Does the predictability of the commute mediates the relation of commuting mode on stress?

Master's Thesis of Human Resource Studies

Faculty of Social and Behavioral Sciences

Tilburg University

23-09-2014

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Project Period: January 2014 - September 2014

Abstract

Purpose - The purpose of this study was to investigate the relation between commuting mode and commuters stress through the predictability of the commute.

Design/Method/Approach - To test the hypotheses, a survey was conducted among employees that commute to work in the Netherlands (N=323). Respondents were gathered through convenience sampling. The respondents covered in this study were employed in twelve different branches in both the public sector (health care and education) and the private sector (financial services and industry).

Findings – It was found that a lower predictability of the commute leads to higher commuting stress. Furthermore, walking/cycling was found to be a more predictable commuting mode compared to transportation by car or public transport. The (partial) mediating effect of predictability of the commute was found to be significant. Finally, it was found that the longer the duration of the commute would take, the less predictable the commute is perceived.

Originality/Value – This study showed a partial mediating role of predictability in the relation between commuting mode and commuting stress. Furthermore, this study compared several ways of active commuting such as walking or cycling and inactive ways of commuting such as commuting by public transportation and car with respect to predictability and stress.

Keywords Commuting stress, Predictability, The Netherlands, Commuting mode

Introduction

According to Statistics Netherlands (CBS, 2012), a total of 5.184.000 people commute to work over 210 working days per year which includes 53,8% of car commuters, 5,5% of co-drivers, 9,7% of public transport commuters, 3,3% of walking commuters, 24,5% of cycling commuters and 1,6% of motorbike commuters. Commuting is known as the regular travel between an individual's place of residence and place of work. Stutzer & Frey (2008) state that: "Commuting is an important aspect of our lives that demands a lot of our valuable time (p.339)." According to this distribution there are three main modes of commuting; commuting by car, commuting by public transport and commuting by walking and/or cycling. In this research the commuting modes will be limited to these three main categories.

For most people commuting is a daily routine, however several studies found that commuting has a large impact on psychological, physiological, and behavioral outcomes, (e.g. Koslowsky, 1997; Novaco et al., 1990). This is in line with Stutzer and Frey (2008) that state that commuting can be perceived by people as a physical and mental burden and a source of work-related stressors. Environmental events that trigger stress are commonly referred to as stressors (Ganster and Rosen, 2013). A stressor that can trigger stress is the commuting event. O'Regan and Buckley (2003) found that 80% of their respondents experienced commuting as a stressful part of their day. Evans & Wener (2006) state that commuting stress is an important largely overlooked aspect in environmental health.

Studies that analyze commuting stress show that there are several stressors which can cause stress. These stressors are divided in two categories: objective and subjective impedance (Novaco, Stokols & Milanesi, 1990). Impedance is known as a behavioral restraint on movement or goal attainment (Novaco et al., 1990). They state that impedance includes anything that frustrates the goal of arriving at a given time at a particular destination for example; distance, slow speed, or traffic congestion. Objective impedance includes stressors such as; commuting time, commuting distance and traffic congestion. Subjective impedance includes factors such as predictability of the commute, control over the commute and personal characteristics. The objective stressors have been the main focus in studies so far. One of the main findings is that commuting time and traffic congestion increases the stress level (Hennessy and Wiesenthal, 1999; Stokols et al., 1978).

Subjective stressors have been studied less, and the findings show inconsistent results. It looks like within the concept of subjective impedance, predictability is the most common significant variable explaining stress (Wener & Evans, 2011; Evans et al., 2002). However,

predictability is not always the best explaining variable explaining commuting stress. In the study by Sposato, Röderer and Cervinka (2012) control was the most powerful predictor of stress. A quick review of the findings on the influence of subjective stressors in commuting shows that further research on predictability is necessary to examine whether predictability explains the relation between commuting mode and stress.

The aim of this study is to investigate the effect of three commuting modes on commuter stress and to test whether predictability of the commute partly mediates this effect. According to Wener and Evans (2011) there is very little empirical information about the differences between various modes of commuting on commuter stress. In addition to that, Gatersleben and Uzzell (2007) found that research to date has been limited to comparing private car use and public transport only. Little to no comparisons has been made between these groups and commuters that walk or use their bike to go to work.

This is why it is useful to study the effects of several commuting modes, especially because almost a quarter of the Dutch commuters use their bike, and this important way of commuting can be taken into account. In case predictability of the commute can be influenced by the transportation mode, it will lead to new insights. Furthermore, this study can lead to further studies on the effect of walking and cycling on commuting stress. Not many studies in this field have used walking and cycling in a mediation model. In this study, the effect of active ways of transportation (cycling, walking) is compared with the more inactive types of transportation (driving, using public transport). Taking this ‘health factor’ into account can help to clarify the insight into motives why commuters prefer a car instead of bike for instance. Finally, this study could answer the question whether commuting by car causes more stress than commuting by bike.

In order to answer the questions formulated before, the following research question is formulated:

To what extent does predictability of the commute mediates the relation of commuting mode on perceived commuting stress?

