On time and ready to go: An analysis of commuters' punctuality and energy levels at work or school

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ABSTRACT

The strain of the daily commute can negatively impact performance at work. This study differentiates how various modes influence commuters' punctuality and energy levels at work and school. The data for this study come from the 2013 McGill Commuter Survey, a university-wide survey in which students, staff and faculty described their typical commuting experience to McGill University, located in Montreal, Canada. Ten multilevel mixed-effects logistic regressions are used to determine the factors that impact 1) a commuter's feeling of being energized when he or she arrives at work or school and 2) his or her punctuality. Our results show that weather conditions and mode of transportation have significant impacts on an individual's energy at work and punctuality. The models indicate that drivers have the lowest odds of feeling energized and the highest odds of arriving late for work. Cyclists, meanwhile, have the highest odds of feeling energized and being punctual. Overall, this study provides evidence that satisfaction with travel mode is associated with higher odds of feeling energized and being punctual. With these findings in mind, policy makers should consider developing strategies that aim to increase the mode satisfaction of commuters. Encouraging the habit of commuting by bicycle may also lead to improved performance at work or school.

Keywords: Commute, Energy, Punctuality, Bicycles, Driving, Satisfaction

1. INTRODUCTION

Commuting is without a doubt a necessary part of many people's daily routine. However, the strain associated with commuting can have a negative impact on academic and work performance. Long travel distances, in particular, contribute to an individual's level of stress and lack of energy (Kluger, 1998; Mokhtarian, Papon, Goulard, & Diana, 2014; Waddell, 2014), which lead to further consequences of lower academic and work performance (Adecco Canada, 2013; Gnoth, Zins, Lengmueller, & Boshoff, 2000; Taris & Schaufeli, 2014). A new Canadian study has shown that 40% of employees have fallen asleep at work, and that 74% of young adults (between the ages of 18-24) have fallen asleep during a class (Mediabrands and Reprise, 2015). The performance of a tired individual has been shown to drop significantly, and is comparable to that of well-rested individuals in the 9th percentile (Durmer & Dinges, 2005). In Canada, it is estimated that the cost of fatigue amounts to 750 million dollars in reduced workplace efficiency per year (Mediabrands and Reprise, 2015). Effectiveness in the workforce is also reduced due to employees arriving late to work. According to surveys conducted in the United States and in the United Kingdom, traffic during commute is the most cited reason for tardiness (Mercer, 2012; Peters-Atkinson, 2012). While the evidence may not draw a direct connection between commuting and work performance, it is reasonable that an individual's commuting experience, based on the cited studies, would partially account for some of these negative impacts. Therefore, it is critical to understand the relationship between commuting and work performance.

The objective of this paper is to investigate how an individual's commute affects his or her 1) feeling of being energized and 2) punctuality at work or school. The study uses cross-sectional data from a university-wide travel behaviour survey conducted during the spring of 2013 in which students, staff and faculty described their typical commuting experiences to McGill University, located in downtown Montreal, Canada. Building on a recent study which has shown that driving is the most stressful transportation mode (Legrain, Eluru, & El-Geneidy, 2015), we hypothesize that individuals who commute by driving are also the ones who feel the least energized when they arrive at their destination. In contrast, we expect those who commute using active transportation to feel the most energized, due to the benefits received from performing physical activity (Biddle, 2003; Fox, 1999). We also anticipate that cyclists and pedestrians will be the most punctual as a result of the greater control they can exert on their commute. On the other hand, due to the dependence on transit operators to provide transit service and thereby lack of control (Legrain et al., 2015), we predict that public transit users will have a relatively strong perception that their commute negatively impacts their punctuality.

The paper begins with a review of the existing literature about the impact of commuting on an individual being energized and punctuality. It then presents the data used for the study, and describes the results of a series of multilevel mixed-effects logistic regression analyses used to determine the factors of a commute that affect a person's energy and punctuality. Finally, the paper concludes with a discussion of the results and proposes suggestions for future transportation studies and policy recommendations.

2. LITERATURE REVIEW

Commuting can be a tiring experience (Evans, Wener, & Phillips, 2002; Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004a; Koslowsky, Kluger, & Reich, 1995; Stutzer & Frey, 2008). Kahneman, Krueger, Schkade, Schwarz, and Stone (2004b) identified commuting as one of the least enjoyable activities in a day, and Mokhtarian et al. (2014) found that among other trip purposes, commuting to work was deemed as the most tiring. Transportation researchers have typically associated fatigue to commuting stress, where higher stress levels are correlated with exhaustion (Barden & Lucas, 2003; Mokhtarian et al., 2014). Legrain et al. (2015) examined the factors that contribute to commuting stress and found that stressors are mode-specific. For instance, a pedestrian's level of stress is influenced by his or her sense of comfort and safety from traffic. Legrain et al. (2015)'s study also found that drivers are concerned with travel duration, whereas transit users become anxious when the time they spend waiting is too long.

Some researchers have begun to specifically examine the factors that influence how energized a person feels after a commute. In their analysis of the 2007-2008 French National Travel Survey, Mokhtarian et al. (2014) found that both individual and trip characteristics impact the perception of whether a trip is tiring. Their findings suggest that less healthy individuals find travelling more tiring, as do people who live in suburban areas compared to those who live downtown. These researchers also found that socioeconomic characteristics (age, gender, household composition and social status), as well as attitudinal characteristics are also associated with whether a person feels tired because of a trip. In addition, they found that time of travel, travel duration, travel mode and activities performed during the trip all have an effect on travel-induced fatigue. More specifically, drivers and individuals with longer commutes are more likely to feel tired than others. Interestingly, those whose trips take place in the evening and at night are more prone to feeling tired. Mokhtarian et al. (2014) proposed that this is due to an accumulation of strains during the day, as well as heightened anxieties regarding safety.

