Travel mode choice and travel satisfaction: bridging the gap between decision utility and experienced utility

Abstract

Over the past decades research on travel mode choice has evolved from work that is informed by utility theory, examining the effects of objective determinants, to studies incorporating more subjective variables such as habits and attitudes. Recently, the way people perceive their travel has been analyzed with transportation-oriented scales of subjective well-being, namely the Satisfaction with Travel Scale. However, studies analyzing the link between travel mode choice (i.e., decision utility) and travel satisfaction (i.e., experienced utility) are limited. In this paper we will focus on the relation between mode choice and travel satisfaction for leisure trips (with travel-related attitudes and the built environment as explanatory variables) of respondents in urban and suburban neighborhoods in the city of Ghent, Belgium. The built environment and travel-related attitudes (important explanatory variables of travel mode choice) and mode choice itself affect travel satisfaction. Public transit users perceive their travel most negatively, while active travel results in the highest levels of travel satisfaction. Surprisingly, suburban dwellers perceive their travel more positively than urban dwellers, for all travel modes.

1. Introduction

Travel mode choice has been analyzed thoroughly over the past decades. Most studies try to explain it with the help of utility theories: the travel mode with the highest utility (based, among other variables, on travel costs and time) in a certain circumstance will be chosen (Domencich and McFadden 1974; McFadden 1986, 2001). This utility, however, can differ between different locations. In dense, mixed-use neighborhoods the utility of using public transit or biking can be higher than that of car use while in most other areas car use has the highest utility, resulting in a higher car use in suburban neighborhoods compared to urban neighborhoods (e.g., Cervero 2002; Schwanen and Mokhtarian 2005). More recently, however, new insights have emerged from the field of social psychology. Attitudes, lifestyle and habits seem to predict travel mode choice better than the objective variables most-often used in discrete choice models (e.g., Van Acker et al. 2010). The higher car use of suburban dwellers can be explained in some measure by the fact that car-loving persons choose to live in suburbs partly to have good car accessibility (residential self-selection), indicating that the relationship between urban form and travel behavior is not entirely a direct one, but is also influenced by travel-related attitudes (e.g., Cao et al. 2009; Ewing and Cervero 2010).

Most utility theories used in transportation studies only focus on the weight of certain attributes in the mode choice decision, i.e. on decision utility. However, utility can also refer to the experience of feelings and emotions, or experienced utility, which is closely related to satisfaction and subjective well-being (SWB) (Kahneman et al. 1997). Recently, transportation studies have analyzed the experienced utility of travelers using domain-specific scales of SWB. The Satisfaction with Travel Scale is based on which feelings travelers experience (affective component of SWB) and how they evaluate the trip they have made (cognitive component of SWB) (Ettema et al. 2010). Since it can reasonably be assumed that people try to maximize their happiness and satisfaction by making choices based on remembered experiences from previous decisions (Kahneman and Krueger 2006), it can be assumed that people will choose a travel mode that gave them the highest travel satisfaction in previous trips, at least insofar as the built environment or other considerations (e.g., income) will not constrain the use of that mode. Hence, a cyclical process between travel mode choice and travel satisfaction seems to occur.

Although travel behavior studies on decision utility (research on travel mode choice) and experienced utility (travel satisfaction research) have recently made substantial progress, this progress occurred in each area independently from the other, such that studies on travel mode choice barely refer to studies on travel satisfaction and vice versa. In this paper we will try to bridge the gap between travel mode choice, residential self-selection and travel satisfaction by conceptually outlining how travel satisfaction and mode choice are interrelated over time and exploring, for a specific moment in time, what explains satisfaction with leisure trips by a specific mode of transport. The empirical analysis in this study addresses the influence of travel mode choice on travel satisfaction, with travel-related attitudes and the residential neighborhood as explanatory variables for leisure trips in urban and suburban neighborhoods in the city of Ghent, Belgium, and therefore partly covers the cyclical process of mode choice and travel satisfaction. The paper is organized as follows. Section 2 reviews literature on travel mode choice, while Section 3 deals with literature on experienced utility and SWB. The data and methods used are presented in Sections 4 and 5. Results are shown in Section 6 and major conclusions are provided in Section 7.

2. Travel mode choice

Travel mode choice has captured the attention of academics from diverse (multi)disciplinary backgrounds, including engineering, economics, geography, transportation studies, planning studies, environmental sciences, and recently public health. However, there is no single theory on what affects travel mode choice most or what makes people prefer one travel mode over another in a specific situation (Schwanen and Lucas 2011). Utility-based models have been the dominant framework for understanding travel mode choice for a long time, particularly in engineering and economics. Most of these models are based on Random Utility Theory (RUT), developed by McFadden and colleagues from the seventies onwards (Domencich and McFadden 1974; McFadden 1986, 2001). RUT assumes that the alternative with the highest net utility, i.e. the alternative that satisfies a person's needs and desires most after accounting for its costs, will be selected. Although RUT is the most common framework for understanding travel mode choice, a range of criticisms of it have been articulated over the years (see Schwanen and Lucas (2011) for further discussion). For instance, in the context of travel mode choice, people are seldom perfectly informed about the different alternatives available to them. Furthermore, people tend to develop habits, so that after repeated positive experiences they no longer consciously trade off the costs and benefits of the available transport alternatives. If the travel mode choice for a particular trip is satisfactory, the degree of deliberation in similar choices will decrease over time.

Personal characteristics not only affect travel mode choice in a direct way; they can also affect the mode choice indirectly through longer-term choices that help to shape – and are shaped by – travel choices. One such long-term choice pertains to the residential location. This longer term decision-making process of where to live affects persons' mobility, since it constrains their activity and travel patterns in space and time, affecting possible destinations' accessibility (De Vos et al. 2013; Kwan 1999; Pirie 1979). In suburban neighborhoods, more locations are accessible within an available time budget when travelling by car compared to travelling with slower modes (Lenntorp 1976; Ritsema van Eck et al. 2005). However, this might not be the case in dense, mixed-use neighborhoods where all kinds of services and facilities are nearby and easily accessible on foot, by bike or with public transit, diminishing the advantage of car use (which often implies congestion and parking problems) (Karsten 2003). This argumentation is aligned with studies investigating the effect of the built environment on travel behavior. These studies state that people residing in urban neighborhoods travel less by car than people living in suburban neighborhoods, due to differences in density, diversity and design (Cervero 1996; Cervero and Kockelman 1997; Chen et al. 2008). However, these travel differences can be explained partly by self-selection processes, whereby people select themselves into neighborhoods which enable them to travel as much as possible with their preferred travel mode (Cao et al. 2007; De Vos et al. 2012; Handy et al. 2005; Schwanen and Mokhtarian 2005; Van Wee 2009). A car lover, for instance, will likely prefer to live in suburban neighborhoods owing to the good car accessibility these tend to offer. Neglecting these subjective processes might result in an overestimation of the effect of the built environment on mode choice in discrete choice models. According to many studies, accounting for residential self-selection tends to attenuate the effects of the built environment on travel (e.g., Cao et al. 2009; Ewing and Cervero 2010).