Theoretical Framework

Commuting modes and predictability

In this study the commuting modes are; commuting by car, commuting by public transport and walking/cycling will be combined. These three categories were chosen because these are the main transportation modes used in the Netherlands (CBS, 2012). Commuting by car is the most popular way of commuting in the Netherlands, most likely because it is perceived by commuters as best way of commuting. However, Gatersleben and Uzzell (2007) suggest that car commuting may not be the optimal transportation mode. Commuting by foot or bike scores better on pleasure and arousal compared to commuting by car and public transport. Therefore it seems to be a better way of transportation from an emotional perspective (Gatersleben and Uzzell, 2007). However, walking and cycling are not always an option for commuters because they might live too far away from their workplace. On the other hand, Gatersleben and Uzzell (2007) found that 35% of the car commuters in the U.K. live within 5 kilometers distance from their workplace. So why does this percentage of workers prefer to commute by car instead of cycling or walking? Wener & Evans (2011) suggests that driving also requires constant attention and effort – more so as conditions worsen. Trains are likely to be more predictable and less effortful as a mode of travel. On the other hand, driving may afford a higher level of control for the driver. The driver has more ability to influence time of departure, route, and road speed.

Commuting modes vary in several dimensions. One of those dimensions is whether the commute to work is predictable. The predictability and the control over the commute are often confused with each other. Sposato et al. (2012) state that the major difference between predictability and control is that predictability is a measure reflecting temporary incidents, which force the commuter too adapt, rather than constituting a constant feature of the journey to work, such as control. Seligman and Miller as cited in Koslowsky (1997), state that: “when conditions do not allow control of the environment, then other variables can substitute it in determining the existence of the stressful *stimulus*. When people cannot control their environment they can be satisfied with being able to predict it”(p. 165). When people cannot control the commute, they will be satisfied with predicting the commute. In other words, when the commute is relatively predictable, the existence of stressful *stimuli* will be mitigated. Evans et al. (2002) explain predictability as follows: “When people cannot exercise behavioral control, predictability can function as a form of cognitive control, providing individuals with a coping strategy for alleviating stress (p.532)”

According to Miller (1981) there are two kinds of predictability: knowing the conditions under which the event will occur (contingency predictability) and knowing what the event will be like (what-kind-of-event predictability). Contingency predictability can be applied when the individual knows *when and under what circumstances an event will occur***.** In other words, an event is predictable when its probability of occurrence is greater under one given set of conditions than under other conditions. For example, if an event only occurs when a tone is on and never occurs when the tone is off, then it is predictable. The what-kind-of event predictability assumes that people get *stimulus* information about the predictability. In other words, information about the physical characteristics of the (prospective) commute, like quality, intensity and properties can influence the predictability.

The difference between these two theories is that contingency predictability concerns the probability of an event and what-kind-of-event predictability concerns the event itself. In predictability of commuting it is about the commute to work (the event) and not about the probability whether people have to commute.

The what-kind-of-event predictability concerns the characteristics of the commute such as delays and traffic jams. This has a link with the predictability of the commute and therefore the what-kind-of-event predictability seems to be a good factor to take into account when studying commuting predictability.

In exploring commuting modes and predictability, it is interesting to know whether commuting modes differ in the extent whether the commute is predictable. Several studies have shown that commuters perceive commuting by car as less predictable compared to commuting by train (e.g., Wener & Evans, 2011; Wener, Evans & Lutin., 2006). These studies have only compared commuters by car and train and did not take other ways of transportation into account. However, it is expected that overall public transportation will be perceived as more predictable than commuting by car.

There seems to be little to no empirical evidence concerning the relation between walking/cycling on predictability of the commute. However, in comparison to other commuting modes, walking and cycling seems more predictable than commuting by car, due to shorter commuting distance. Furthermore there seems to be less external factors which can impede the commute, such as congestion and hinder from traffic lights. Therefore it is assumed that walking or cycling to work is perceived as more predictable than other commuting modes.

Taken into account the studies that have been discussed, the following hypotheses are proposed:

Hypothesis 1A: Commuting by public transportation is perceived as more predictable than commuting by car.

Hypothesis 1B: Commuting by walking / cycling is perceived as more predictable than commuting by car or using public transport.

Predictability and perceived stress

Stress is generally viewed in terms of the fit of people's needs, abilities and expectations with environmental demands, changes and opportunities (Cummings & Cooper, 1979). Ganster and Rosen (2013) state that stress can be defined in three ways: "a feature of the external environment that acts on an individual, the individual's responses (psychological, physiological, and behavioral) to environmental demands, threats and challenges, or an interaction between those two (p. 1088)". In short, stress is considered as an environmental demand and how individuals cope with that. In this study stress is related to commuting. Stutzer and Frey (2008) state: "For most people, commuting is a mental and physical burden, giving cause for various complaints" (p.329). Evans et al. (2002) conclude that: "commuting has been shown to be a stressor with adverse affective, motivational, and physiological consequences." Most studies confirm the expectation that, commuting can cause stress and that it can have negative consequences on person's overall well-being. According to Hennessy and Wiesenthal (1999) the negative effects of car use such as driving stress are caused by congestion, speed and general overstimulation, and acute poor health is caused by air pollution.