The commuting experience impacts mental and physical energy differently. For example, Gatersleben and Uzzell (2007) found that bicycle trips are the most mentally stimulating, while walking trips are the most relaxing for commuters. On the other hand, Mokhtarian et al. (2014) suggested that those who utilize active transportation are more inclined to experience physical tiredness, and those who use public transportation or drive tend to feel tired mentally. Understanding how each mode affects the physical and mental energy of commuters is important in order to analyze the productive capacity of employees and students. For example, an employee working in a labour-intensive job may consider using transportation modes that are less physically draining.

Commuting can also affect work performance. For example, Schaeffer, Street, Singer, and Baum (1988) demonstrated that an exhausting commuting experience can have a negative impact on eventual task performance, and White and Rotton (1998) found that a stressful commuting experience can influence a person's subsequent frustration tolerance and persistence in problem solving.

Finally, commuting affects punctuality due to its potential unpredictability (Kluger, 1998; Nicholson & Goodge, 1984). The variability in travel time can be attributed to various events within the commute such as traffic congestion, limited parking availability or delayed transit service (Emre & Elci, 2015; Koslowsky, 2000). This frequently results in tardiness. Travel distance is also a factor; the greater the commuting distance, the more likely it becomes that an individual could arrive late (Leigh & Lust, 1988). As well, a previous study has shown that weather plays a role in influencing when a person arrives at work (Muesser, 1953). Apart from the environmental factors of the commute, Koslowsky (2000) mentioned individual characteristics, which influence the punctuality of workers as well. These include an individual's attitude, personality, culture and sense of time urgency. A recent study examining the relationship between personality and punctuality of university students showed that those who travelled by bicycle or foot, arrived significantly later than those who travelled by car or train (Werner, Geisler, & Randler, 2015). However, the study did not take into account the impacts of the commuting experience. To the best of the authors' knowledge, no previous studies have examined how the commuting experience influences an individual's energy level and punctuality across different modes.

3. METHODOLOGY

3.1 Survey

The data used for this study are derived from the 2013 McGill Commuter Survey, an online commuter survey conducted during March and April 2013. The target population was composed of approximately 38,000 McGill University students, staff and faculty, who make regular trips to McGill University's two main campuses. In total, 20,851 survey invitations were sent to randomly selected members of the McGill University community. Respondents had a window of thirty-five days to complete the online survey, and prizes were offered as incentives for participation. The survey had a response rate of 31.7%, which is comparable to a previous study conducted by Whalen, Páez, and Carrasco (2013), whose online survey targeting a Canadian university-based population obtained a 22% response rate.

After cleaning the database by removing incomplete and unreasonable responses, 5,599 records were retained. The survey recorded the respondents' typical commute from their home location to their destination within the two McGill University campuses for a cold and snowy day, and likewise for a warm and dry day. The respondents answered detailed questions regarding each aspect of their daily commute, including duration, satisfaction with service quality, and mode. The survey also collected information about the respondents' socio-demographic information, travel preferences, and personal attitudes toward the commute (Shaw et al., 2013).

3.2 Study Sample

This study focuses on individuals who travelled to McGill University's downtown campus by walking, cycling, driving or transit (bus, metro and commuter rail). The decision to concentrate only on commuters travelling to McGill University's downtown campus is based on the fact that there are stark differences between the experiences of travelling to McGill University's suburban Macdonald campus compared to McGill University's downtown campus, which is located in the city centre.

Using a 5-point Likert scale, where "1" = strongly disagree and "5" = strongly agree, survey respondents reported their level of accordance with the statements: 1) "I feel energized when I arrive at McGill" and 2) "My commute to McGill negatively impacts my punctuality / attendance / working hours". Self-reported answers are subjected to the response styles of respondents, and Likert-scale data are constrained by interpretation that is relative and lacks in precision (Baumgartner & Steenkamp, 2001; van Herk, Poortinga, & Verhallen, 2004; Weijters, Cabooter, & Schillewaert, 2010). Hence, for each respective statement, ordinal responses were transformed into binary variables by recoding "1", "2" and "3" as "no", and "4" and "5" as "yes". While this practice is common and simplifies the interpretation of the results, we acknowledge that it may induce unknown bias and impact the model estimates (Manor, Matthews, & Power, 2000).

Respondents are classified by their main mode of transportation; for example, those who used public transit for at least one leg of their trip were identified as transit users. The study does not include commuters who carpooled as car passengers or rode the private university shuttle bus, which offers transportation service between the two McGill University campuses, due to the small number of observations. Additionally, those who claimed to drive, but did not possess a driver's license, were also eliminated from this study.

Travel duration of each trip was calculated using the travel times of each trip leg as reported by each respondent. This includes out-of-vehicle time, such as the time it takes an individual to reach his or her bus stop, as well as in-vehicle time, for instance how long he or she travelled on the bus. Travel distance was not retained due to its strong correlation with travel duration (Pearson's correlation coefficient = 0.70). Furthermore, travel duration was selected over travel distance because it serves as a better representation of the actual commute since it accounts for different travel speeds and delays that occur along the way (Gordon, Kumar, & Richardson, 1988; Legrain et al., 2015; Mokhtarian et al., 2014; St-Louis, Manaugh, van Lierop, & El-Geneidy, 2014). The survey inquired about how much extra time the individual allots for the commute, by asking "On a typical [cold snowy / warm dry] day, how much additional time (in minutes) do you budget to ensure that you get to McGill on time?" Respondents answered the question using a drop-down menu allowing a range of responses from one to 200 minutes. It is important to note that additional budgeted time is separate from, and not integrated with, travel duration.

