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Psychometric analysis of the satisfaction with travel scale

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ABSTRACT

Confirmatory factor analyses are used to examine the psychometric properties of the satisfaction with travel scale (STS), including tests of measurement invariance across urban areas and travel modes (car, public transport and slow modes). The data set consists of questionnaire responses from random samples of residents of Sweden's three largest urban areas. A theoretically supported, one-factor second-order measurement model with three separate constructs received empirical support in analyses of satisfaction with daily travel in general, satisfaction with the commute to work, and satisfaction with the commute from work in the different urban areas and with different travel modes. On the three first-order factors, high loadings were as expected obtained on scales involving cognitive evaluations (e.g. "low vs. high standard") and affective evaluations with respect to positive deactivation (e.g. "relaxed vs. stressed") and positive activation (e.g. "alert vs. tired"). Satisfaction with daily travel in general differed significantly in the largest urban area from the medium-large urban area and the smallest urban area. The results also revealed that commuters travelling by bicycle or on foot are more satisfied with their work commute than people using other travel modes.

1. Introduction

Utility-maximization theory (McFadden, 2001) is commonly used to assess travel satisfaction. In this theory it is assumed that choices people make that maximize (random) utility result in satisfaction with the outcomes of their choices. The satisfaction with travel is therefore derived from observed choices (Carrasco et al., 2005; Hess et al., 2007; Newman and Bernardin, 2010). However, this assumed correspondence between utility and satisfaction has been challenged. In alternative conceptualizations (Kahneman et al., 1997) a distinction is made between experienced utility and decision utility. Experienced utility is the satisfaction with the outcome of a choice (i.e., the degree to which it is liked or disliked), whereas decision utility is the degree to which the outcome is desired when the choice is made. Empirical research (e.g. Kahneman, 2000; Kahneman and Sugden, 2005) has convincingly shown that experienced utility frequently differs from decision utility. In a similar vein, Oliver (2010) reviews research that empirically demonstrates that attitude, as commonly defined (Ajzen, 1991; Eagly and Chaiken, 1993; Fishbein and Ajzen, 1975), does not always correspond to satisfaction.

Experienced utility theoretically directly reflects satisfaction with the service level of transport. If experienced utility differs from decision utility, in transport planning aiming to improve the service level, it is therefore advisable to measure experienced utility instead of, or as a complement to, decision utility inferred from choices. Such an argument is made by Carse (2011) in an analysis of transport policy. It is also recognized in some recent travel behavior research. For instance,

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Abou-Zeid and Ben-Akiva (2011, 2012a), Abou-Zeid et al. (2012b) have developed methods for measuring satisfaction with travel (referred to as travel happiness) as well as how such measures can be integrated in a discrete-choice modelling framework.

In this paper our aim is to propose and validate a self-report measure of travel satisfaction referred to as the satisfaction with travel scale (STS) which we claim can be generally used. Our point of departure is current research on subjective well-being (SWB) (e.g. Diener et al., 2009; Diener and Seligman, 2004). One component of SWB is people's cognitive judgments of their satisfaction with the overall quality of their lives (Diener, 1984; Diener et al., 1999; Diener and Suh, 1997; Kahneman, 1999). Such cognitive global life-satisfaction judgments are assumed to be relatively stable across time and go beyond, but implicitly include, satisfaction with life circumstances in domains such as work, family life, and leisure (Schimmack, 2008). The cognitive component of SWB is commonly measured by self-report rating scales (e.g. Arhaud-Day et al., 2005; Costa Galinha and Pais-Ribeiro, 2008) such as the Satisfaction With Life Scale (SWLS) (Diener et al., 1985; Pavot and Diener, 1993; Slocum-Gori et al., 2009). SWB also depends on context-specific factors, including various episodes or events that give rise to momentary affects (Kahneman et al., 2004). In line with this, Diener (1984) (see Busseri and Sadava, 2011, for a review) posited that SWB also has two affective components consisting of the frequency (or duration) and intensity of positive and negative affects during a given past time span.