According to Miller (1981) individuals elect predictability over unpredictability. She classified five traditional theories on predictability and stress; safety signal, information seeking, preparatory set, preparatory response and uncontrollability. Overall, the traditional theories emphasize the stress-reducing role of predictability. Characteristics that determine predictability are: information seeking, preparatory response, uncontrollability and safety signal. Individuals prefer predictability over unpredictability and show less anticipatory arousal with predictability. In other words, when the commute is predictable it reduces stress. In addition, the commuter shows less tension with when there is predictability. Of these five theories, information seeking and preparatory set are the most applicable when looking at the predictability of the commute. Information seeking in this context of this study could be;

checking weather forecast, traffic jams, delays and road works. Preparatory set could be taking a rain suit, planning a detour and telecommuting.

Gottholmseder et al. (2009) found that several dimensions of the commuting situation, such as impedance, control and predictability of commuting can influence the perceived stress level significantly. In addition to that, Evans et al. (2002) found that the degree of predictability of the commute appears to be a striking contributor to commuting stress.

Taken into account the studies that have looked into the relation between predictability and stress the following hypothesis is proposed:
Hypothesis 2: The lower the predictability the higher the commuter's perceived stress.

Mediation effect of predictability

Hypotheses discussed hitherto imply that predictability could be a mediator in the relation of commuting mode on stress. According to MacKinnon, Fairchild and Fritz (2007) the mediator is a variable that is in a causal sequence between two variables.

The job demand-control model of van der Doef and Maes (1999) can be used in studying the mediating effect of predictability in the relation of commuting mode on stress. Van der Doef and Maes (1999) adjusted the job demand-control (-support) model of Karasek (1979) this model is useful in the context of this study (appendix 3). Job demands stand for the way of commuting and whether the commute is demanding. For example, a commuting mode which demands much effort, such as standing in a crowded train for one hour is a high demand. Studies show that it differs whether commuting is high or low on demands. The job control is the amount of control that is perceived, control also entails predictability of the commute to work. When the predictability (control) is low and the demands are high it will lead to high strain which eventually leads to psychological strain. However, when the commute is predictable the control will be high and the demand will remain high it will lead to so called: 'active job'. The model suggests that when the commute has high demands but is also highly predictable, it will not lead to extra strain. In other words, a predictable commute leads to less strain than an unpredictable commute.

Empirical evidence from Wener and Evans (2011) proves that predictability partly mediates the effect of commuting mode on stress. It was found that train commuters experienced less stress and created a less negative mood compared to commuters by car (Wener & Evans, 2011). Reasons for higher stress for car commuters are that car commuters

perceive their commute by car as more effortful and less predictable than train commuters do (e.g., Wener & Evans, 2011; Wener, Evans & Lutin., 2006).

Based on these studies that have been described one might predict that car commuting is perceived as more stressful than commuting by train, particularly because of differences in predictability and effort, both of which have been linked to environmental stress (Evans, Lercher, Meis, et al., 2001; Kluger, 1998). For example, the traffic congestion, sudden accidents or other kinds of traffic jams make the commute to and from work unpredictable, especially in densely populated major metropolitan areas. Driving also requires constant attention and effort, more so as conditions worsen. Trains are likely to be more predictable and less effortful as a mode of travel. On the other hand, driving may afford a higher level of control for the driver. The driver has more ability to influence time of departure, route, and road speed. Past research in other situations also indicates that control may be an important factor in reducing stress (Glass & Singer, 1972). Car commuting also holds a greater degree of control over social interaction, a critical aspect of privacy. If drivers do, indeed, have higher levels of perceived control than train commuters do, driving may be perceived as a less stressful mode of travel.

Taking this into account, the expectation is that commuting mode has an effect on predictability and predictability has an effect on perceived stress of commuters. In case these effects are significant, predictability could partly mediate the effect of commuting mode on perceived stress.

Therefore the following hypothesis is proposed:

Hypothesis 3: The effect of commuting mode on commuters stress is (partly) positively mediated by the predictability of the commute.

Commuting mode and perceived stress

Earlier on, the effect of commuting mode on predictability and the effect of predictability on commuting stress were discussed. In this study it seems to be useful to verify whether commuting mode has a direct effect on perceived stress as well. Gottholmseder et al. (2009) show that commuting is a factor that should be taken in account when explaining stress. Previous studies showed that commuter journeys by car and public transport can be stressful and that the main sources of this stress are delays caused by traffic volume, the behavior of other road users (for car users), and poor infrastructure provision (for users of

public transport) (e.g., Evans et al., 2002; Novaco et al., 1990; Rasmussen et al., 2000; Schaeffer et al., 1988; Wener et al., 2004).

O'Regan and Buckley (2003) found that 80% of the respondents experienced their commute as stressful. Train commuters were found to have the highest levels of stress and most negative moods on reaching their workplace. Car commuters were found to have the second highest levels of stress, followed by bus commuters. Finally, walkers perceived the lowest levels of stress and the most positive moods. This implies that train commuters perceive their commute as more stressful compared to than car commuters. However, this study showed that car commuters perceive their commute as more stressful than bus commuters. Therefore it is hard to predict whether public transportation in general (by train and bus) will be perceived as more or less stressful as commuting by car. However, it is expected that commuting by car is found to be less predictable (*H1A)* and therefore found to be more stressful than commuting by public transport (*H4A).*

Studies have been carried out concerning the positive effects of walking and cycling on health and stress. As for physical health, active commuting that incorporates walking and cycling was associated with an overall 11% reduction in cardiovascular risk, which was more robust among women (Hamer & Chida, 2008).