Residential self-selection variables are included to control for any effect resulting from the choice of home location. In the survey, respondents used a 5-point Likert scale to evaluate the importance of various factors when they were selecting their current residence. For this study, we tested proximity to McGill, proximity to public transit, the cost of commuting and not having to drive. The survey also asked respondents to rate their satisfaction with various aspects of their trip using a 5-point Likert scale. To ensure that the impact of mode-specific attributes can be evaluated accordingly, records of respondents who did not provide an answer or stated that they had no opinion were removed. Our data includes a total of 3068 individuals and 6116 observations consisting of 3065 trips on a warm and dry day, and 3051 trips on a cold snowy day.

Table 1 summarizes the sample statistics by mode of transportation and presents the independent variables that will be tested across all modes for energy and punctuality respectively in the following section of the paper. The sample is composed of 46% students, 33% staff and 21% faculty, while the mode split is 10% cycling, 15% driving, 50% public transit, and 25% walking. While the trips are generally equally distributed between the two weather conditions, the majority of cycling trips (92%) occurred on a warm and dry day.

A brief assessment of the study sample reveals that drivers tend to be older (mean age of 46 years), have a higher income and budget the most additional time for their commute (mean of 17 minutes). Transit users have the longest commute (mean of 44 minutes) while pedestrians have the shortest commute (mean of 19 minutes). Pedestrians have the highest proportion of students and hence are younger (mean age of 30 years). Together with the cyclists, they place the highest importance of living in proximity to the university and not having to drive. Lastly, cyclists and drivers have the highest life satisfaction (7.71/10) among the commuters.

TABLE 1 Summary Statistics – Mean of Variables

	GENERAL	CYCLE	DRIVE	TRANSIT	WALK
Sample size	6116	610	914	3058	1534
DEPENDENT VARIABLES					
I feel energized when I arrive at McGill.	0.36	0.81	0.28	0.27	0.42
My commute to McGill negatively impacts my punctuality / attendance / working hours.	0.26	0.05	0.29	0.32	0.21
WEATHER					
Warm, dry day (dummy)	0.50	0.92	0.47	0.43	0.50
TIME					
Duration (minutes)	33.63	23.53	32.55	43.53	18.56
Additional budgeted time (minutes)	11.40	5.10	17.03	13.77	5.80
I use my commute time productively (Strongly disagree – 1, Strongly agree – 5)	3.37	3.48	3.19	3.46	3.24
PERSONAL ATTRIBUTES					
Age	37.21	35.66	46.44	38.17	30.42
Male (dummy)	0.42	0.53	0.46	0.38	0.41
Student (dummy)	0.46	0.48	0.20	0.40	0.71
Staff (dummy)	0.33	0.26	0.35	0.43	0.15
Faculty (dummy)	0.21	0.26	0.45	0.17	0.14
Income (Low – 0, High – 10)	2.12	2.18	4.10	1.94	1.28
Number of children in the household	0.41	0.37	0.82	0.43	0.10
Life satisfaction (Low – 1, High –10)	7.43	7.71	7.71	7.31	7.39
HOME SELECTION					
Importance of the following factors in selecting current home: Proximity to McGill (Low – 1, High – 5)	3.46	3.76	3.08	3.05	4.40
Proximity to public transit (Low – 1, High – 5)	4.08	4.24	3.47	4.33	3.87
Cost of commuting (Low – 1, High – 5)	3.26	3.24	3.06	3.30	3.31
Not having to drive (Low – 1, High – 5)	3.72	4.29	2.66	3.64	4.27
MODE USED					
Cycling (dummy)	0.10	na	na	na	na
Driving (dummy)	0.15	na	na	na	na
Transit (dummy)	0.50	na	na	na	na
Walking (dummy)	0.25	na	na	na	na

na= "not applicable"

Figures 1 and 2 respectively show the proportion of respondents who feel energized when they arrive to McGill and those whose commute negatively impacts their punctuality. In general, travel mode and weather conditions are significant for both an individual's energy and punctuality; this observation is confirmed by a series of t-tests and chi-square tests. More precisely, users of active transportation have higher rates of feeling energized and are less likely to be late for work. For instance, on a typical warm and dry day, 82% of cyclists reported that they feel energized when they arrived at McGill, and only 3% experienced problems with punctuality. This is in contrast to transit users, of which only 38% felt energized when they arrived on a typical warm and dry day, and 19% reported that they arrived late.