Studies in the San Francisco Bay Area (Schwanen and Mokhtarian 2004), in Flanders, Belgium (De Vos et al. 2012) and in Brisbane, Australia (Kamruzzaman et al. 2013) indicate that a substantial share of people do not live in their preferred residential neighborhood (residential dissonance). Both urban and suburban dissonant residents can face difficulties in travelling with their preferred travel mode. The built environment (both in urban and suburban neighborhoods) can impose restrictions on the travel mode choice, often forcing dissonant residents to use a travel mode which is not the preferred one. A suburban dissonant will often be forced to travel by car due to long distances and limited public transit services in suburban areas. An urban dissonant, on the other hand, will often have to make use of alternative transportation modes due to traffic congestion and expensive and limited parking places within urban neighborhoods (Bagley and Mokhtarian 2002; De Vos et al. 2012; Schwanen and Mokhtarian 2005).

3. Experienced utility and subjective well-being

Most utility-based studies of travel behavior consider only one type of utility – the decision utility associated with the prospective choice of an alternative. The weights of various attributes in the decision are inferred from observed choices and are used to explain these choices (Kahneman et al. 1997). However, the concept of utility has carried two different meanings throughout its history. Besides decision utility, utility can also refer to the experience of feelings and emotions (or pleasure and pain as Bentham (1789/1948) stated), resulting from the outcome of a choice (Ettema et al. 2010). This experienced utility has long been ignored in empirical studies, but experimental research of Kahneman and colleagues (Kahneman et al, 1997; Kahneman and Krueger 2006) has shown that experienced utility can be measured in real time (instant utility) and through retrospective evaluation of past episodes (remembered utility). Remembered utility can be predicted by considering the peak (most intense value) in momentary affect (instant utility) during a time-span and the momentary affect near the end of the time-span (peak-end rule); the duration of the time-span has little or no effect on the remembered utility (duration neglect). When given the choice of which time-span to repeat, individuals generally choose the activity that has the highest remembered utility. This suggests that remembered utility affects decision utility, and that people seek to maximize experienced utility or happiness – the sum of momentary utilities during a period of time (Kahneman and Krueger 2006) – by choosing an activity that minimizes pain and maximizes pleasure.

Allied to experienced utility but developed in another discipline – psychology – is the notion of subjective well-being (SWB), which is widely considered to consist of two dimensions (Diener 2009). The first is affective and refers to an individual's emotional state during an activity (i.e., intensity, frequency, and duration of positive and negative affect), the other is cognitive in nature and consists of the individual's cognitive judgment of satisfaction with a certain activity or time-span. SWB is typically measured using self-reported responses to items comprising psychometric scales. Examples include the Positive and Negative Affect Scale (PANAS) (Watson et al. 1988), the Swedish Core Affect Scale (SCAS) (Västfjäll et al. 2002; Västfjäll and Gärling 2007) and the Scale of Positive and Negative Experience (SPANE) (Diener et al. 2010). To capture the affective dimension of well-being, these scales use opposing adjectives, such as *ashamed/proud* (PANAS) and *depressed/happy* (SCAS), or ask respondents how often they experienced certain emotions during a certain time frame (SPANE). Cognitive well-being is often measured by means of the Satisfaction With Life Scale (SWLS) (Diener et al. 1985). This scale asks respondents to rate statements like 'I am satisfied with my life' on a 7-point Likert scale going from 'totally disagree' to 'totally agree'.

Scales that are derived from or inspired by SCAS, SWLS and so forth can be used to measure SWB for the domain of traveling. Thus, the Satisfaction with Travel Scale (STS) (Ettema et al. 2011) measures affect during travel and a cognitive evaluation of a trip made. The items measuring *affect* are based on the SCAS, which is based on Russell's (1980, 2003) core affect approach and assumes that emotions can be decomposed into two underlying dimensions referring to the way and extent a person is stimulated by cues from the environment: activation (varying from activated to deactivated) and valence (varying from positive to negative). In the STS a particular trip is *cognitively* evaluated with the help of three items that refer to the general quality and efficiency of the trip. Recent studies using STS indicate that the travel mode choice can affect travel satisfaction. They state that active travel results in the highest levels of travel satisfaction, while public transit users experience travel most negatively (Friman et al. 2013; Olsson et al. 2013).

To the best of our knowledge, no empirical study to date has analyzed the influence of the built environment and (travel-related) attitudes on travel satisfaction. Built environment effects in travel satisfaction can nonetheless be expected: people who do not live in their preferred type of neighborhood can experience reduced travel satisfaction because the built environment restricts use of their preferred travel mode and forces them to use an alternative mode. Dissonant residents who are able to travel with their preferred travel mode can also experience reduced travel satisfaction. A person who lives in an urban neighborhood but with a preference for suburban living and car-based travel patterns may be pleased to be able to drive a car. Yet, this person may still experience low satisfaction with car trips, for instance because living in an urban setting means that he or she often experiences congestion and parking problems.

In summary, while travel mode choice tends to depend on objective characteristics of the built environment (density, diversity and design) and travel modes (travel time and cost) as well as travel-related attitudes and other subjective factors, the experienced utility (travel satisfaction) can be affected by this decision utility (mode choice), but might also be affected by characteristics of the built environment and travel-related attitudes. In the following sections we will analyze how travel satisfaction with leisure trips, using a specific mode, is affected by a range of factors, such as the built environment and travel-related attitudes, as this is a key step in the cyclical process of mode choice and travel satisfaction.

4. Research design

4.1. *Neighborhood selection*

This study utilizes survey data collected in twelve neighborhoods in the Belgian city of Ghent (250,000 inhabitants). At the neighborhood selection stage the aim was to choose neighborhoods with typical urban characteristics versus neighborhoods with typical suburban characteristics. After screening of all neighborhoods in the city five urban and seven suburban neighborhoods were selected (Figure 1). Table 1 shows that the urban neighborhoods, which were all built before the Second World War, are all characterized by high levels of density and diversity and extensive public transit facilities. The bottom picture in Figure 2 suggests that the urban locations are characterized by relative high densities and good facilities for public transit and active travel. This contrasts with the suburban neighborhoods, which were mostly built after the Second World War and are characterized by low levels of density, diversity and public transit availability, street patterns encouraging car use (curvilinear, broad streets circumscribing large building blocks and with many T-intersections and cul-de sacs; footpaths and especially bike lanes are often lacking) and limited public transit facilities.

In socio-demographic terms, the urban neighborhoods are characterized by lower household car possession, smaller household sizes and lower median incomes, compared to suburban neighborhoods. Urban neighborhoods are also inhabited by a relatively high share of citizens from outside the EU-15 area (9.5%), while this is not the case in suburban neighborhoods (non-EU-15 citizens only account for 1.6%). Urban residents are in general younger than suburban residents, although age distribution can vary between the different urban and suburban neighborhoods. Finally, comfort levels of dwellings are considerably higher in suburban neighborhoods compared to urban neighborhoods (Table 1). While there are small variations *within* urban versus suburban neighborhoods, physical characteristics of the neighborhood and socio-demographics of the residents differ more considerably *between* urban versus suburban neighborhoods.