We view satisfaction with travel as a domain-specific SWB (Ettema et al., 2010; Olsson et al., 2012a) and analogously to SWB, the STS should include cognitive and affective components. Previous studies have found a correlation between domain-specific and global SWB (Schimmack, 2008). Olsson et al. (2012b) similarly found that travel satisfaction measured as a domain-specific SWB is positively correlated with global cognitive and affective SWB. The parallel results to the research showing correlations between overall SWB and domain SWB provides support for the claim that we with our approach measure travel-related SWB. In the following we present justification for including both cognitive and affective components.

In research on customer satisfaction, measurements are made of the degree to which goods or services fulfil certain needs (Oliver, 2010). The transport system provides a service that should fulfil travel needs, and satisfaction is thus in this research defined as the degree to which it does. In a similar vein, in travel behavior research travel is generally viewed as being instrumental for participation in activities in different places (Axhausen and Gärling, 1992; Ettema and Timmermans, 1997; Jones et al., 1983). In assessing need fulfilment by means of self-reports, studies elicit cognitive judgments of satisfaction with the transport system or parts thereof. The cognitive component of satisfaction with travel is primarily related to cost, travel time, and punctuality (Eriksson et al., 2008; Fellesson and Friman, 2008). But also other factors may be important, including travel information (Friman et al., 2001; Friman and Gärling, 2001; Hensher et al., 2003). For instance, lack of information causing poor orientation and navigation in the transport system may lead to cognitive satisfaction judgments that are negative (Dziekan and Dicke-Ogenia, 2010). Cognitive judgments of satisfaction may also be influenced by events experienced when using a particular travel mode, for instance delays due to road congestion.

Some research has focused on the positive experience of travel itself (Mokhtarian and Salomon, 2001; Mokhtarian et al., 2001). In this vein Jakobsson (2007) and Steg (2005) reported psychological reasons for car use, which are connected to the emotions (feelings of pleasure-to-use and freedom) that driving a car evokes as well as symbolic (self-presentation) motives. Thus, we note that driving has positive affective consequences, which partly may explain why it is attractive. Several previous, predominantly US studies have also found that work commutes induce stress (see Novaco and Gonzales, 2009, for review). Thus, it has been found that long commute drives in congested traffic cause residual stress in the workplace (Novaco et al., 1990). Stress due to work commutes by public transport increases with the complexity of the commute (Wener et al., 2003) and with crowding in vehicles (Singer et al., 1978). A study conducted by Gatersleben and Uzzell (2007) suggested that a focus on stress may be too limited and that other emotions such as boredom and depression need to be taken into account. In the context of public transport, Stradling et al. (2007) found that satisfaction with bus services depends on a range of non-instrumental factors, including cleanliness, privacy, safety, convenience, stress, social interaction, and scenery. It was also found that pedestrians evaluate their walking trips according to many non-instrumental criteria, such as crowdedness, air quality, presence of trees and flowers, presence of beggars, and type of pavement. This seems to imply a role of affective factors. Friman et al. (1998, 2001), Friman and Gärling (2001), and Friman (2004) demonstrated that single critical incidents (incidents that deviate from users' expectations) and memory of their frequencies have an emotional impact on satisfaction with public transport. Taken together, research suggests that independent of travel mode, a travel will result in affective responses that are likely to impact on satisfaction with travel.