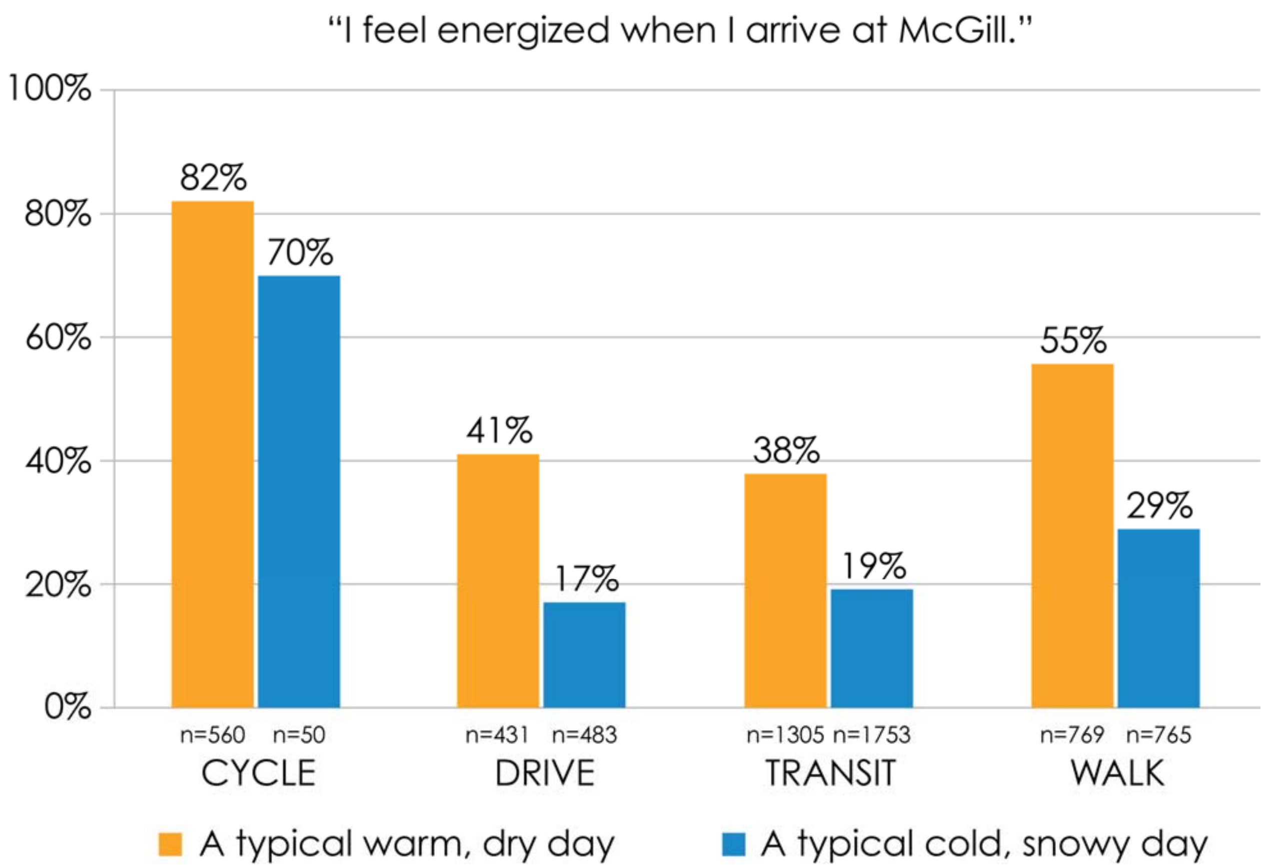

FIGURE 1 Proportion of commuters who feel energized when they arrive McGill classified by mode and weather.

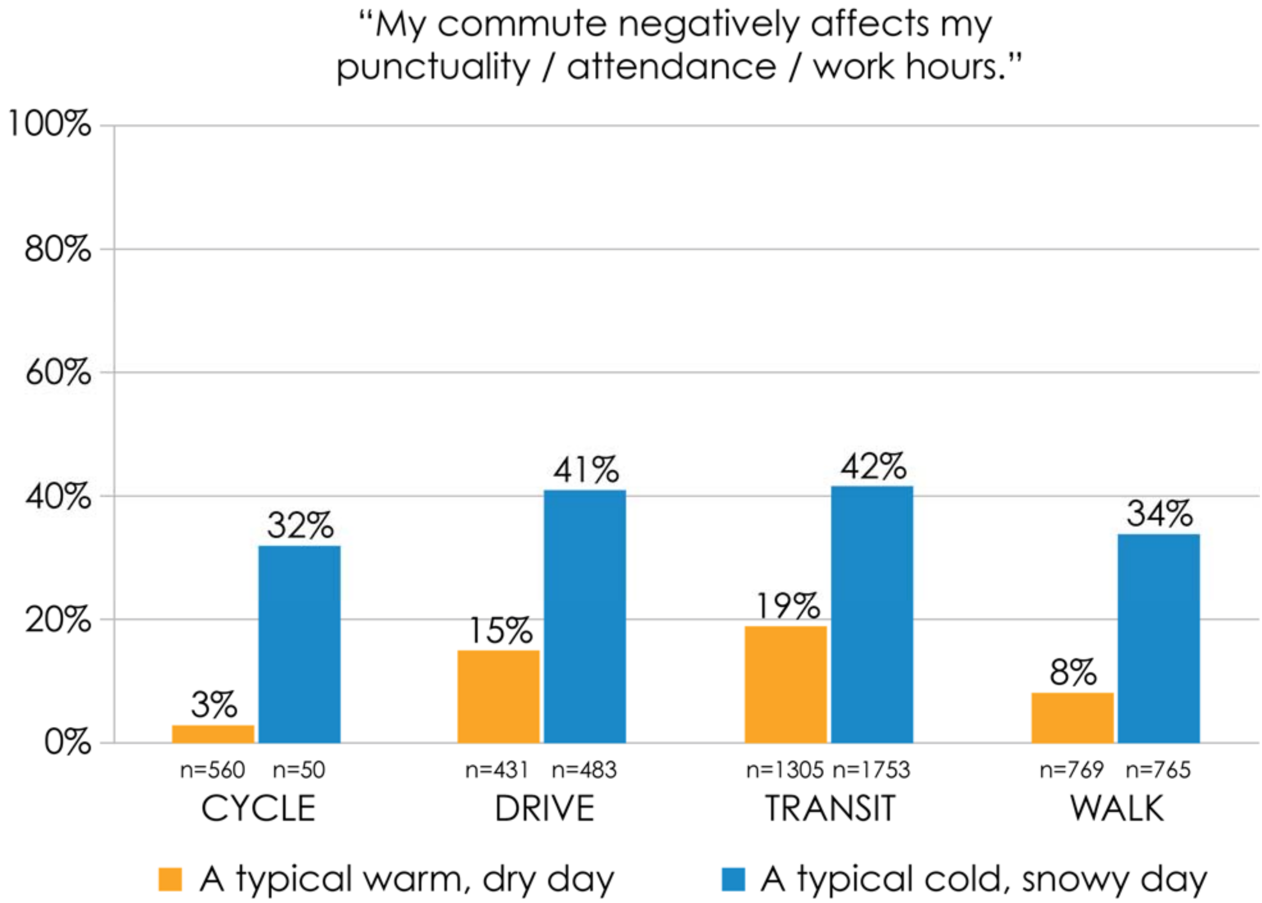

FIGURE 2 Proportion of commuters whose commute negatively impacts their punctuality, attendance or working hours classified by mode and by weather.