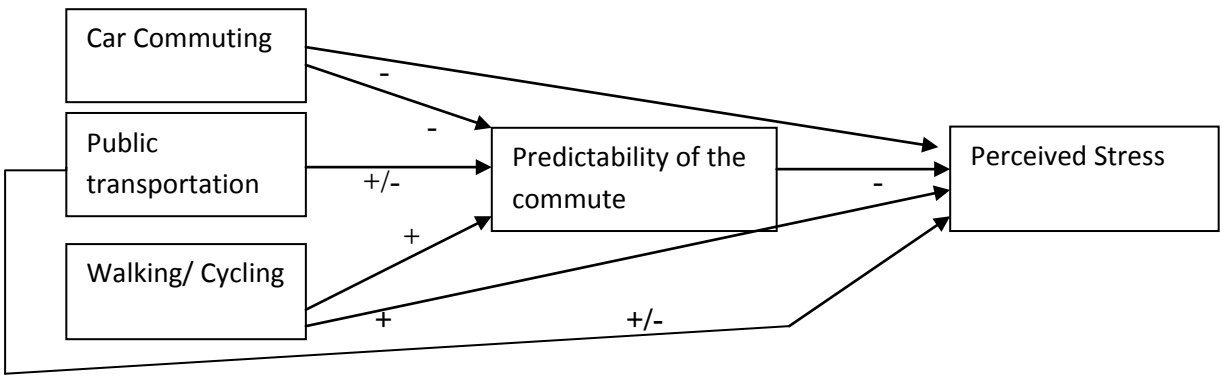
Taken into account the studies that have looked into the relation between commuting mode and stress the following hypotheses are proposed:

Hypothesis 4A: Commuters that commute by public transportation perceive less stress than commuters by car.

Hypothesis 4B: Commuters that walk /cycle perceive less stress than commuters by car or commuters using public transportation.

Based on the hypotheses discussed before, the following model has been developed.

Conceptual model



Method

Design and sample

For this hypothesis testing study, cross-sectional data by Dutch questionnaires was used. This study's target population consisted of commuting employees living in the Netherlands. The sample was gathered by using convenience sampling. Friends and acquaintances were contacted whether they would like to participate in this research and they could forward this request to others interested. This resulted in a total sample of 335 respondents and a final sample of 323 (N) respondents. The sample consisted of Dutch employees that commute to work. The average age of the employees in this sample was 37.04 years and 57.3 % of the sample was male.

The respondents covered in this study were employed in twelve different branches in both the public sector (health care and education) and the private sector (financial services and industry). Approximately 20% of the sample was employed at a large nutrition company in the Netherlands. 16.4% of the sample was employed in industry, 15.8% in healthcare and 12.8% in education and science.

Almost three-quarters (74.9%) of the sample is higher educated, which was defined in this study as having finished higher vocational education or university. 21.5 % of the sample finished (secondary) vocational education. When this sample is compared to the Dutch population, there are a few differences in distribution of educational background. In the Dutch population 30% of the people are lower educated, 42% finished (secondary) vocational education and 28% is higher educated (CBS, 2013). These differences in should be taken into account when analyzing the results of this study. Because the method of convenience sampling was used, the higher educated people are overrepresented.

Instruments

Commuting mode

In the questionnaire, respondents could choose their main way of transportation, and this commuting mode was only taken into account in this study. Commuting mode was expected to have an effect on predictability and commuting stress. Commuting mode was the independent variable and was measured by a categorical variable defined as: commuting mode (1 = car/motor commuting, 2 = public transport, 3 = walking/cycling and 4 = moped/scooter). Of the sample 57.0 % indicated that car is their main way of commuting,

16.8 % commuted by public transportation and 26.2 % walked or cycled to work. One respondent commuted by moped/scooter; however one respondent is too small to represent a reliable commuting group so therefore this person and thereby commuting mode 4 was deleted.

Predictability (Evans et al., 2002)

Predictability was measured in the questionnaire, predictability is expected to be the mediating variable and have an effect on commuting stress. The variable was measured on a six-item scale. Sample items included "I can usually predict when I get to work," and "my commute to work is consistent on a day to day basis." All items are rated on a 1-5 scale of "Strongly Disagree; Disagree; Neither Agree nor disagree; Agree; Strongly Agree" Because the scale was used by several researchers in the U.S. the questions and answers had to be translated into Dutch. Factor analysis showed that all six items measured the predictability concept. Reliability analysis showed that each item contributed to the reliability of the scale (Cronbach's alpha =. 82).

Stress (Evans et al., 2002)

Stress is the dependent variable and was measured in the questionnaire. This was measured with an eight-item scale. The scale for commuting stress has propositions like: "Overall, commuting is stressful for me" and "In general, I feel positive about my commute to work." All items are rated on a 1-5 scale of "Strongly Disagree; Disagree; Neither Agree nor disagree; Agree; Strongly Agree". Factor analysis showed that all eight items measured the commuting stress concept. Reliability analysis showed that every item contributed to the reliability of the scale (Cronbach's alpha =. 87).