A first attempt to measure travel-related SWB is reported by Jakobsson Bergstad et al. (2011b, 2012) proposing a five-item self-report scale. This scale includes four cognitive and a single affective evaluation item. Since the scale only has one affective item, it is limited in its ability to tap the affective components of travel satisfaction. Therefore, Ettema et al. (2011) proposed a measure that extends the scale in the affective domain. Specifically, the measure combines cognitive judgments of travel satisfaction with measures of the activation and valence dimensions of affect. As such, it is consistent with measurement of affective well-being by the Swedish Core Affect Scale (SCAS) (Västfjäll et al., 2002). SCAS is derived from the affect circumplex (Russell, 1980, 2003) that includes two affect dimensions, valence that varies from positive to negative and activation that varies from activated to deactivated. The Positive and Negative Affect Scale (PANAS; Watson et al., 1988) has frequently been used to measure the affect components of SWB. This scale measures separately the positive and negative ends of the valence dimension. Yet, Diener and Lucas (2000) recommended that measures of affective SWB should be based on a dimensional description of affect varying in valence and activation. When measuring travel satisfaction, we similarly conjecture that it is important to measure both valence and activation. For this reason we included in STS two orthogonal measures of affect varying obliquely to valence and activation, either ranging from positive activation (e.g. enthusiastic) to negative deactivation (e.g. bored) and from positive deactivation (e.g. calm) to negative activation (e.g. stressed). We felt that these dimensions would best capture the affects experienced during travel. Note that these dimensions can be rotated to coincide with valence and activation.

The improved STS was tested in a survey of undergraduates who commute to the university (Ettema et al., 2011). The undergraduates evaluated their travel during three hypothetical days of travel to and from the university. On each occasion, they were asked to evaluate their travel during the day by means of the STS rating scales (see Section 2). It was shown that the subscales of STS (cognitive evaluation, positive activation–negative deactivation, and positive deactivation-negative activation) had satisfactory internal consistencies. An overall STS index based on the subscales furthermore discriminated between travel modes (bus vs. car), differences in travel time, high or low access to bus stops, and the number of activities in the daily agenda.

For a validation of the STS to be used in the general population of travellers, a limitation of Ettema et al. (2011) study is that it employed a small sample of university students who were asked to mentally simulate their commutes to the university. Neither was any psychometric analysis using confirmatory factor analyses performed given the small homogenous sample. Therefore, we conducted the study to be reported here by recruiting a population-based sample of work commuters in the three largest urban areas of Sweden. A survey was conducted of their actual work commutes. The data from the survey are submitted to confirmatory factor analyses to investigate the factor structure of the STS, as well as both the invariance of this factor structure and differences in STS across urban areas, commutes to and from work, and commuters using different travel modes. We hypothesize that STS will have three components or subscales: a cognitive evaluation and two affective evaluations (positive activation–negative deactivation and positive deactivation-negative activation).

2. Method

2.1. Participants

Three random samples of 1500 Swedish residents aged between 20 and 65 years living in Sweden's largest urban areas – Stockholm, Göteborg and Malmö – were obtained from the Swedish tax-payer register (State Person and Address Register or SPAR). The sampled participants were contacted by regular mail and were asked to answer a questionnaire enclosed in an envelope together with a postage-paid return envelope. The first 200 participants to return completed questionnaires received a ticket for a national lottery valued 25 Swedish Crowns (SEK) (approximately USD 5). All participants received a combined gratitude and reminder postcard that was mailed out three days after the first mailing. One week later, the questionnaire was mailed again to those who had not yet responded.

A total of 1156 questionnaires were returned. Of these, 87 were returned with an unknown address and 73 were returned blank with a comment that the recipient did not want to participate. A total of 996 questionnaires were returned with a majority of the questions answered, representing a total response rate of 24.2%.

Of the 996 participants who returned their questionnaires, 951 answered questions about their travel in general during the preceding month and were included in the following analyses. A smaller number of 791 answered questions about both their commutes to and from work, whereas 799 answered questions only about their commute to work. Table 1 shows the socio-demographic characteristics of the participants. Compared to population statistics (Statistics Sweden, 2012), cohabiting households are overrepresented in all areas. Women are also overrepresented. Other background factors are close to the overall population statistics.

2.2. Questionnaire

The questionnaire consisted of the following three modules (for a full description, see Olsson et al., 2011): (1) questions about the participant's commute to and from work or school on their last normal travel day ("a day where nothing exceptional occurred such as extreme weather or unexpected delays") followed by ratings of satisfaction with the commutes (using STS); (2) ratings of satisfaction the last month with travel in general (using STS), overall cognitive subjective well-being and affective subjective well-being; and (3) questions about socio-demographic characteristics. The following only describes the collection of the STS data to be analysed. For reports of analyses of the other data, see Olsson et al. (2012b), Ettema et al. (2012), and Suzuki et al. (2012).