3.3 Multilevel Mixed-Effects Logistic Regressions

Using multilevel mixed-effects logistic regressions, this study sets out to determine which factors influence a commuter's energy level at work and punctuality. Since the typical commuting trips for both weather conditions of each individual are of interest, multilevel models allow us to appropriately isolate and capture the effects of listed variables, while acknowledging unmeasured individual-level factors (Gelman & Hill, 2007). In other words, multilevel models enable us to distinguish between the variation within individuals and the variation among individuals. The likelihood-ratio rest (LR test) was used to validate the appropriateness of using multilevel regressions.

Based on an evaluation of the independent variables discussed in literature, the models retain variables that proved to be theoretically relevant and consistently statistically significant in the final results. The models also include control factors, such as residential self-selection variables, to enable appropriate interpretation of the results. The decision on whether to keep or drop a variable that was not significant in a model was based on its effect on the model's Log-likelihood and the changes that occurred in the other variables.

General models and mode-specific models were developed to improve the understanding of how each mode and specific aspects of different modes influence a commuter's energy level at work and punctuality. The general models consist of universal variables as well as dummy variables to indicate the mode used. The universal variables presented in the general models are also found in the mode-specific models, which contain additional variables specific to a particular mode that is tested. These mode-specific variables are generally related to the satisfaction with the different aspects of the modes used. For example, a respondent who typically rides a bus and takes the metro during his or her commute would answer satisfaction questions for both the bus and the metro. Yet, someone who only takes the bus would only rate his or her satisfaction with the bus. In order to analyze transit users as one group regardless of how many transit modes they use, the average satisfaction for the specific transit modes used was generated. In addition, variables were developed to indicate how many buses, metro and commuter rail lines each commuter took.

For ease of interpretation, ordinal data collected in the form of a 5-point Likert-scale were transformed into dummy variables. We recoded answers of "1" and "2" as "Low", "3" as "Medium", and "4" and "5" as "High". In the case of transit satisfaction variables, we recoded averages of less than 2.5 as "Low", and greater than 3.5 as "High". Averages falling within and including 2.5 and 3.5 were recoded as "Medium".

4. RESULTS AND DISCUSSION

Tables 2 and 3 present the results of the multilevel mixed-effects logistic regression analyses using odds ratio (OR) and 90% confidence intervals (CI). The Intraclass correlation coefficient (ICC) presented at the bottom of each table is a statistic that measures the consistency of responses by each individual and compares the proportion of variability in energy and punctuality that is due to differences within individuals to the differences across individuals. In predicting the odds of a commuter feeling energized at work, the ICC is estimated to be 71.2%, 72.0%, 76.4%, 78.9% and 70.0% for the general, cyclist, driver, transit user and pedestrian models, respectively. Likewise, the ICC is estimated to be 75.1%, 68.6%, 77.5%, 79.7% and 72.1% for the general, cyclist, driver, transit user and pedestrian models predicting the odds of a commuter arriving late at work. To put this into context, the ICC of 68.6% that is associated with the model predicting the odds of a cyclist arriving late at work suggests that 68.6% of the variation is due to differences between cyclists, or unmeasured factors at the individual level, rather than differences within individual cyclists.

TABLE 2 Multilevel Regression Results for Energy at Work

"I feel energized when I arrive at McGill."

WEATHER	Dummy Level	**GENERAL** OR [95% CI]	**CYCLE** OR [95% CI]	**DRIVE** OR [95% CI]	**TRANSIT** OR [95% CI]	**WALK** OR [95% CI]
A typical warm, dry day		6.069*** [4.865, 7.570]	4.181** [1.119, 15.627]	5.726*** [2.936, 11.168]	4.570*** [3.234, 6.458]	5.965*** [3.833, 9.280]
TIME						
Additional budgeted time (per ten minutes)		0.309*** [0.252, 0.380]	0.813 [0.506, 1.604]	0.292*** [0.179, 0.475]	0.201*** [0.142, 0.284]	0.357*** [0.188, 0.677]
Additional budgeted time (per ten minutes squared)		1.124*** [1.094, 1.155]	–	1.133*** [1.073, 1.195]	1.161*** [1.110, 1.216]	1.246*** [1.079, 1.437]
I use my commute time productively	High	3.294*** [2.461, 4.410]	2.477** [1.007, 5.6.093]	4.712*** [1.994, 11.134]	3.807*** [2.290, 5.329]	2.726*** [1.599, 4.646]
PERSONAL ATTRIBUTES						
Student		0.699** [0.519, 0.940]	2.267* [0.938, 5.479]	1.339 [0.489, 3.668]	0.965 [0.591. 1.576]	0.235*** [0.129, 0.425]
Life satisfaction (1-10)		1.301*** [1.194, 1.417]	1.146 [0.883, 1.489]	1.251 [0.957, 1.636]	1.274*** [1.105, 1.470]	1.241*** [1.058, 1.456]
HOME SELECTION						
Importance of the following factors in selecting current home:						
Proximity to transit	High	2.162*** [1.507, 3.103]	2.277 [0.705, 7.358]	–	2.002* [0.949, 4.225]	–
Cost of commuting	High	–	–	1.732 [0.748, 4.008]	–	–
Cost of commuting	Low	1.520** [1.097, 2.106]	–	–	1.713* [0.975, 3.011]	–
Not having to drive	High	–	–	–	–	2.025** [1.035, 3.959]