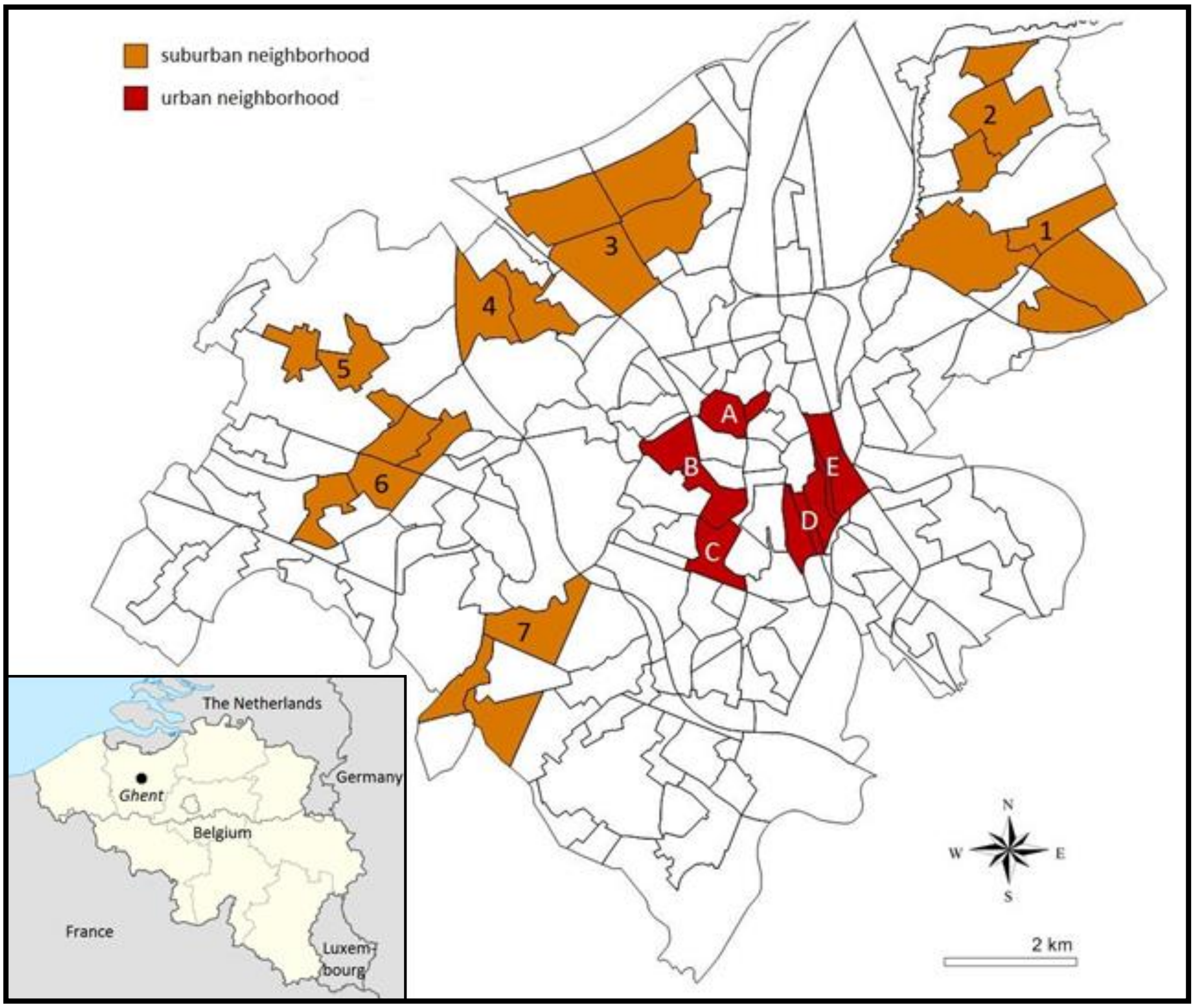

Figure 1. Distribution of neighborhoods in Ghent Region[1]

[1] Suburban neighborhoods: 1: Oostakker; 2: Oostakker-center; 3: Mariakerke/Wondelgem; 4: Mariakerke-center; 5: Drongen Luchteren/Campagne; 6: Drongen-center; 7: Sint-Denijs-Westrem. Urban neighborhoods: A: Patershol/Begijnhofdries; B: Ekkergem/Bijloke; C: Station; D: Zuid; E: Heernis/Sint-Macharius.

Table 1: Neighborhood population characteristics (Source: http://gent.buurtmonitor.be/; http://www.delijn.be/)

	Urban neighborhoods						Suburban neighborhoods							
	A	B	C	D	E	Total	1	2	3	4	5	6	7	Total
Density indicators														
Area (km^2)	0.48	0.83	0.53	0.79	0.74	3.37	4.68	1.85	4.56	1.61	0.98	1.77	2.11	17.56
Population	4,133	5,038	4,446	6,574	6,504	26,695	5,199	3,769	11,284	2,852	1,644	2,706	2,559	30,013
Population density	8,657	6,070	8,373	8,343	8,841	7,921	1,111	2,037	2,476	1,770	1,680	1,527	1,210	1,709
Building density (%)	47.9	36.1	39.0	35.7	33.0	37.2	11.4	11.2	11.8	10.6	9.5	9.6	10.6	11.0
Diversity indicators														
Number of high schools	1	4	3	5	1	14	1	0	0	1	0	0	0	2
(per km^2)	(2.1)	(4.8)	(5.7)	(6.3)	(1.4)	(4.2)	(0.2)	(0)	(0)	(0.6)	(0)	(0)	(0)	(0.1)
Number of pharmacies	7	5	9	8	3	32	1	1	1	0	1	1	1	6
(per km^2)	(14.6)	(6.0)	(17.0)	(10.1)	(4.1)	(9.5)	(0.2)	(0.5)	(0.2)	(0)	(1.0)	(0.6)	(0.5)	(0.3)
Number of restaurants	38	15	25	27	9	114	4	2	5	2	0	1	3	17
(per km^2)	(79.2)	(18.1)	(47.2)	(34.2)	(12.2)	(33.8)	(0.9)	(1.1)	(1.1)	(1.2)	(0)	(0.6)	(1.4)	(1.0)
Public transit														
Number of public transit lines[a]	5	4	7	7	4	12	2	2	2	1	1	1	2	8
Number of public transit stops	11	13	7	13	8	52	18	16	10	7	4	9	10	74
Frequency (per hour)[b]	28	21	43	54	24	54	7,5	6	8	4	2,5	4,5	7,5	7.5
Age (distribution)														
0-29 (%)	36.9	34.1	38.6	36.9	40.5	37.8	34.9	33.2	29.9	31.5	32.2	32.4	32.2	32.6
30-59 (%)	43.6	42.0	41.8	39.2	44.0	42.1	43.4	44.5	40.8	39.0	40.2	42.0	37.7	41.9
60+ (%)	19.5	23.9	19.6	24.0	15.5	20.1	21.6	22.3	29.2	29.5	27.7	25.6	30.1	25.5
Household composition														
Average household size	1.8	1.8	1.7	1.7	1.9	1.8	2.6	2.6	2.4	2.4	2.6	2.5	2.5	2.5
Household car possession														
0 (%)	38.8	34.7	32.0	35.6	38.4	35.9	8.4	11.1	9.7	11.7	6.7	11.2	9.3	9.7
1 (%)	49.5	54.2	55.6	52.7	50.6	52.5	56.7	55.6	59.8	56.0	49.6	57.2	49.3	55.5
>1 (%)	11.7	11.1	12.4	11.7	11.0	11.6	34.9	32.3	30.5	32.4	43.7	29.6	40.3	34.8
Personal income														
Median net income/year (euro)	18,870	21,940	23,550	22,060	21,310	21,550	28,980	27,590	27,570	27,770	29,590	25,920	28,020	27,880
Ethnicity														
% non-EU (15) citizen	9.3	6.1	8.6	9.5	13.1	9.5	1.6	1.0	2.2	2.2	0.5	0.6	1.0	1.6
Comfort level dwellings														
% dwellings without comfort[c]	7.2	7.3	4.9	4.3	7.0	5.9	3.0	2.4	2.4	2.4	2.9	3.8	1.7	2.6

Note: Urban neighborhoods: A: Patershol/Begijnhofdries; B: Ekkergem/Bijloke; C: Station; D: Zuid; E: Heernis/Sint-Macharius. Suburban neighborhoods: 1: Oostakker; 2: Oostakker-center; 3: Mariakerke/Wondelgem; 4: Mariakerke-center; 5: Drongen Luchteren/Campagne; 6: Drongen-center; 7: Sint-Denijs-Westrem. [a] tram lines or major city bus lines. [b] measured at most important public transit stop of the neighborhood during morning peak hours (7-9) on a normal week day. [c] dwellings without toilet and/or bathroom.