In the first module, a number of questions were asked separately for the commute to work and the commute from work. The first four questions were related to objective characteristics of the commute trip: date of travel, starting time, duration, and whether the trip was made alone or in the company of someone else, either for part of the trip or for the entire trip. For each leg of the commute to and from work, participants indicated which mode they used (walk, bike, train, bus, moped/motorbike, car, tram, subway, other). Participants were classified as car users if they for the work commute used a car for at least one leg (to work $n = 291$; from work $n = 283$). In addition, participants were classified as slow-mode users if they walked or cycled for all legs of the journey (to work $n = 179$; from work $n = 207$). Finally, participants were classified as public-transport users if they used public transport for at least one leg of the journey and did not use a car for any of the other legs (to work $n = 291$; from work $n = 289$).

Table 1
Sample characteristics.

	Stockholm (large)	Göteborg (medium-large)	Malmö (small)
Population	850,000	510,000	295,000
Sample size	330	333	288
Response rate (%)	22.0	22.2	19.2
Women (%)	58.0	60.5	60.7
Missing (%)	1.8	0	0.7
Mean age (M/SD)	43.4/13.1	42.2/13.6	41.6/13.0
Missing (%)	3.6	2.4	2.0
Household type (%)			
Single households without children	21.5	21.9	19.1
Single households with children	6.7	3.6	7.2
Cohabiting households without children	32.1	29.4	30.6
Cohabiting households with children	30.6	38.4	35.4
Missing (%)	9.0	6.6	7.6
Number of years of education (M/SD)	15.1/3.5	14.7/3.6	14.6/3.5
Missing (%)	3.3	1.8	1.7
Working hours/week or more (M/SD)	36.7/13.8	35.8/14.2	34.1/14.8
Missing (%)	7.6	5.7	9.4
Employment type (%)			
Employed	72.4	68.5	68.1
Unemployed	1.5	4.8	5.9
Own business	8.2	5.1	7.3
Student	7.0	10.8	10.1
Pensioner	4.7	4.2	4.9
Homemaker	0.0	1.2	0.7
Other	3.6	5.1	2.4
Missing (%)	2.7	0.3	0.7
Monthly household gross income in '000 SEK (%)			
<42	34.2	41.4	40.3
42–64	30.0	33.6	28.1
64<	25.2	15.6	18.8
Do not know	4.5	5.4	8.0
Missing (%)	6.1	4.0	4.5
Driver's licence (%)	78.5	86.8	81.9
Missing (%)	3.9	1.8	3.8
Access to a car (%)			
Always	50.9	57.1	59.7
Several times a week	10.0	14.7	12.2
Once a week	2.1	4.2	4.5
Less than once a week	12.7	9.3	7.3
Never	19.7	13.5	13.2
Missing (%)	4.5	1.2	3.1

Three numerical seven-point rating scales in STS tapped *positive activation–negative deactivation* (STS_PA) with end-points defined by the following adjectives (translated from Swedish): very bored-very enthusiastic, very fed up–very engaged, and very tired–very alert. Another three scales tapped *positive deactivation–negative activation* (STS_PD) with end-points defined by the following adjectives: very stressed–very calm, very worried–very confident, and very hurried–very relaxed. Three additional scales tapped *cognitive evaluation* (STS_CE) with end-points defined by the following adjectives: worked very poorly–worked very well, very low standard–very high standard, and worst imaginable–best imaginable. The order between the scales was counterbalanced.

In the second module, the participants were asked to use the STS to report their satisfaction with their daily travel in general over the last month.