SATISFACTION WITH MODE		**GENERAL** OR [95% CI]	**CYCLE** OR [95% CI]	**DRIVE** OR [95% CI]	**TRANSIT** OR [95% CI]	**WALK** OR [95% CI]
Comfort	High	na	6.456** [1.547, 26.937]	–	–	6.151*** [3.098, 12.213]
Safety from traffic	High	na	2.207* [0.876, 5.556]	–	na	–
Safety from traffic	Low	na	–	0.115*** [0.024, 0.539]	na	–
Length of travel time	High	na	–	3.430*** [1.589, 7.410]	–	–
How long it takes to reach the bus stop, metro station or commuter rail station	High	na	na	na	2.103** [1.179, 3.752]	na
Reasonable waiting time for the bus, metro or commuter rail	High	na	na	na	2.392*** [1.443, 3.965]	na
MODE(S) USED						
Compared to: Cycling		v	na	na	na	na
Driving		0.092*** [0.055, 0.154]	na	na	na	na
Bus		0.152*** [0.104, 0.221]	na	na	na	na
Number of bus routes		na	na	na	0.562** [0.355, 0.889]	na
Metro		0.130*** [0.089, 0.191]	na	na	na	na
Number of metro lines		na	na	na	0.527** [0.298, 0.932]	na
Commuter rail		0.100*** [0.057, 0.173]	na	na	na	na
Number of commuter rail lines		na	na	na	0.493* [0.228, 1.069]	na
Walking		0.258*** [0.172, 0.387]	na	na	na	na
Constant		0.090*** [0.038, 0.213]	0.065* [0.004, 1.140]	0.006*** [0.0005, 0.079]	0.005* [0.001, 0.025]	0.015*** [0.003, 0.071]
n		6116	610	914	3058	1534
Log likelihood		-3117.109	-277.343	-422.560	-1420.786	-861.008
Intraclass correlation coefficient		71.2%	72.0%	76.4%	78.9%	70.0%

*”*** significant at 99%, ** significant at 95%, * significant at 90%, – “found to be insignificant and removed”, na “not applicable”, v “comparison variable*

TABLE 3 Multilevel Regression Results for Punctuality

"My commute to McGill negatively impacts my punctuality / attendance / working hours."

	Dummy Level	**GENERAL** OR [95% CI]	**CYCLE** OR [95% CI]	**DRIVE** OR [95% CI]	**TRANSIT** OR [95% CI]	**WALK** OR [95% CI]
WEATHER						
A typical warm, dry day		0.049*** [0.036, 0.067]	0.011*** [0.001, 0.207]	0.067*** [0.032, 0.140]	0.060*** [0.039, 0.092]	0.041*** [0.020, 0.083]
TIME						
Travel duration (per ten minutes)		1.405*** [1.283, 1.539]	–	1.436*** [1.124, 1.834]	1.330*** [1.158, 1.528]	1.313** [1.033, 1.669]
PERSONAL ATTRIBUTES						
Student		4.625*** [3.228, 6.626]	1.168 [0.310, 4.402]	6.255*** [2.221, 17.613]	3.634*** [2.199, 6.004]	5.717*** [2.554, 12.802]
HOME SELECTION						
Importance of the following facts in selecting current home:						
Proximity to McGill	High	2.224*** [1.542, 3.207]	1.733 [0.352, 8.536]	1.649 [0.685, 3.970]	2.421*** [1.444, 4.059]	4.775*** [1.691, 13.488]
SATISFACTION WITH MODE						
Comfort	Low	na	–	–	–	4.371*** [1.743, 10.959]
Length of travel time	High	na	–	0.392** [0.174, 0.880]	–	–
Length of travel time	Low	na	8.020* [0.705, 91.289]	–	–	2.888* [0.985, 8.465]
Consistent travel time	Low	na	–	6.379*** [2.020, 20.146]	–	–
How long it takes to reach the bus stop, metro station or commuter rail station	High	na	na	na	0.394*** [0.233, 0.667]	na
Reasonable waiting time for the bus, metro or commuter rail	High	na	na	na	0.154*** [0.094, 0.251]	na

MODE(S) USED	**GENERAL** OR [95% CI]	**CYCLE** OR [95% CI]	**DRIVE** OR [95% CI]	**TRANSIT** OR [95% CI]	**WALK** OR [95% CI]
Compared to: Cycling	v	na	na	na	na
Driving	11.259*** [6.091, 20.813]	na	na	na	na
Bus	8.836*** [5.607, 13.934]	na	na	na	na
Number of bus routes	na	na	na	4.864*** [3.013, 7.852]	na
Metro	2.758*** [1.806, 4.214]	na	na	na	na
Number of metro lines	na	na	na	2.283*** [1.303, 4.000]	na
Commuter rail	2.214** [1.150, 4.263]	na	na	na	na
Number of commuter rail lines	na	na	na	1.905 [0.824, 4.407]	na
Walking	2.432*** [1.450, 4.080]	na	na	na	na
Constant	0.006*** [0.003, 0.013]	0.096* [0.009, 1.029]	0.074*** [0.019, 0.288]	0.057*** [0.019, 0.168]	0.007*** [0.001, 0.035]
n	6116	610	914	3058	1534
Log likelihood	-2775.209	-95.657	-434.132	-1491.885	-633.357
Intraclass correlation coefficient	75.1%	68.6%	77.5%	79.7%	72.1%

**** significant at 99%, ** significant at 95%, * significant at 90%, – "found to be insignificant and removed", na "not applicable", v "comparison variable"*

4.1 General Model

Since the factors affecting both energy at work and punctuality are very similar, this section discusses the results of both models simultaneously while highlighting the relevant differences.