Control variables

The control variables age, gender and commuting duration were included. First, gender differences were measured by a dichotomous variable called: gender (1=Male, 2= Female). In previous research, females reported higher levels of commute strain than males (Koslowsky et al., 1995). Second, age was measured by continuous variable called 'age'. Langford and Glendon (2002) suggest that older drivers are more adapt at moderating the potentially negative impact of work-related stressors upon reported driver stress. Therefore age is an important control variable when studying commuting stress. Lastly, the model was controlled for commute duration. It is possible that higher predictability and lower stress for

commuters that walk or cycle to work is not explained by the predictability but by the shorter commuting duration, which is less stressful and more predictable (Wener & Evans, 2011).

Procedure

The data was collected through convenience sampling, whereby friends, family and acquaintances were contacted. The participants were contacted by email in the beginning of May, in which an explanation was given about the purpose of the research. In addition, the email explained the content of the investigation and the state of affairs surrounding the investigation. It was mentioned that participation is voluntary and the results are anonymously used for scientific research. The participants needed to fill in the questionnaire and the questions and answers were administered in Dutch. The questionnaire was available via a link through email.

Analysis

The scale was controlled for the content validity and reliability with a factor analysis and a reliability test in SPSS. The descriptive statistics were calculated (means, correlations and standard deviations). In order to test hypotheses regarding comparing commuting modes there has to be an effect between commuting mode and predictability and commuting stress. ANOVA's were performed to test whether there was an effect of commuting mode on the dependent variables. Eventually, post-hoc tests were used to compare means of different commuting mode groups on predictability and commuting stress. To test the mediation effect, the three step approach for testing a mediation effect of Mackinnon, Fairchild, and Fritz (2007) was used. According to Mackinnon et al. (2007) a mediation effect can only exist when there is a significant association between the independent variable and the mediator (*H1A* and *H1B*) and a significant association between the mediator variable and the dependent variable (*H2*). Furthermore, the direct effect of commuting mode on stress should be diminished when the mediating variable is added.

Results

The means, the standard deviations and the correlations of the variables investigated in this study are presented in Table 1. In accordance with the theoretical framework, Table 1 shows that predictability is negatively related with commuting stress (r = -0.58, $p < 0.01$). Furthermore, the commute duration is negatively related with predictability (r = -0.36, $p < 0.01$) and commute duration is positively related with commuting stress (r = 0.52, $p < 0.01$). Unexpectedly, commute duration is negatively related with age(r = -0.17 $p < 0.01$). This implicates that the older you get the shorter the average commute duration is. Finally, predictability is positively related with age (r= 0.17 $p < 0.01$). This implicates that older respondents perceive their commute as more predictable.

Table 1. Correlations

Measures	M	SD	1	2	3	4	5
1. Gender	1.43	0.49					
2. Age	37.04	12.25	-0.07				
3. Commute duration	53.66	36.86	0.09	-0.17**			
4. Predictability	4.13	0.69	-0.03	0.17**	-0.36**		
5. Commuting Stress	1.84	0.65	-0.08	-0.07	0.52**	-0.58**	

($p<.01$ ** $p<.05$ *)

Notes: Gender: male (1), female (2), Age: in years, commute duration in minutes total (to work and home), Predictability: mean score of 6 items 1-5. Commuting stress: mean score of 8 items 1-5.

ANOVA's were used to test whether commuting mode had an effect on predictability. This was needed in order to test whether several commuting modes differ in their predictability (*H1A* and *H1B*). Table 2 shows that commuting mode had an effect on the predictability of the commute (F =16.68, $p < 0.01$). Additional analysis (Post-hoc test), were performed in order to compare the commuting modes and their perceived predictability. Furthermore, commute duration was found to have a negative effect on predictability (F = 17.32, $p< 0.01$). Finally, age was found to have a positive effect on predictability (F = 6.04, $p < 0.05$).

Table 2. ANOVA's: way of commuting on predictability of the commute

	Predictability	
Measures	df	F
Corrected Model	5	16.94
Gender	1	2.82
Age	1	6.04*
Commute duration	1	17.32**
Commuting mode	2	16.68**
R^2		0.23

(p<.01 ** p<.05*)

Table 3 shows commuting mode had an effect on commuting stress (F = 4.02, p < 0.05). This means that there is a direct effect between these two variables. Additional analysis (Post-hoc test) is necessary to compare the several commuting modes regarding their stress level (*H4A* and *H4B*). Furthermore, Table 3 shows that the predictability of the commute had an effect on commuting stress (F = 4.90, p < 0.01). Further analysis showed that predictability had a negative effect on commuting stress (β = 0.46, p <0.01). Therefore H*2*: The lower the predictability the higher the commuter's perceived stress is accepted. Finally, control variable gender had also a significant negative effect on commuting stress (F = 9.89, p < 0.01).

