviously, cycling is not always an option for commuters. Because of commuting distances and Montreal weather during colder months of the year as one of the student cyclist said "biking is my main of transportation, I cycle all around the year except during the cold winter months". However, a study by Morency and Godefroy (2011) shows that 18% of trips by car on the island of Montréal are relatively short journeys that could be made by cycling. Such a shift in transportation choices would increase cycling mode of commute by nine times. This study and future studies on utilitarian cycling could provide insight into examining how commuters can be encouraged to replace bicycle for short distance journeys that are made by car. For example, safety and the lack of bike paths in some areas in the city was a major concern for several student cyclists. Hence an important factory that will encourage more cycling is improving safer cycling. Increasing utilitarian cycling requires a persistent and coordinated effort involving a number of stakeholders such as employers, transport managers, and public policy makers. Some researchers in their effort to direct attention of transportation managers have examined the impact of improved cycling facilities and infrastructure on cycling as a commute mode. Dill (2009) argued that improved road infrastructure and separate bike paths encourage more bicycling among adults. Organizations and employers could also benefit from encouraging and promoting more bicycling as interesting, safe and enjoyable mode of transport

among employees. There exists an opportunity for organizations, with a relatively low cost investment, to gain substantial returns for their organization and their communities. Organizations could gain a better corporate image by advocating the welfare of their employees as well as reducing the company's carbon footprint through promoting sustainable modes of travel. There is also economic benefit of the workplace travel plan in terms of reduced work hours lost in traffic congestion, reduced absenteeism, and reduced healthcare costs due to the effects of increased physical activity and reduced pollution. Employees, who cycle to work, take advantage of an economical way to get fitter, healthier, and less stressed to start their day.

To encourage more bicycling for everyday travel, planners, policy makers and organizations need to consider investing in bike facilities, incentives and awareness programs. Bike facilities include safe and conveniently located bike parking, on-site bike facilities (e.g., change rooms, showers and lockers), and a repair area for basic bicycle repairs. Cycling incentives and rewards such as workshops to raise employees' awareness of the benefits of cycling and acknowledging the efforts of bicycle commuting employees can all help make cycling a realistic, alternative option for travelling to work.

8 Limitations and Future Research

First, self-report measures were the only instrument measuring stress and mood, however, to better assess stress and mood, other measurements need to be used to properly measure all components of stress and mood. Obtaining data from multiple measures, including physiological reactivity and behavioral outcomes (e.g., work performance) might provide additional insights about impact of commuting on stress and mood. Second, the study was a cross sectional research, a potential drawback of which is that whether someone chooses to cycle to work could be as a result of their being more energetic and less stressed initially. Third, this study focused

only on stress and mood as the affective responses related to commuting experience. Future research needs to extend to measuring other emotions and affects such as boredom and fatigue because this may have important implications, especially in relation to the promotion of sustainable transport behavior. Fourth, the data were collected from a limited population of commuters and the findings are unlikely to be representative for the commuting population as a whole. More research among different and larger samples is necessary to verify the findings of this study. And finally, the study was limited in that it did not examine or compare the behavioral aftereffects among the three commuting modes. However, it seems worthwhile to further examine the potential impact of commute mode on employees' behavior in subsequent environments such as workplace.

9 Conclusion

Long and time-consuming commute from home to work is a major part of many workers' everyday life and a source of stress and frustration for them. With growing concerns over traffic congestion and increased air pollution, public policy makers are increasingly promoting non-motorized commuting modes such as walking and cycling as alternative modes of transport and for an increasing number of workers, the morning commute to work starts with getting on a bicycle and ride to work. This project compared the immediate impacts of different modes of commute on commuters' health, namely their stress and mood upon arrival at work. The findings revealed that compared to drivers, cyclists showed reduced commuting stress, meaning that cycling provide a more affirmative transition between home and work environments. The implications of the findings were discussed in terms of ways that public policy makers and organizations could promote cycling as the optimum mode of travel to work.