First, dummy variables are included for each mode to determine how mode choice influences energy at work and punctuality. Although individual modes are generally mutually exclusive since respondents are classified according to their main mode of transportation, it is possible for a transit rider to use the bus, metro and commuter rail in one trip. In previous studies, bus, metro and commuter rail users have been grouped under the single category of public transit users (Grimsrud & El-Geneidy, 2014; Mokhtarian et al., 2014). However, the findings from this study suggest that the commuting experience of individuals using different transit modes impact their energy at work and punctuality in different ways. Hence, a distinction between the transit modes is provided in the general models. According to the results, cyclists are the most likely to feel energized at work and the least likely to be late due to the commute. While it is plausible that those who already have an active lifestyle and tend to be more energized are self-selecting to commute by bicycle, research has also shown that physical activity increases alertness and personal well-being (Biddle, 2003; Fox, 1999). Compared to cyclists, other mode users felt less energized at the end of their commute showing an odds between 91% to 74% lower. On the other hands, the odds of being tardy increased between 2.21 to 11.26 times for all modes compared to cycling, while controlling for other variables. Put simply, drivers have the lowest odds of feeling energized at work (91% compared to cyclists) and the highest odds of arriving late (11.26 times more compared to cyclists). A careful examination of the confidence intervals, however, reveals that drivers and public transit users (bus, metro or commuter rail passengers) have similar odds of feeling energized, and that bus users and drivers have similar odds of being less punctual compared to cyclists (8.83 and 11.26 times more than cyclists).

Secondly, weather plays a significant role in affecting an individual's energy at work and punctuality. More precisely, the odds of an individual feeling energized at work are 6.07 times higher on a warm and dry day than on a cold and snowy day. Likewise, the odds of being late for work when commuting on a warm and dry day decrease by 95% compared to traveling on a cold and snowy day. The effects of the weather can be interpreted as an indirect result of higher stability of the transportation systems and consequently, lower energy exertion required on the part of the individual. The effect of weather conditions, however, may have been exaggerated due to the survey respondents' enthusiasm towards warmer weather after experiencing an unusually long and harsh winter in 2013.

Thirdly, there are temporal factors that influence a commuter's energy level and punctuality. With regard to feeling energized, the model reveals that the amount of additional budgeted time allotted for the trip is a significant factor, albeit a nonlinear relationship. Planning extra time for a commute is usually a response to unpredictability in the length of travel time, and perhaps an indicator of commuting stress. The results indicate that the more extra time allocated up to a certain point, the lower the odds of feeling energized at work. After surpassing a certain point, the reverse holds true. In general, this point happens at the 50-minute mark, but varies depending on travel mode as discussed in the following sections. This nonlinear relationship may suggest that some people are not allocating enough additional time for their commute, and thereby negatively affecting their energy at work. Overall, these findings suggest that there is a diminishing marginal reduction in the odds of feeling energized as additional budgeted time increases. Also, the odds of feeling energized is 3.29 times higher for an individual who perceives that he or she is productive during the commute compared to someone who does not. However, future research is required to understand this relationship. Travel duration is a significant factor in predicting the odds of whether a commuter will be late for work. More specifically, the model reveals that the odds of an individual being late are 1.41 times greater for every additional ten minutes of travelling.

Next, we consider the model's results with regard to personal attributes. Compared to staff and faculty, when other variables are controlled for, the odds of students feeling energized is 30% less, and the odds of being late increases by 363%. This finding is in line with the theory that there are significant differences between the behaviour of students and those of workers (Barr & Hitt, 1986; Carpenter, Burks, & Verhoogen, 2005). These dissimilarities can be attributed to differences in attitudes, lifestyle, responsibilities and stages of life. Other socio-demographic variables were tested in the models, of which age was significant, while gender, income and the number of children living in the same household were not significant. Although age was a significant factor, it was not retained in the final models due to its strong correlation with student status (Pearson's correlation = -0.74). Student status was preferred over age, since being a student often implies other personal characteristics such as younger age, having fewer children, a lower income and less consistent schedule. In contrast, a person's age is not as telling. For instance, the average age of a student is 26 years compared to the average age of a non-student, which is 46 years. Moreover, the median income category for students is from $0 to $19,999, while that of faculty and staff is $60,000 to $79,999. The results reveal a positive relationship between life satisfaction and the odds of feeling energized. While it is possible that the higher life satisfaction has a positive impact on how energized a person feels at work, the reverse is also plausible. Having enough energy to perform well at work may increase overall life satisfaction. Hence, a causal relationship between these two variables cannot be established based on this model.

Finally, the general models account for residential self-selection variables. The models reveal that those who valued the importance of living in proximity to transit have 2.16 times greater odds of being energized after the commute, compared to those who did not value living in proximity to transit. Similarly, individuals who did not consider the cost of commuting to be important have 1.52 times greater odds of being energized after the commute compared to others. On the other hand, the models also reveal that those who considered it important to live in proximity to the university have 2.22 times greater odds of being late compared to those from this was not highly important. Although the previous statement may not seem intuitive, it is possible that those who live closer to the university campuses may be underestimating their commute time. Nonetheless, it is also probable that those who are aware of their tendencies to be late consider it more important to be living near the university.

4.2 Mode-Specific Models

When interpreting the results of the mode-specific models, it is critical to understand that even though the same variables may appear across different mode-specific models, there are important distinctions. For instance, a comfortable experience for a driver is different than a comfortable experience for a public transit user. More specifically, a driver may be concerned with the congestion he or she is facing while a public transit user may desire more room and seating. Nevertheless, the results, as discussed below, consistently show that satisfaction with travel mode is associated with being both more energized and more punctual.

4.2.1 Cyclists

Similar to the general model, the results for cyclists show that weather conditions have a significant impact on a cyclist's energy and punctuality; when cycling on a warm and dry day instead of a cold and snowy day, commuters tend to feel more energized at work and tend not to arrive late. With regard to feeling energized the odds for a cyclist who believes that he or she uses his or her commute time productively is 2.48 times greater than those who do not believe that they use their commute time productively. While being a student does not significantly impact the odds of a cyclist being late, it does increase the odds of a cyclist feeling energized at school by 2.27 times compared to staff and faculty. In terms of mode-specific attributes, the models reveal that cyclists who are satisfied with the comfort of the commute and safety from traffic have a much higher odds of feeling energized. Dissatisfaction with the length of travel time, on the other hand, is associated with being less punctual. However, it is not possible to confirm the direction of the causal relationship by simply using these models; dissatisfaction with travel time may be an effect rather than a cause of the perception that the commute negatively impacts the individual's punctuality at work. Nevertheless, these results point to the importance of policies directed at improving the travel environment of cyclists.