Table 3. ANOVA's: way of commuting on commuting stress

	Commuting stress	
Measures	df	F
Corrected Model	42	5.28
Gender	1	9.89**
Age	1	0.17
Commute duration	1	2.58
Predictability	17	4.90**
Commuting mode	2	4.02*
Predictability*Commuting mode	2	1.37
R^2		0.56

(p<.01 ** p<.05*)

ANOVA's were used to test the mutual differences of commuting modes on predictability and commuting stress. Post Hoc test by Tukey HSD was used to test whether these differences are significant. Before analyzing variances there are some general assumptions to check. First, homogeneity of variance, test to be sure that the variability of scores for each of the groups is similar. This is tested with Levene's test, unfortunately not all ANOVAs did passed this. The direct effect of commuting mode on commuting stress violated Levene's test (Levene's F (4, 71), $p = 0.01$). This violation suggests that the variance of the dependent variable across the groups is not equal. Pallant (2010) recommends in this case setting a more stringent significance level (e.g. .01). This suggestion is adopted regarding the ANOVA tests. Secondly, the sample needs have normal distribution. However ANOVAs are reasonably robust to violations of this assumption if groups contain more than 30 respondents. Pallant (2010). This is the case in this study, so the violation of this assumption should not cause major problems.

Table 4 shows the means and the standard errors of the commuting modes were compared to find out whether they differ with respect to the dependent variables. There were statistically significant differences at $p < 0.01$ level in predictability scores for the three commuting modes: F (2,283) = 26.67, $p = 0.00$. Table 4 shows that walking/cycling (M = 27.17, SD = 3.07) significantly differs from transportation by car/motor (M = 23.83, SD = 3.93) and public transportation (M = 23.78, SD = 2.57), which confirms *H1B*. The means show that walkers and cyclist perceive higher predictability than car/motor and public transportation. However, public transportation and car/motor do not differ significantly in mean scores from each other, therefore *H1A* is rejected.

Table 4. Post-hoc tests predictability (Tukey HSD)

	Predictability	M difference	SE
Way of Commuting	Compared with		
Car/Motor	Public transportation	0.05	0.58
	Walk/ Cycle	-3.34**	0.48
Public transportation	Car/Motor	-0.05	0.58
	Walk/ Cycle	-3.38**	0.64
Walk/ Cycle	Car/Motor	3.34**	0.48
	Public transportation	3.38**	0.64

($p<.01$ ** $p<.05$*)

Table 5 shows that all three commuting modes differ significantly from each other in commuting stress (F (2,230) = 19.44, p = 0.00). The mean shows that people that walk or cycle to work (M = 12.27, SD = 2.95) perceive less commuting stress compared to car/motor commuters (M = 15.20, SD = 5.41) and commuters that use public transportation (M = 18.4, SD = 5.92). This implies that *H4B* is accepted. However, Table 5 also shows that commuters by car perceived less commuting stress than commuters that use public transportation. *H4A* stated the exact opposite, therefore *H4A* is rejected.

Table 5. Post-hoc tests commuting stress (Tukey HSD)

	Commuting stress	M difference	SE
Way of Commuting	Compared with		
Car/Motor	Public transportation	-3.23**	0.95
	Walk/ Cycle	2.92**	0.71
Public transportation	Car/Motor	3.23**	0.95
	Walk/ Cycle	6.15**	1.02
Walk/ Cycle	Car/Motor	-2.92**	0.71
	Public transportation	-6.15**	1.02

(p<.01 ** p<.05*)

The ANOVA's and Post-hoc tests show that commuting mode had an effect on predictability and that walking/cycling is perceived to be significantly more predictable than public transportation and commuting by car. Furthermore, predictability had an effect on commuting stress and the analysis showed that commuting mode had an effect on commuting stress.

The prerequisite for mediation is that there has to be an effect between variable 1 (commuting mode) and variable 2 (predictability), an effect between variable 2 (predictability) and 3 (commuting stress) and a direct effect between variable 1 (commuting mode) and 3 (commuting stress). These conditions were met, however, Table 2 it shows that only walking/cycling differs significantly on predictability. Furthermore the direct effect of commuting mode on commuting stress (F = 16.68) should be mitigated by adding the mediated variable predictability (F = 4.02). Therefore, *H3* is that entails that the effect of commuting mode on commuters stress is (partly) positively mediated by the predictability of the commute is accepted.

Discussion

This study examined the role of predictability in the relation of commuting mode related to commuting stress. This was tested with a mediation model and the commuting modes were divided in three groups; car/motor, walk/cycle and public transportation.

H1A entailed that people that commute by public transportation perceive their commute as more predictable than car commuters. This hypothesis is rejected because there were no significant differences between the two groups regarding predictability. The results support *H1B*, which implies that commuting by walking/cycling is perceived as more predictable than commuting by car or using public transportation. This study supports the assumption that the lower the predictability leads to higher commuters stress (*H2)*. These findings are consistent with the theories that confirm that predictability strongly influences the stress level. Furthermore, the results support the (partial) mediating effect of predictability in the relation between commuting mode and stress (*H3*). These findings are consistent with the theoretical framework. Finally, the results support *H4B* that assumes that walking/cycling is perceived as less stressful than commuting by public transportation or car. Car commuters experienced less stress than people that commute by public transportation which is the exact opposite of *H4A* and therefore *H4A* is rejected.