3. Results

3.1. Descriptives

The results were analyzed for STS Overall (satisfaction with daily travel in general the last month), STS to Work (satisfaction with the commute to work), and STS from Work (satisfaction with the commute from work). Table 2 provides correlation coefficients, means and standard deviations, with maximum internal missing values of 1.1% for any variable replaced by the mean for this variable. The table also includes standardized measures of skewness and kurtosis, suggesting that the dis-

Table 2
Correlations, means (M), standard deviations (SD), standardized skewness (Sk) and standardized kurtosis (Kur) for STS overall, STS to work, and STS from work.

	1	2	3	4	5	6	7	8	9
STS Overall (N = 951)									
1. Worked poorly–worked well									
2. Low standard–high standard	.65								
3. Worst imaginable–best imaginable	.73	.70							
4. Stressed–calm	.53	.48	.54						
5. Worried–confident	.60	.53	.60	.70					
6. Hurried–relaxed	.53	.46	.56	.76	.71				
7. Bored–enthusiastic	.58	.48	.53	.54	.48	.52			
8. Fed up–engaged	.53	.52	.57	.49	.49	.57	.73		
9. Tired–alert	.53	.49	.53	.61	.57	.62	.61	.61	
M	1.29	0.91	1.02	0.60	1.00	0.63	0.46	0.38	0.44
SD	1.28	1.19	1.13	1.47	1.29	1.37	1.20	1.36	1.15
Sk	−.71	−.14	−.13	−.23	−.35	−.14	−.15	−.22	.04
Kur	.31	−.18	−.05	−.65	−.04	−.39	.23	−.22	.41
STS to Work (N = 799)									
1. Worked poorly–worked well									
2. Low standard–high standard	.47								
3. Worst imaginable–best imaginable	.59	.57							
4. Stressed–calm	.45	.36	.37						
5. Worried–confident	.45	.43	.48	.55					
6. Hurried– relaxed	.45	.37	.46	.69	.65				
7. Bored–enthusiastic	.33	.40	.39	.31	.28	.34			
8. Fed up–engaged	.36	.44	.50	.33	.35	.46	.64		
9. Tired–alert	.29	.39	.33	.35	.37	.42	.43	.44	
M	1.76	0.90	1.08	0.76	1.25	0.78	0.39	0.33	0.38
SD	1.38	1.25	1.24	1.57	1.40	1.47	1.18	1.56	1.08
Sk	−1.03	−.04	−.19	−.21	−.43	−.15	−.14	−.14	.23
Kur	.46	−.23	−.13	−.75	−.48	−.76	.77	−.62	1.11
STS from Work (N = 791)									
1. Worked poorly–worked well									
2. Low standard–high standard	.56								
3. Worst imaginable–best imaginable	.67	.63							
4. Stressed–calm	.44	.38	.45						
5. Worried–confident	.51	.46	.54	.60					
6. Hurried–relaxed	.50	.44	.53	.74	.69				
7. Bored–enthusiastic	.38	.43	.39	.36	.33	.36			
8. Fed up–engaged	.44	.48	.55	.35	.44	.45	.59		
9. Tired–alert	.30	.41	.35	.31	.32	.34	.42	.43	
M	1.49	0.80	0.94	0.87	1.16	0.90	0.54	0.42	−0.01
SD	1.40	1.27	1.26	1.53	1.36	1.40	1.31	1.13	1.56
Sk	−.70	.06	−.16	−.30	−.34	−.18	−.21	.19	.05
Kur	−.17	−.33	−.10	−.62	−.35	−.53	.29	.89	−.58

tributions were flat and negatively skewed; however, with two exceptions (worked very poorly, very fed up, STS to Work), the measures fell inside an acceptable range of −1 to +1. Besides, in the confirmatory factor analyses reported below, the asymptotic distribution free estimation method was used.

3.2. Confirmatory factor analysis

Confirmatory factor analysis (CFA) was performed with Amos 19.0 to test the second-order factor model displayed in Fig. 1. If this model fits the data, the first-order factor's loading on the three second-order factors could be interpreted as components of a higher-order construct of global satisfaction with travel (*STS_Global*). One rationale for choosing a second-order factor model is that the first-order factors are substantially and similarly correlated. In the analyses of STS Overall, STS to Work and STS from Work, reported below, the hypothesized model is compared to a one-factor model.