Figure 2. top: residential street in suburban neighborhood (Mariakerke/Wondelgem); bottom: residential street in urban neighborhood (Station)

4.2. *Sample recruitment and representativeness*

All addresses in the selected neighborhoods received an invitation with a link to an Internet survey on travel satisfaction, the residential location choice and well-being (November and December 2012). In total 27,780 invitations were distributed, covering about one fourth of all households in Ghent. The cover letter asked for an adult household member who participated in the residential location choice to complete the survey. Eventually, 1,807 adult persons completed the survey (response rate: 6.5%), of which 1,720 were retained after data cleaning. Although this sample recruitment method results in a rather low response rate, making it impossible to generalise the results of this study to the population of the neighborhoods, it does unable us to differentiate between urban and suburban respondents. Recent travel-related studies using similar sampling methods obtain comparable response rates (see for instance Ben-Elia et al., 2014; Cao, 2012).

Table 2 indicates that urban and suburban respondents are approximately representative with respect to the total population of the chosen urban and suburban neighborhoods. The age distribution of urban and suburban respondents is comparable with the age distribution of the total population of the chosen neighborhoods; on average, urban respondents are younger than suburban respondents. Similar to the total population of the neighborhoods, the size, income and car ownership of households in our sample is considerably higher in suburban neighborhoods than in urban neighborhoods. Furthermore, socio-demographic differences between urban and suburban respondents are noticeable (Table 2). In comparison with suburban respondents, more women and highly educated people in our sample live in urban neighborhoods.

Table 2: Sample socio-demographic statistics for urban and suburban respondents (Source: De Vos et al., 2014)

	Urban respondents (survey)	**Urban residents (reference)**	**Suburban respondents (survey)**	**Suburban residents (reference)**	**Total respondents**
Age (distribution)					
18-34 (%)	43.5	41.3	20.4	22.2	33.7
35-49 (%)	23.2	22.7	27.3	26.2	24.9
50-64 (%)	19.6	17.9	31.5	26.8	24.7
65 + (%)	13.7	18.1	20.7	24.8	16.7
Gender					
Female (%)	48.8	49.5	41.4	51.0	45.7
Education					
High educ. (university degree) (%)	82.1	N/A	70.8	N/A	77.3
Household composition					
Average household size	2.0	1.8	2.7	2.5	2.3
Household net income/month					
Low income (< 1750 euro) (%)	24.1	N/A	9.9	N/A	17.9
Avg. income (1750-3499 euro) (%)	49.3	N/A	49.4	N/A	49.4
High income (3500+ euro) (%)	26.5	N/A	40.7	N/A	32.7
Household car possession					
0 (%)	32.4	35.9	7.7	9.7	21.9
1 (%)	54.4	52.5	50.3	55.5	52.6
>1 (%)	13.2	11.6	42.3	34.8	25.5
N	991	23,279[a]	729	23,440[a]	1720
%	57.6	49.8	42.4	50.2	100

Note: [a] only adult inhabitants were taken into account

5. Methods

5.1 *Residential consonance and dissonance*

If it is to be assumed that people are likely to select themselves into a residential location where the built environment does not impose many restrictions on the use of their preferred travel mode, then it is important to establish if study participants actually live in their preferred type of residential neighborhood. Information is therefore required on participants' actual residential neighborhood, travel-related attitudes and land use preferences. The actual neighborhood can be derived from the information participants supplied when responding to the survey invitation. We assumed that travel attitudes and land use preferences could be approximated using a series of twenty questions that sought to capture attitudes toward different travel modes and certain physical land use characteristics. Half of the questions asked respondents to indicate (on a scale from 1 to 10) what their ideal neighborhood looks like, ranging from a neighborhood with good car accessibility to a peaceful neighborhood. Five statements asked to which degree respondents like to travel with five different travel modes (car; bus/tram; train; cycling; and walking) on a 5-point Likert scale. Finally, five questions asked which of the following twelve positive aspects respondents link with the use of the five travel modes: good for image; environmentally friendly; relaxing; comfortable; time saving; flexible; cheap; offering privacy; healthy; safe; reliable; possibility to perform activities during travel. Table 3 shows the average scores on these variables of respondents living in urban and suburban neighborhoods. These primary results indicate that urban respondents – compared to suburban respondents – have a more positive stance toward public transit and active travel and also prefer to live in an urban-type neighbourhood with sufficient facilities for using these preferred modes. For each travel mode we counted the number of positive aspects respondents indicated. In order to subdivide the respondents according to their land use preferences, we conducted a factor analysis (principal axis factoring, promax rotation) of these 20 variables, resulting in 7 factors (based on eigenvalues and scree plot): Built environment stimulating alternatives to cars; Pro car (accessibility); Pro public transit; Suburban built environment; Pro bicycling; Pro walking; and Urban built environment (Table 4). These factors explain 66.0% of the total variance in travel-related attitudes and land use preferences.

Table 3: Average scores of urban and suburban respondents on travel-related attitudes

	Urban respondents	**Suburban respondents**	**t-test**
What does your ideal neighbourhood look like? (ranging from 1 to 10)			
Sufficient side walks	**8.31**	8.03	**
Sufficient bike lanes	**8.06**	7.87	*
Sufficient public transit	**8.41**	8.26	*
Shops/amenities nearby	**8.13**	7.32	**
Good accessibility by car	6.65	**7.79**	**
Sufficient parking places	5.92	**6.03**	*
Sufficient privacy	6.97	**7.83**	**
Peaceful	7.89	**8.78**	**
Big dwellings and gardens	5.48	**6.57**	**
High density	**4.84**	3.86	**
Do you agree? (ranging from 1 to 5)			
I like to travel by car	2.65	**3.04**	**
I like to travel by bus or tram	2.80	2.78	
I like to travel by train	**3.56**	3.19	**
I like to travel by bike	**3.43**	3.27	**
I like to walk to my destination	**4.13**	3.66	**
Number of positive aspects linked to mode use (ranging from 0 to 12)			
Car use	3.96	**4.74**	**
Bus/tram use	**3.15**	2.33	**
Train use	**2.03**	1.86	*
Cycling	**6.52**	5.98	**
Walking	**6.32**	4.65	**

Note: * significant difference in mean at $p < 0.1$; ** significant difference in mean at $p < 0.05$.