Strength of the research

This study distinguishes itself from other studies on commuting stress because active and inactive ways of commuting were taken into account. Usually the environmental research focuses on comparing commuting by train and car, while health research focuses on whether walking/cycling has effects on health related outcomes.

A notable outcome of this study is the role of the control variable commuting duration. This variable was taken into account to control whether predictability was a biased predictor for explaining stress, this was not the case. However, further analysis showed that commute duration is a salient contributor in explaining predictability. Commuting duration had a negative effect on predictability. This implies that the longer the commute takes, the less the predictability of the commute will be. Commute duration and commuting mode are related to each other in the way that a longer commute duration is more likely to occur when you travel with public transportation or car compared to walking/cycling. This could be explained by the fact that with longer commute duration, traffic congestion is more likely to occur compared to shorter commute duration.

This study shows that subjective impedance such as predictability explains commuting stress. As stated before the relation between subjective impedance and stress is inconsistent in result, however this study is in favour of a significant relation between predictability of the commute and commuting stress.

Unexpectedly, the control variables age and gender had an effect on the dependent variables. ANOVA's showed that age had a positive effect on predictability ($F = 6.04$, $p < 0.05$). This implicates that the older people perceive their commute as more predictable. An underlying reason could be that older employees work closer to their homes or that younger people are willing to commute longer to work. This is in line with the study of Langford and Glendon (2002) that found that older drivers are more adapt to potentially negative stressors. Furthermore, ANOVA's showed that gender had a negative effect on commuting stress ($F = 9.89$, $p < 0.01$). This implicates that males experienced more commuting stress than females, this contradictory with the theory regarding gender and stress in this study. Additional analysis showed that the sample contained more females who cycle/walk to work than males. In this study people that walk or cycle perceive less commuting stress than people that commute by car or public transport. This could be an explanation why females perceive less stress than males in this sample.

Unfortunately, *H1A* is rejected; no significant differences were found between car and public transportation in predictability of the commute. In the studies discussed before (e.g. Wener & Evans, 2011; Wener, Evans & Lutin, 2006) commuting by car was compared to commuting by train. In this study commuting by train was part of the category commuting by public transportation, so train is not analyzed as a separate way of commuting. Public transportation in this study entails train commuters, but also commuters by bus or metro.

Although forms of public transportation might be comparable in many ways, there could also be differences in perceived predictability between these types of transport. Metro and bus rides may take shorter commuting duration which leads to a higher predictability compared to train rides that might take longer. Another explanation is that the studies discussed before were carried out in the USA and might not be applicable for the Dutch commuting climate.

Finally, *H4A* is rejected; car commuters perceived less stress than commuters that use public transportation. This is the exact opposite of what was proposed. A possible explanation could be that car commuters have the feeling of control when driving, which could lead to less stress. Also it could be that the sample perceived public transportation in the Netherlands as very stressful. It could be that the public transportation in the Netherlands is perceived to

be more stressful compared to other countries. It might be that Dutch public transport system is more vulnerable and has more delays than other countries.

Practical and theoretical implications

This study has some practical and theoretical implications which will now be discussed.

Practical implications

For Human Resources (HR) departments it is important to have healthy employees, a commuter confronted with an unpredictable commute can be expected to respond with higher stress levels and eventually lower productivity or greater absenteeism (Koslowsky, 1995). Higher commute duration leads to lower predictability of the commute. So HR can advice employees that want a high predictable commute to consider shorten to their commute duration by moving closer to work. This study shows that walking/cycling to work is perceived as more predictable than when using car or public transportation and therefore causes less commuting stress. These results should be considered by Human Resource (HR) professionals that would like to improve their employees' mental health. HR professionals could support employees to combine public transportation with walking or cycling. For example; in case an employee commutes by train and the last part by bus, HR could suggest them to replace the bus ride by walking or cycling in the last part of their commute. They could also support this decision financially in order to make it a more attractive option.

Theoretical implications

This study has contributed to the studies concerning commuting by testing a mediation model. This model shows that predictability is a significant contributor in explaining the relation between commute by walking/cycling and commuting stress. It shows that predictability and therefore subjective impedance is a factor to take into account when studying commuting issues.

Recommendations for future research

In this study there were no significant differences found between using a car or public transportation regarding the predictability of the commute. However, this study shows that car commuters perceive their commute as less stressful than public transportation commuters. These contradictory outcomes gives reason to further investigate commute aspects like predictability and stress because it can give insights whether HR needs to support use of car or public transportation to increase their employees' mental health.

Furthermore, the mediation model can be extended to see whether differences in experienced commuting stress can lead to differences in performance related outcomes. It would be interesting to take the differentiation in predictability into account while studying the effect of stress on performance. This model could be extended with effects on productivity or absenteeism for example. HR could see the effect of different ways of commuting on performance through predictability and commuting stress. This could be a way to support and enhance active ways of commuting, financially or through other ways.

Hitherto there is little to no research regarding public transportation and other ways of commuting regarding predictability. There are studies that compare car and train commuters, however especially in the Netherlands; where public transportation is used intensively more studies are needed.