3.2.1. STS overall

A one-factor model resulted in an unsatisfactory fit: χ^2 = 267.38, df = 27, p = .01, NFI = 0.65, CFI = 0.67, and RMSEA = 0.10. In contrast, the model specified in Fig. 1 resulted in a better, but still not quite satisfactory, fit: χ^2 = 141.12, df = 24, p = .01, NFI = 0.82, CFI = 0.84, and RMSEA = 0.07. Estimating co-variances between some of the errors associated with the measured variables[1], as suggested by the modification indices, achieved a substantial improvement in model fit: χ^2 = 56.35, df = 18,

[1] Error covariances between measured variables are stochastic dependencies that have an unknown source, for instance that two rating scales are close to each other in the response form or similar. They have no bearings on the measurement model.

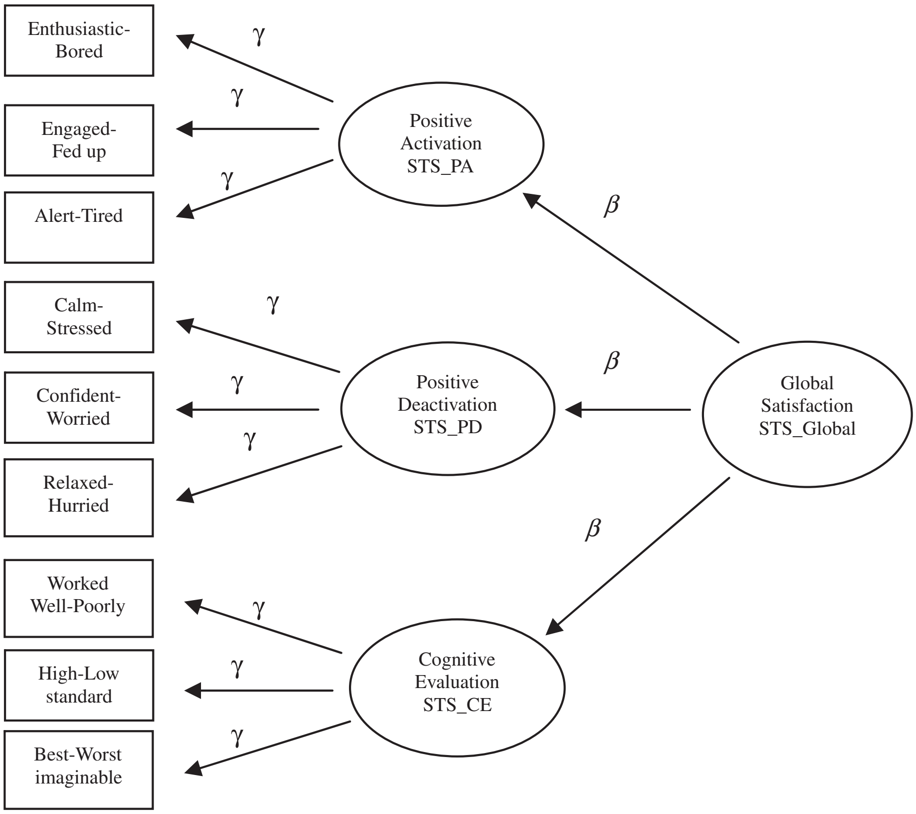

Fig. 1. Proposed measurement model.

p = .01, NFI = 0.93, CFI = 0.95, and RMSEA = 0.05. The parameter estimates in Table 3 show that the paths from the cognitive evaluation (STS_CE), positive activation (STS_PA) and positive deactivation (STS_PD) to global satisfaction (STS_Global) are positive and significant.