4.2.2 Drivers

Driving on a warm and dry day, instead of a cold and snowy day improves the odds of a commuter feeling energized at work and reduces the odds of being late. This is expected, as road conditions in Montreal during the winter can become quite challenging due to the presence of snow and ice. The results also show that as drivers increase their amount of extra budgeted time, their odds of feeling energized decreases. The models also reveal that with regard to feeling energized at work, the odds for drivers who use their commute time productively are 4.71 times greater compared to drivers that do not use their commute time productively. In addition, students who drive tend to be less punctual than staff and faculty. With regards to mode satisfaction, the models show that users who are dissatisfied with safety from traffic tend to feel less energized when they arrive at work compared to those who are satisfied with safety. Additionally, when a driver is satisfied with his or her travel duration, the odds of feeling energized increase by 3.43 times compared to users who are not satisfied with their travel time. This may be because drivers who are satisfied with their travel time are those who do not experience congestion during their commute. Satisfaction with travel time is also associated with being punctual, while dissatisfaction with travel time consistency is associated with being late. Again, the interaction between satisfaction with travel time duration, travel time consistency and the odds of being late are difficult to fully capture using these models; thus theoretically, no causal relationships can be established. In addition it is difficult to capture an individual's level of energy before his or her commute, and differences might exist between those who wake up full of energy compared to those who are more sleep deprived. However, it is evident that satisfaction with traffic safety and travel duration has an impact on the odds of a driver feeling energized after the commute.

4.2.3 Transit Users

According to the transit models, the more number of transfers required during the commute, the lower the odds of an individual feeling energized at work and the greater the odds of being late. It is particularly interesting that among the transit modes, commuter rail users have the lowest odds of feeling energized, while bus users have the greatest odds of being late. Transit users are sensitive to the time it takes to reach their bus stop, metro station or commuter rail station and how much time they have to wait for their transit service. Users who are satisfied with the time it takes to reach the transit station or stop tend to feel more energized and be punctual. Furthermore, satisfaction with waiting time at the transit stop or station is estimated to enhance an individual's odds of feeling energized at work by 2.39 times compared to users who are not satisfied with the waiting time and influence their odds of being on time by 81%. In other words, satisfaction with waiting time and the time it takes an individual to reach his or her desired transit service have important effects on an individual's energy level and is associated with being punctual. Moreover, similar to the results of the other modes, adding addition travel time decreases their odds of feeling energized. Transit agencies, therefore, could make an effort to improve both service accessibility and reliability as such improvements are expected to impact the individuals they are serving.

4.2.4 Pedestrians

For pedestrians, a comfortable commute is associated with feeling energized. An uncomfortable commute and being dissatisfied with travel time is associated with arriving late for work or school. Students have lower odds of feeling energized, and a plausible reason is that students simply do not get enough sleep and start the day feeling tired. It may also be due to the shorter distances that students travel as a result of many living in student residences close to campus. Students walk for an average of 15 minutes to the university, while staff and faculty walk for an average of 25 minutes. It is possible that the amount of time students spend walking to school is not enough for them to reap the benefits of walking (Biddle, 2003; Fox, 1999). Another possible explanation is that students may have to carry heavier loads when travelling to school.

5. CONCLUSION

In conclusion, the findings of this study suggest that similar factors have significant effects on the odds of a commuter feeling energized and being punctual. The results support the hypotheses and demonstrate that the impact of commuting on both energy at work and punctuality is significantly influenced by the transportation mode and weather conditions. Furthermore, this study indicates that drivers have the lowest odds of feeling energized at work, and the highest odds of arriving to work late. Cyclists, on the other hand, have the highest odds of being energized and punctual. While it is possible that individuals who already have an active lifestyle are self-selecting to commute by bicycle, previous research has also found that physical activity increases alertness and personal well-being (Biddle, 2003; Fox, 1999). Thus, it may be valuable for schools and employers to encourage the habit of commuting by bicycle.

Mode satisfaction improves the odds of an individual feeling energized, and is also found to be associated with increased odds of punctuality. However, a theoretically sound causal relationship cannot be established between the variables related to satisfaction with travel time and the odds of arriving on time, and further research is required to rigorously unravel the interactions between these variables.

Nonetheless, this study presents evidence that cyclists who are satisfied with their travel environment, in terms of comfort and safety from traffic, have increased odds of feeling energized. Hence, it would be beneficial to develop policies aimed at improving the safety of cyclists in traffic. The odds of a driver feeling energized, meanwhile, is affected by his or her satisfaction with travel duration and safety from traffic, likely alluding to a drivers dissatisfaction with congestion and the behaviour of other road users. In addition, the odds of a transit user feeling energized are impacted by the time it takes to reach the transit station or stop, as well as the waiting time. Hence, transit agencies should prioritize the improvement of service accessibility and reliability to provide a better commuting experience for their customers. Results from this study indicate that being productive while commuting is associated with higher odds being energized at work. However, this relationship is not well understood and future studies should focus specifically on understanding the interaction of these variables.

Future studies should also distinguish between physical and mental fatigue, as it will lead to an improved understanding of how each mode affects the physical and mental energy of commuters and ultimately, the productive capacity of employees and students. Other factors such as sleep deprivation, overall exhaustion, being in a cheerful mood and enjoyment of activity should be controlled for in order to isolate the effects of commuting on a person's feeling of being energized. Finally, policy makers should consider developing strategies that aim to increase the mode satisfaction of commuters, as the results of this study have shown a positive relationship between mode satisfaction and a commuter's energy and punctuality.

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