Limitations

The sample of this study was slightly unequally distributed among commuting modes. More than half of sample consisted out car/motor commuters (57%). This was due to the method of sample selection; snowball and convenience sampling can cause an unequal distribution among the several commuting modes. On the other hand, the sample distribution is relatively comparable with the distribution of commuting modes in the Netherlands (CBS, 2012).The smallest represented group (public transportation) consisted of 55 participants which was acceptable regarding conditions for ANOVA's. Furthermore, by using convenience sampling the population was a less representative reflection. Therefore, the educational background of the sample, was not representative. This could have been prevented by using random sampling.

This study had a cross-sectional design. With a longitudinal design, more data would have been available and effects over time could have been studied. Because the participants were not able to fill out additional information, relevant information might have been left out. With an additional qualitative study, the background of the answers that were given, could have been taken into account.

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Appendix 1 Questionnaire

1. Predictability scale (α = .649)

All items below are rated on a 1-5 scale of “Strongly Disagree; Disagree; Neither Agree nor disagree; Agree; Strongly Agree”

1. My commute to work rarely varies from day to day.
2. Commuting to work is consistent on a day to day basis.
3. In my daily commute to work, I typically know how long it is going to take.
4. My commute to work is unpredictable.
5. I can usually predict what time I will get to work.
6. I can usually predict what time I will be home.

Scale translated in Dutch

Alle onderstaande items worden beoordeeld op een 1-5 schaal van "Zeer mee oneens; oneens; Eens noch oneens; mee eens; Helemaal mee eens "

1. Mijn woon-werkverkeer varieert zelden van dag tot dag.
2. Mijn woon-werkverkeer is consistent op een dagelijkse basis.
3. In mijn dagelijkse woon-werkverkeer, weet ik meestal hoe lang het gaat duren.
4. Mijn woon-werkverkeer is onvoorspelbaar.
5. Ik kan meestal voorspellen hoe laat ik op het werk zal zijn.
6. Ik kan meestal voorspellen hoe laat ik thuis zal zijn.

Evans, G. W., Wener, R. E., & Phillips, D. (2002). The Morning Rush Hour Predictability and Commuter Stress. *Environment and behavior*, *34*(4), 521-530.

2. Commuters stress scale: (α = .942)

All items below are rated on a 1-5 scale of “Strongly Disagree; Disagree; Neither Agree nor disagree; Agree; Strongly Agree”

Stress items

1. Overall, commuting is stressful for me.
2. I resent the length of my commute to work.
3. My commute affects my productivity on the job
4. I resent the hassles by commute causes me.
5. In general, I feel positive about my commute to work.

Effort items

6. My commute to work is pretty easy.
7. My commute to work each day takes a lot of effort.
8. My daily commute takes little effort.

Scale translated in Dutch

Alle onderstaande items worden beoordeeld op een 1-5 schaal van "Zeer mee oneens; oneens; Eens noch oneens; mee eens; Helemaal mee eens "

Stress items

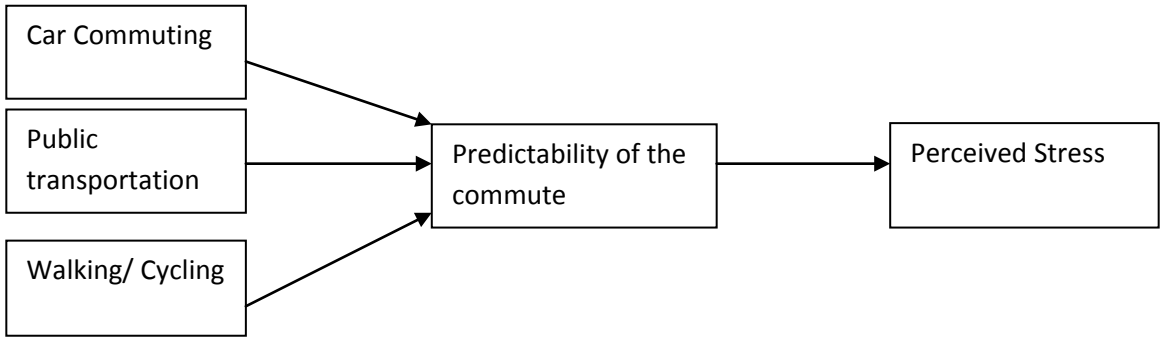
1. Over het algemeen is de reis naar mijn werk stressvol voor mij.
2. Ik heb een hekel aan de lengte van mijn reis naar het werk
3. Mijn woon- werkverkeer beïnvloedt mijn productiviteit op het werk.
4. Ik heb een hekel aan het gedoe wat mijn reis naar het werk veroorzaakt.
5. In het algemeen, voel ik me positief over mijn reis naar het werk.

Effort items

6. Mijn reis naar het werk gaat vrij makkelijk.
7. Mijn dagelijkse reis naar het werk kost veel inspanning.
8. Mijn dagelijkse reis naar het werk kost weinig inspanning.

Evans, G. W., Wener, R. E., & Phillips, D. (2002). The Morning Rush Hour Predictability and Commuter Stress. *Environment and behavior*, *34*(4), 521-530.

Appendix 2 Conceptual model



Appendix 3 Job-Demand-Control model