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Appendix A

To all Autodesk Canadian employees,

Autodesk has always been an active supporter of research. We have recently been approached by Roshan Javadian and Stéphane Brutus Ph.D. from the John Molson's school of Business who are conducting a research on **individuals' moods, feelings and motivation in the workplace**. In short, you will be asked to respond to a survey early in the morning before starting work. You will be able to fill in the survey from your computer or any other device.

Canadian employees will soon receive more information on this project and a link to a survey directly from the researchers. Autodesk supports this research but the decision to participate is yours!

Stay tuned !

Stéphane Brutus, Ph.D.
Associate Dean
John Molson School of Business
Concordia University
Phone: 514-848-2424 ext. 2992

A tous les employés canadiens d'Autodesk,

Autodesk a toujours été un fier partisan de la recherche. Nous avons récemment été approchés par Roshan Javadian et Stéphane Brutus Ph.D. de la John Molson School of Business qui mènent une recherche sur les **humeurs, les sentiments et la motivation des personnes au travail**. En bref, vous serez invité à répondre à un sondage d'enquête tôt le matin avant de commencer le travail. Vous serez en mesure de répondre à l'enquête à partir de votre ordinateur ou tout autre appareil.

Les employés canadiens recevront de la part des chercheurs plus d'informations concernant ce projet de recherche ainsi qu'un lien vers le sondage sous peu. Autodesk vous encourage à participer de facon volontaire à cette recherche.

A bientôt !

Roshan Javadian
Research Assistant
John Molson School of Business
Concordia University
Phone: 514-812-1799

Appendix B

Hello, my name is Roshan Javadian and I am a student in the Master of Science in Administration (MScA) program of John Molson School of Business. I would like to invite you to participate in my research and I am seeking your voluntary participation for a research project concerning individuals' moods, feelings and motivation at work. Within a week you will be sent a link which contains a survey designed for the purpose of this project. You will be asked to respond to the survey early in the morning before starting work. You are welcome to fill in the survey from your computer or any other device. The survey will take approximately 10 minutes and you will receive a $10 iTunes gift card for your participation from our contact person at Autodesk.

Please note that the information that you provide will not be disclosed to any third party and the research results will only be used for research purposes. You will be asked to provide your name but this is only for the purpose of compensating you; your responses will not be linked to your names.

To connect to the English survey click here.

We would like to thank you for your cooperation in this project. If at any time you have questions about the proposed research, please do not hesitate to contact me (r_javadi@jmsb.concordia.ca) or my thesis supervisor Dr. Stéphane Brutus (brutus@jmsb.concordia.ca).

Thank you in advance for your time,
Roshan Javadian

Stéphane Brutus
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Bonjour, je m'appelle Roshan Javadian, et je suis étudiante au programme de maîtrise en sciences de l'administration (MScA) de l'École de gestion John-Molson. J'aimerais vous inviter à participer à un projet de recherche sur les humeurs, les sentiments et la motivation au travail. Votre participation est tout à fait volontaire. Dans les prochains jours, vous recevrez un lien vers un sondage spécialement conçu pour ce projet. Vous devrez répondre au sondage en début de matinée avant de commencer le travail. Vous pouvez répondre au sondage à partir de votre ordinateur ou de tout autre dispositif. Le sondage prend environ 10 minutes, et pour vous remercier de votre participation, nous vous offrons une carte-cadeau iTunes d'une valeur de 10 $ de notre contact à l'Autodesk.

Veuillez prendre note que les renseignements que vous fournirez ne seront pas divulgués à un tiers, et que les résultats de la recherche seront utilisés uniquement aux fins de la recherche. On vous demandera votre nom dans le seul but de vous envoyer votre carte-cadeau. Vos réponses ne seront pas associées à votre nom.

Pour le sondage en français, cliquez ici.

Nous vous remercions de votre collaboration à ce projet. Si, en tout temps, vous avez des questions sur la recherche proposée, n'hésitez pas à communiquer avec moi (r_javadi@jmsb.concordia.ca) ou avec mon directeur de thèse, Stéphane Brutus, Ph. D. (brutus@jmsb.concordia.ca).

Merci à l'avance de votre temps,
Roshan Javadian

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