3.2.2. STS to work

A one-factor model again resulted in an unsatisfactory fit: χ^2 = 654.31, df = 27, p = .01, NFI = 0.79, CFI = 0.80, and RMSEA = 0.17. A second-order factor model fitted better but was still unsatisfactory: χ^2 = 114.81, df = 24, p = .01, NFI = 0.84, CFI = 0.87, and RMSEA = 0.07. Estimating error co-variances, as suggested by the modification indices, resulted in a substantial improvement in model fit: χ^2 = 49.78, df = 17, p = .01, NFI = 0.93, CFI = 0.95, and RMSEA = 0.05. As Table 3 shows, the paths from the STS_CE, STS_PA, and STS_PD to STS_Global are positive and significant.

3.2.3. STS from work

A one-factor model resulted in an unsatisfactory fit: χ^2 = 216.51, df = 27, p = .01, NFI = 0.66, CFI = 0.69, and RMSEA = 0.09, whereas the second-order factor model resulted in a fit that was somewhat improved but still unsatisfactory: χ^2 = 77.41, df = 24, p = .01, NFI = 0.88, CFI = 0.91, and RMSEA = 0.05. Estimating error co-variances, as suggested by the modification indices, resulted in a substantial improvement in model fit: χ^2 = 41.38, df = 20, p = .03, NFI = 0.94, CFI = 0.97, RMSEA = 0.04. As Table 3 shows, the paths from the STS_CE, STS_PA and STS_PD to STS_Global are positive and significant.

3.3. Construct equivalence and mean differences between urban areas

Additional analyses were conducted to determine whether the factor structures for STS Overall, STS to Work and STS from Work, respectively, are invariant across the three different urban areas. This was accomplished by the procedure described by Byrne (2010). In a baseline model (M1) parameters were first simultaneously estimated for all urban areas, implying that no parameters were constrained to be equal. A second model (M2) constrained all parameters of the indicator variables to be equal. Since the χ^2 values shown in Table 4 are not significant at p = .05, it is concluded that the parameters do not differ across the urban areas (Cudeck and Browne, 1983; MacCallum et al., 1992).

Second-order factor models for STS Overall, STS to Work, and STS from Work were calculated separately for each urban area, resulting in similar factor structures (Table 5). An exception is STS from Work in Malmö, where one scale (very low

Table 3
Parameter estimates and *t*-statistics for structural models of STS overall, STS to work and STS from work.

Latent variables	Variables	β			γ			t		
		STS Overall	STS to Work	STS from Work	STS Overall	STS to Work	STS from Work	STS Overall	STS to Work	STS from Work
STS_PA		.91	.76	.81				20.3*	11.6*	12.0*
	Bored				.78	.72	.71	21.0*	11.9*	14.9*
	Fed up				.81	.90	.83	20.9*	15.6*	15.5*
	Tired				.79	.67	.59			
STS_PD		.91	.79	.80				20.9*	15.3*	17.2*
	Stressed				.86	.77	.81	37.8*	22.5*	25.8*
	Worried				.84	.76	.81	31.3*	25.9*	29.8*
	Hurried				.88	.88	.91			
STS_CE		.89	.91	.91						
	Poorly				.83	.71	.78	32.1*	17.4*	26.6*
	Low standard				.78	.72	.73	30.0*	16.9*	22.2*
	Worst				.88	.78	.87			

Note: β = path coefficients corresponding to the relations between latent variables; γ = path coefficients corresponding to the relations from measurement variables to latent variables.
* $p < .05$.

Table 4
Goodness-of-fit statistics for tests of multigroup invariance across urban areas.

Concept	Model	Comparison	X^2	df	Δx^2	Δdf	Statistical significance
STS overall							
	M1. Baseline model (no equality constraints imposed)	–	179.4	66	–	–	–
	M2. Measurement weights (factor loadings constrained equal)	M2 versus M1	190.9	78	11.5	12	NS
STS to work							
	M1. Baseline model (no equality constraints imposed)	–	193.1	66	–	–	–
	M2. Measurement weights (factor loadings constrained equal)	M2 versus M1	206.3	78	13.2	12	NS
STS from work							
	M1. Baseline model (no equality constraints imposed)	–	140.9	66	–	–	–
	M2. Measurement weights (factor loadings constrained equal)	M2 versus M1	159.4	78	18.5	12	NS

Note: Δx^2 = Difference in X^2 values between models; Δdf = difference in number of degrees of freedom between models.