Table 4: Pattern matrix of attitudes toward residential neighborhoods and travel modes

	Prefer built environment stimulating alternatives to cars	Pro car (accessibility)	Pro public transit	Prefer suburban built environment	Pro bicycling	Pro walking	Prefer urban built environment
What does your ideal neighborhood look like: sufficient side walks	0.93						
What does your ideal neighborhood look like: Sufficient bike lanes	0.78						
What does your ideal neighborhood look like: Sufficient public transit	0.52						
What does your ideal neighborhood look like: shops/amenities nearby	0.39						0.29
What does your ideal neighborhood look like: good accessibility by car		0.81					
What does your ideal neighborhood look like: sufficient parking places		0.67					
Number of positive aspects linked to car use		0.54					-0.46
Do you agree? *I like to travel by car*		0.50					
Number of positive aspects linked to bus and tram use			0.74				
Number of positive aspects linked to train use			0.63				
Do you agree? *I like to travel by tram or bus*			0.51				
Do you agree? *I like to travel by train*			0.46				
What does your ideal neighborhood look like: Sufficient privacy				0.82			
What does your ideal neighborhood look like: Peaceful				0.66			-0.27
What does your ideal neighborhood look like: Big dwellings and gardens				0.52			
Do you agree? *I like to travel by bike*					0.78		
Number of positive aspects linked to bicycling					0.74		
Number of positive aspects linked to walking						0.96	
Do you agree? *I like to walk*						0.32	0.31
What does your ideal neighborhood look like: High density				-0.27			0.47

Note: Factor loadings between -0.25 and 0.25 have been suppressed to enhance readability

To create groups with homogeneous travel and land use preferences, the respondents have been segmented using a cluster analysis on their scores on the seven factors. Applying the K-means cluster technique, we produced solutions for predefined numbers of clusters ranging from two to five. Based primarily on the criteria of interpretability and maintenance of statistically robust segment sizes, we selected the two-cluster solution. The centroids of both clusters (i.e., the average score of respondents in each cluster on the seven factors) are shown in Table 5. The cluster sizes are rather similar, with 53.1% (914 respondents) of the sample being allocated to the first cluster and 46.9% (806 respondents) to the second. The first cluster consists of respondents with preferences toward urban-style neighborhoods, public transit use, and cycling or walking. Respondents in the second cluster prefer travelling by car and living in suburbs. The between-cluster mean sum of squares (BMSS) indicates that, although all factors have a significant affect (at $p < 0.05$), not all factors contribute equally to the separation of the clusters.[2] Factors mainly capturing land use preferences contribute less to the cluster identification than factors mainly capturing travel mode preferences.

Table 5: Cluster centroids and between-clusters mean of squares (BMSS) (*N* = 1720)

	Cluster centers		**BMSS**	**Significance**
	Urban preferences	**Suburban preferences**		
Prefer built environment stimulating alternatives to cars	0.39	-0.45	427.3	0.00
Pro car (accessibility)	-0.45	0.51	664.2	0.00
Pro public transit	0.45	-0.51	736.7	0.00
Prefer suburban built environment	-0.16	0.18	67.7	0.00
Pro bicycling	0.42	-0.48	619.0	0.00
Pro walking	0.41	-0.47	465.9	0.00
Prefer urban built environment	0.04	-0.04	4.4	0.04

Juxtaposing participants' preferences with their actual residential neighborhood creates four groups (based on De Vos et al. 2012; Kamruzzaman et al. 2013; and Schwanen and Mokhtarian 2005): urban consonants, urban dissonants, suburban dissonants, and suburban consonants. According to Table 6, most urban respondents (611/991≈62%) have an urban land use preference, just as most suburban respondents (426/729≈58%) have an affinity for suburban neighborhoods. Consequently, most respondents (60%) live in their preferred type of residential neighborhood, while a sizable minority (40%) is experiencing residential neighborhood type dissonance. It should be cautioned that these descriptive statistics may not represent the entire population of Ghent (due both to the purposeful sampling from stereotypical neighborhoods and to nonresponse biases in the sample), but as a matter of interest, this percentage lies in between residential dissonance levels of previous studies (i.e., 24% in the San Francisco Bay Area (Schwanen and Mokhtarian 2004) and 51% in Flanders (De Vos et al. 2012) – although similar cautions apply to these studies as well).

[2] For a given variable, the BMSS is based on the distance of the cluster means from the grand mean. The larger the BMSS, the more strongly the associated variable contributes to the distinction between clusters (Mokhtarian et al. 2009).

Table 6: The amount of residential dissonance

		Actual neighborhood		
		Urban neighborhood	Suburban neighborhood	Total
Land use preferences	Urban preferences	611 (35.5%) Urban consonant	303 (17.6%) Suburban dissonant	914 (53.1%)
	Suburban preferences	380 (22.1%) Urban dissonant	426 (24.8%) Suburban consonant	806 (46.9%)
	Total	991 (57.6%)	729 (42.4%)	1720 (100%)

5.2 *Travel mode choice*

Respondents were asked to indicate which travel mode (car, train, bus/tram, bicycle or on foot) they used to reach their most recent out-of-home leisure activity. In case they used more than one travel mode to reach their destination, they were asked to indicate the travel mode which covered the longest distance. We used the most recent leisure trip (instead of asking for the travel mode they 'usually' use) because we also asked respondents to evaluate their trip (travel satisfaction, see Section 5.3). Doing so, we minimize the effect of distortions following from the delayed recall and evaluation of experiences. Leisure trips were chosen because of the assumption that mode choice is most free for these trips, especially compared to more mandatory trips such as commuting. 51.8% of the respondents travelled by car, 9.7% used public transit, 19.8% biked and 18.7% walked to their most recent leisure activity.

Figure 3 shows the travel mode choice of respondents in the four different groups. The use of public transit[3] and particularly walking seems to be affected most by the built environment; urban residents walk or use public transit more than suburban residents. Land use preferences seem to have only a limited effect on the use of these travel modes. Car use appears to be affected by both the residential neighborhood and by land use preferences; suburban residents use the car more than urban residents, just as respondents with a suburban land use preference (i.e., urban dissonants and suburban consonants) use it more than respondents with an urban land use preference (i.e., urban consonants and suburban dissonants).

Finally, bicycling also seems to be affected by both the residential neighborhood and by land use preferences because respondents with urban land use preferences cycle more than those with suburban preferences and participants in urban neighborhoods cycle more than those in suburban locations. However, preferences appear to have the stronger effect, as shown by the greater bicycle use of suburban dissonants compared to urban dissonants. That cycling is affected less strongly by the residential neighborhood than public transit use and walking may in part reflect that in the suburban neighborhoods many destinations are within cycling distance but not accessible by public transit or on foot.

[3] Bus, tram and train are combined because train use is low, especially in suburban neighborhoods.

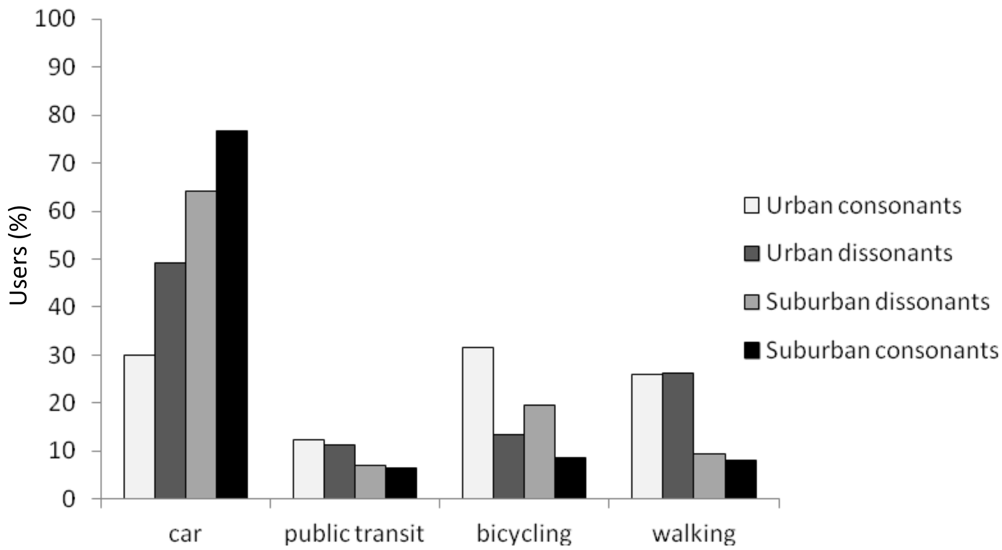

Figure 3: Travel mode choice (for the most recent leisure trip) within groups of similar preferred and actual residential neighborhood

5.3 *Travel satisfaction*

The study participants' satisfaction with the most recent leisure trip will be analyzed using the Satisfaction with Travel Scale (STS) (Ettema et al. 2011). This scale measures the affective feelings based on two dimensions (valence and activation) assessed by the Swedish Core Affect Scale (SCAS) (Västfjäll et al. 2002; Västfjäll and Gärling 2007). The endpoints of each scale are combinations of the valence and activation dimensions. Six items are used: three range from negative deactivation to positive activation (i.e., bored-enthusiastic; tired-alert; fed up-engaged) and three range from negative activation to positive deactivation (i.e., stressed - calm; worried - confident; hurried - relaxed). The cognitive evaluation of the trip is measured by three items referring to general quality and efficiency of the trip (i.e., the trip was the worst - best I can think of; the trip was very low - high standard; the trip did not work out - worked out well). For all nine items, scores vary from -3 to 3 with a higher score implying higher satisfaction.

While previous studies have worked with the three sub-scales of negative activation/positive deactivation, negative deactivation/positive activation and cognitive evaluation (e.g. Friman et al. 2013), we follow the approach advocated in De Vos et al. (2014). This study argues that a two-dimensional structure fits the STS data from Ghent better. Two factors – one affective and the other cognitive – can be extracted from the nine items using principal axis factoring and promax rotation. The first factor refers to positive feelings experienced during the trip, with the item *hurried - relaxed* loading most highly (i.e., factor loading: 0.84). The second factor refers to a positive evaluation of the trip, with the item *the trip was the worst - best I can think of* loading most highly (i.e., factor loading: 0.96). Together these factors explain 67.2% of the total variance in the data.

6. Results

6.1. *Neighborhood or preferences?*

In order to analyze the effect of the residential neighborhood and preferences toward travel and land use on travel satisfaction (i.e., feelings during the most recent leisure trip and the evaluation of this trip) by travel mode, we performed a two-factor ANOVA (Figure 4; see Table 7 for cross-tabulation of these variables). The first conclusion that can be drawn from Figure 4 is that respondents using active travel (especially walking) are most satisfied with travel, followed by car users; public transit users experience the lowest levels of travel satisfaction. These findings concur with previous research on travel satisfaction (Abou-Zeid 2009; Duarte et al. 2010; Friman et al. 2013; Olsson et al. 2012).

Table 7: Travel mode on most recent leisure trip, by residential neighborhood and preferences toward travel and land use

	Urban neighborhood		**Suburban neighborhood**	
	Urban preferences	Suburban preferences	Urban preferences	Suburban preferences
Car	183	184	194	322
Public transit	75	43	21	26
Bicycling	191	51	59	36
Walking	158	99	28	34

However, there are also differences in travel satisfaction according to residential neighborhood and preferences toward travel and land use. The level of travel satisfaction (both affect and cognitive evaluation) with car trips is mainly affected by residential neighborhood, as suburban residents are more satisfied than are urban residents. This may in part reflect restrictions the urban built environment imposes on car use (e.g., congestion). Preferences only play a limited role in the travel satisfaction of car users (Figure 4).

Travel satisfaction (i.e., affect and evaluation) of public transit users is affected by both the residential neighborhood and residential preferences. Somewhat unexpectedly, suburban residents experience public transit use more positively than urban residents. On the other hand, respondents with urban land use preferences and a positive stance toward active travel and public transit experience their public transit trip more positively than respondents with positive suburban and car attitudes. The combined effects of neighborhood and preference imply that urban consonants and especially urban dissonants experience their public transit trip very negatively while suburban dissonants have a fairly high travel satisfaction (Figure 4). The low travel satisfaction of urban residents (urban dissonants in particular) using public transit suggests that these respondents might be forced to travel by public transit (e.g., since they might not possess a car and/or distances might be too long to walk or cycle). Alternatively, public transit may be more crowded or otherwise more unpleasant in urban areas than in suburban ones, and combined with a disinclination to travel by transit on the part of urban dissonants in the first place, results in especially low satisfaction for that group.

The cognitive evaluation of cycling trips is not significantly affected by the residential neighborhood or residential preferences. Feelings perceived during cycling trips, however, are significantly affected by the residential location of respondents: suburban dwellers experience more positive feelings when cycling than urban dwellers (Figure 4). Satisfaction with walking trips to the most recent leisure activity is strongly affected by land use preferences: respondents with urban land use preferences experience their walking trip more positively than respondents with suburban preferences. Suburban dwellers also evaluate their walk more positively than their urban counterparts. As a result, urban consonants and suburban dissonants are most satisfied with their most recent leisure trip on foot while urban dissonants perceive those walk trips rather negatively.

The residential neighborhood has a significant effect on the feelings during travel for all trips combined. Suburban dwellers experience more positive feelings when travelling, compared to urban dwellers. The cognitive evaluation of the trip is affected by both the residential location and the land use preferences. Both suburban dwellers and respondents with an urban land use preference evaluate their trip more positively (Figure 4). The latter can be explained by the fact that land use preferences do not affect travel satisfaction of car drivers, while urban preferences positively affect the evaluation of public transit and walking trips. These observations indicate that for the cognitive evaluation of trips (all modes combined) there are significant interaction effects, meaning that the impact of land use preferences varies by neighborhood type. Land use preferences have important effects on travel evaluation in urban neighborhoods but not in suburban neighborhoods. Although urban dwellers in general experience their travel less positively than suburban dwellers, urban dissonants evaluate their trip even more negatively than urban consonants. Thus, residential neighborhood type dissonance has a negative effect on travel satisfaction, but only for urban dwellers.

In sum, the results suggest that both attitudes and the built environment affect satisfaction with leisure trips, although the relative importance of each differs across transport modes. Urban land use preferences result in higher levels of satisfaction on public transit and walking trips, while the urban built environment seems to reduce travel satisfaction, especially on car and public transit trips. For people walking and cycling, the suburban built environment only affects travel satisfaction to a limited degree. This suggests that urban land use constraints (e.g., congestion) are perceived to be less rigid than suburban land use constraints (e.g., long distances). If distances in suburban areas become too long, cycling and especially walking are simply not feasible anymore and people are forced to travel with another travel mode, while car use and public transit use are possible, though negatively perceived, in congested city centers.

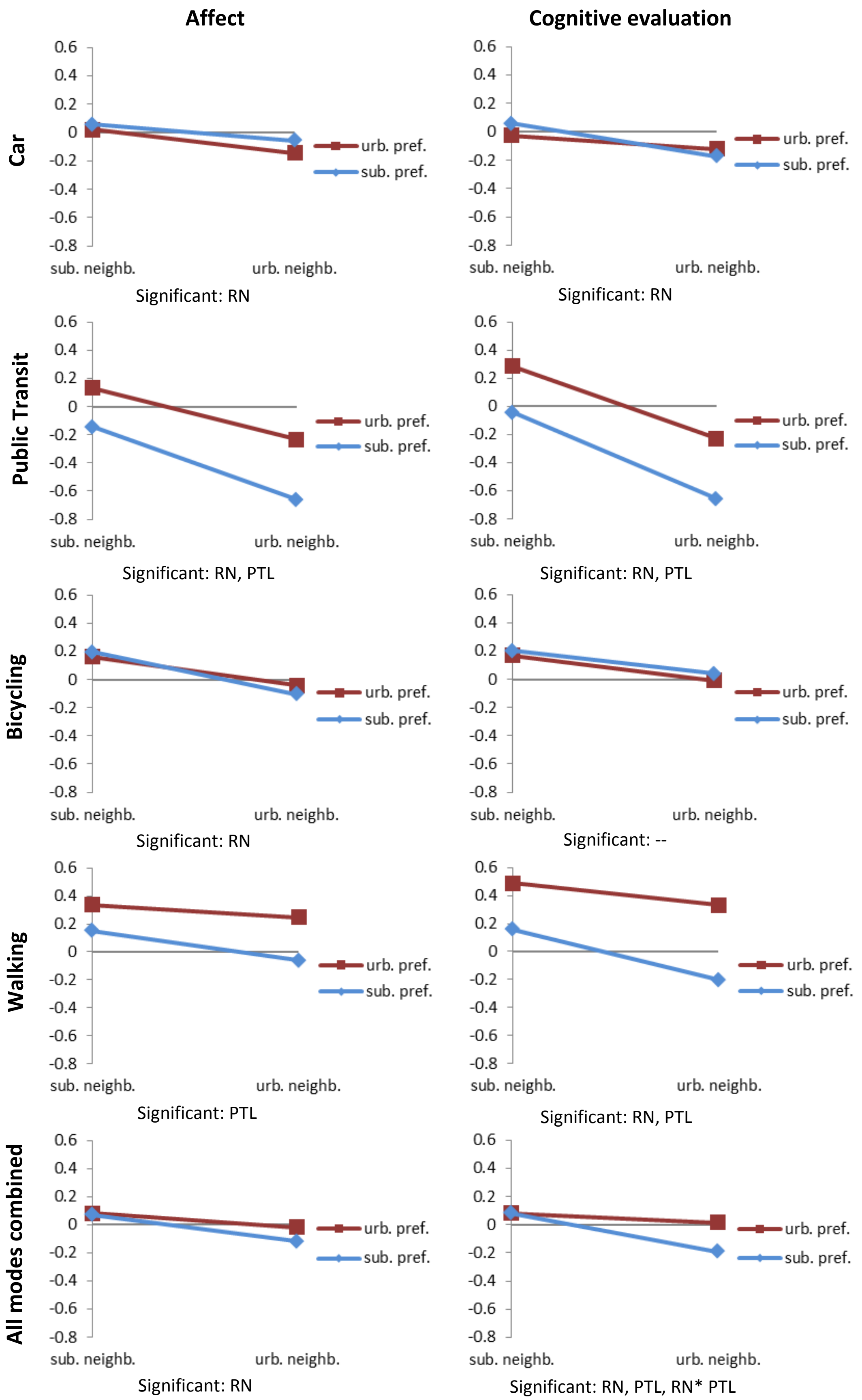

Figure 4: Mean factor scores on the constituents of travel satisfaction by residential location and preference toward travel and land use. Effects statistically significant ($p < 0.05$) in a two-way analysis of variance are listed. RN= Residential neighbourhood, PTL = Preferences toward travel and land use

6.2. *Explaining travel satisfaction*

To ascertain what affects the satisfaction when traveling with a certain travel mode, we have conducted linear regression analyses on the affective and cognitive experiences during the most recent leisure trip by mode. The following variables have been considered as candidates:

a) Neighborhood – suburban (0) versus urban (1);
b) Attitudes toward travel and land use – the seven factors in Table 4;
c) Indicators of socio-demographic background – age, gender, household income, household size, education, and employment status;
d) Indicators of transport mode access and affordability – driver's license, household car possession (i.e., number of cars available to household members), cars per household member, concessionary fares on bus/tram or train, season ticket for bus/tram or train, and car club membership; and
e) Travel distance and travel duration of the most recent leisure trip.

This has resulted in eight models in total; a forward stepwise procedure has been used to arrive at parsimonious model specifications (Tables 8-11). Adjusted R^2 values range from 0.06 (for car satisfaction) to 0.30 (for the cognitive evaluation of public transit); these are typical values for disaggregate travel behavior-related models.

The residential neighborhood has a statistically significant effect on the cognitive evaluation of leisure trips by car and public transit; all else equal, urban dwellers evaluate car trips and public transit trips more negatively than suburban respondents. In the remaining six of the eight regressions, however, the difference between urban and suburban neighborhoods – and hence presumably the built environment – is not a statistically significant influence on either component of travel satisfaction. This is rather surprising since Figure 4 indicates that travel satisfaction is higher for suburban residents than for urban residents (especially for car and public transit users). The discrepancy between the descriptive and regression analysis is due in large measure to the facts that elements like age, travel distance, household income and driver's license possession are all higher, on average, for suburban residents than for urban residents, and that satisfaction tends to be higher for those with higher values on those variables. Thus, it is primarily those differences that account for the higher satisfaction among suburban dwellers, rather than the residential location per se.

Attitudes also affect travel satisfaction. Respondents with positive attitudes toward car use, for instance, experience more positive feelings during a car trip and cognitively evaluate the trip more positively. However, the effects of attitudes are not always so straightforward. Positive *feelings* during a trip made by a given mode are not always affected by people's attitudes toward that mode. Positive feelings during the most recent leisure trip by public transit, for instance, are not affected by attitudes toward public transit, although they are correlated positively with a positive stance toward bicycling and living in a high-density neighborhood. The *cognitive evaluation* of a trip is, however, more closely related with the attitudes toward that specific mode. A person with a positive stance toward a certain travel mode will positively evaluate a trip being made with that mode. These findings are in line with the hypothesized decision making process whereby remembered utility affects decision utility: a positive evaluation of a certain chosen mode will presumably increase the probability of that mode being chosen for the next trip.[4]

Satisfaction with the most recent leisure trip is also dependent on socio-demographic background and transport mode access and affordability. Satisfaction tends to increase with age; older people have more positive feelings and a more positive evaluation of the trip for all travel modes (except for the evaluation of bicycle trips). Concessionary fares for public transit increase travel satisfaction for both public transit use and car use. The possession of a driving license and car(s) has a positive effect on travel satisfaction for active travel and public transit. This is in line with Abou-Zeid et al. (2012), who state that an increase in the possible ways of travelling can increase travel satisfaction. Emotions perceived during a car trip, however, are negatively affected by the number of cars per household member.

For leisure trips by car and public transit, we can also see that longer travel *times* reduce travel satisfaction while longer travel *distances* increase travel satisfaction. The relationship between travel time and travel satisfaction is in line with previous studies (Ettema et al. 2011, 2012; Stutzer and Frey 2008). The fact that travel satisfaction is positively affected by travel distance suggests that travel can be perceived positively and that people like, among other factors, to enjoy the scenic beauty and explore new places (Mokhtarian and Salomon 2001). However, respondents may also be partly confounding their liking for a distant (mostly less common and perhaps more attractive) activity with their liking of the travel required to reach that activity (Ory and Mokhtarian 2005). In any case, it is plausible – and interesting – that longer-distance leisure trips are perceived more positively than shorter-distance ones, while given a trip of a certain distance, completing it in a shorter time is still considered desirable.

Table 8: Linear regression models for satisfaction with the most recent leisure trip by car (*N* = 883)

	Affect			**Positive evaluation**		
	Coef.	t-stat.	Sig.	Coef.	t-stat.	Sig.
Constant	-1.07	-4.31	0.00	-1.22	-3.53	0.00
Neighborhood (urban=1)				-0.17	-2.01	0.04
Pro car (accessibility) attitude	0.14	2.95	0.00	0.21	3.80	0.00
Age	0.01	5.69	0.00	0.01	2.74	0.01
Student				0.59	2.26	0.02
Cars per household member	-0.26	-2.35	0.02			
Concessionary fares public transit				0.29	1.99	0.04
Travel time				-0.11	-2.55	0.01
Travel distance	0.05	1.99	0.02	0.15	2.71	0.01
Adjusted R^2		0.06			0.06	

[4] It has to be borne in mind that the remembered utility may also be affected by trips preceding the most recent one. The relative importance of the most recent trip is likely to differ across different types of trips, as well as the intensity of experienced events during the most recent trip (cf. peak end rule).

Table 9: Linear regression models for satisfaction with the most recent leisure trip by public transit (*N* = 165).

	Affect			Positive evaluation		
	Coef.	t-stat.	Sig.	Coef.	t-stat.	Sig.
Constant	-1.18	-4.97	0.00	-0.42	-1.37	0.18
Neighborhood (urban=1)				-0.36	-2.33	0.02
Pro bicycling attitude	0.22	2.53	0.01	0.24	3.27	0.00
Pro public transit attitude				0.30	3.66	0.00
Urban built environment attitude	0.26	2.24	0.03			
Age	0.01	2.42	0.02	0.02	3.81	0.00
Driver's license	0.23	2.08	0.04			
Concessionary fares public transit	0.85	2.96	0.00			
Travel time				-0.08	-2.39	0.02
Adjusted R^2		0.26			0.30	

Table 10: Linear regression models for satisfaction with the most recent leisure trip by bicycle (N = 337)

	Affect			Positive evaluation		
	Coef.	t-stat.	Sig.	Coef.	t-stat.	Sig.
Constant	-0.92	-5.13	0.00	-0.52	-4.24	0.00
Pro car (accessibility) attitude	0.28	4.40	0.00	0.22	3.13	0.00
Pro bicycling attitude	0.53	3.95	0.00	0.62	4.67	0.00
Urban built environment attitude	0.28	3.36	0.00	0.18	2.21	0.03
Age	0.02	4.26	0.00			
Gender (female=1)				0.23	2.10	0.04
Household car possession				0.19	2.23	0.03
Adjusted R^2		0.18			0.12	

Table 11: Linear regression models for satisfaction with the most recent leisure trip on foot (N = 339)

	Affect			Positive evaluation		
	Coef.	t-stat.	Sig.	Coef.	t-stat.	Sig.
Constant	-1.21	-4.69	0.00	-0.73	-3.27	0.01
Pro public transit attitude	0.22	3.50	0.00			
Pro bicycling attitude				0.20	3.13	0.00
Pro walking attitude				0.16	2.33	0.02
Age	0.01	2.86	0.01	0.01	2.93	0.00
Household income	0.12	3.24	0.00			
Driver's license	0.49	2.52	0.01	0.22	2.67	0.01
Adjusted R^2		0.13			0.13	

7. Conclusion

In this study we combined the well-documented research on travel mode choice with the growing transportation domain of travel satisfaction. Our empirical analysis of residents of Ghent, Belgium finds that respondents' mode choice, as well as their residential neighborhood and their travel-related attitudes, affect travel satisfaction. In line with recent research, active travel (especially walking) results in the highest levels of travel satisfaction, while public transit use is perceived most negatively. Although the effects of travel and land use preferences on travel satisfaction are in line with expectations, the effect of the residential neighborhood itself on travel satisfaction is rather surprising. Travel satisfaction is lower for urban residents than for suburban residents, even for typical urban travel modes. Although the lower travel satisfaction of urban respondents can be partly explained by socio-demographic variables (e.g., age), urban dwellers evaluate car and public transit trips more negatively than suburban dwellers, even after controlling for other variables (such as travel distance and travel time).

The evaluation of a trip is closely related to the attitudes toward the chosen mode, suggesting that the remembered utility affects decision utility: a positive evaluation of a trip made with a certain mode will presumably increase the probability of that mode being chosen for the next trip. This indicates that active travel, inducing the highest travel satisfaction levels, has the potential to decrease car trips, on the condition that average travel distances decrease and more destinations are within walking or cycling distance. From this point of view, concepts such as Compact City and Transit-Oriented Development (TOD), pursuing dense, mixed-use neighborhoods with a design oriented toward public transit and active travel, are of interest. More people walking and cycling can increase overall travel satisfaction, but also satisfaction with the activity at the destination of the trip and overall well-being (Bergstad et al. 2011; Olsson et al. 2013). Furthermore TODs, offering frequent and high-quality public transit to these compact neighborhoods, could help to increase the dramatically low travel satisfaction of (urban) public transit users, which in turn can result in an extra increase in public ridership (beyond the increase realized by the TOD itself). Recent research also indicated that people with a high accessibility to public (light rail) transit experience higher levels of satisfaction with travel (Cao, 2013).

The findings on the interdependence of mode use and travel satisfaction should be considered preliminary; there is ample room for further research. The link between travel mode choice, emotions during travel and a cognitive evaluation of a trip made could be analyzed in greater detail. To this end, feelings and emotions could be measured in real time (during a trip) using the Experience Sampling Method (ESM) (Csikszentmihalyi and Larsen 1987; Scollon et al. 2003) or Ecological Momentary Assessment (EMA) (Stone et al. 1999). Ettema and Smajic (2014), for instance, recently observed students' affective state while walking using a smartphone questionnaire. Comparing these real-time feelings with a retrospective evaluation of the trip makes it possible to examine the extent to which the peak-end rule and duration neglect apply to the context of travel satisfaction. It might also give better insight into what affects variations in travel satisfaction between different modes and between trips of urban and suburban dwellers. Although this study focuses on the influence of mode choice on travel satisfaction, travel satisfaction could also affect (future) mode choices. In order to explore this full cyclical process between mode choice and travel satisfaction, a companion paper will employ Structural Equation Modeling (SEM) to test the significance and causal direction of direct and indirect relations between mode choice, emotions during travel and a cognitive evaluation of a trip. The trip evaluation can be the outcome variable (or dependent variable) in one set of relationships (i.e., with emotions during travel) and at the same time be a predictor (or explanatory variable) of travel mode choice. Finally, future research should also analyze the link between mode choice and travel satisfaction for trips other than those to access leisure activities.

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