Table 5
Overall model fits for STS overall, STS to work, and STS from work in urban areas (Malmö, Göteborg and Stockholm).

Urban area	STS Overall	STS to work	STS from work
Malmö	x^2 = 36.7, df = 22, p = 0.03, NFI = 0.85, CFI = 0.93, RMSEA = 0.05	x^2 = 39.3, df = 21, p = 0.01, NFI = 0.84, CFI = 0.91, RMSEA = 0.06	x^2 = 29.4, df = 17, p = 0.04, NFI = 0.88, CFI = 0.94, RMSEA = 0.06[a]
Stockholm	x^2 = 34.1, df = 21, p = 0.04, NFI = 0.91, CFI = 0.96, RMSEA = 0.04	x^2 = 34.9, df = 21, p = 0.03, NFI = 0.84, CFI = 0.97, RMSEA = 0.05	x^2 = 30.2, df = 24, p = 0.18, NFI = 0.88, CFI = 0.97, RMSEA = 0.03
Göteborg	x^2 = 27.5, df = 20, p = 0.12, NFI = 0.93, CFI = 0.98, RMSEA = 0.03	x^2 = 37.4, df = 22, p = 0.02, NFI = 0.90, CFI = 0.95, RMSEA = 0.05	x^2 = 36.2, df = 23, p = 0.04, NFI = 0.88, CFI = 0.95, RMSEA = 0.05

[a] One item (low/high standard) is excluded.

standard–very high standard) had to be excluded to achieve satisfactory results. Table 6 presents the parameter estimates for each model. Inspection of the estimates reveals that the paths from STS_PA, STS_PD and STS_CE to STS_Global in each model and urban area were positive and significant.

Tests were conducted to determine whether the means on the latent factors obtained by CFA were significantly different for the different urban areas. Equality constraints were imposed on item intercepts and the factor intercepts were for one of the samples set to zero. As a result, the estimated latent means for the other groups represent the mean differences between groups. Three models were estimated separately, for STS Overall, STS to Work and STS from Work, in order to make all possible comparisons: Model M1 for Stockholm versus Göteborg, model M2 for Stockholm versus Malmö, and model M3 for Göteborg versus Malmö. Fit statistics were acceptable for each model (see Table 8). Stockholm had a significantly lower mean on overall satisfaction than Göteborg and Malmö. No differences were detected in satisfaction to and from work.

Table 6
Parameter estimates and *t*-statistics for structural models of STS overall, STS to work and STS from work in three urban areas (Malmö, Göteborg and Stockholm).

Latent variables	Variables	β			γ			t		
		Malmö	Göteborg	Stockholm	Malmö	Göteborg	Stockholm	Malmö	Göteborg	Stockholm
STS overall										
STS_PA		.90	.88	.88				14.5*	14.1*	14.1*
	Bored				.84	.84	.84	15.3*	16.3*	16.3*
	Fed up				.90	.89	.89	15.8*	16.2*	16.2*
	Tired				.90	.82	.82			
STS_PD		.96	.94	.94				18.8*	14.4*	14.4*
	Stressed				.87	.89	.89	26.7*	29.2*	29.2*
	Worried				.88	.85	.85	23.5*	23.0*	23.0*
	Hurried				.94	.87	.87			
STS_CE		.92	.86	.86						
	Poorly				.88	.83	.83	20.8*	21.6*	21.6*
	Low standard				.79	.82	.82	20.2*	20.5*	20.5*
	Worst				.88	.90	.90			
STS to work										
STS_PA		.76	.83	.82				6.7*	6.9*	7.4*
	Bored				.74	.78	.77	8.7*	9.0*	9.8*
	Fed up				.88	.87	.85	10.4*	9.3*	9.3*
	Tired				.75	.60	.58			
STS_PD		.77	.74	.84				8.8*	9.3*	10.2*
	Stressed				.78	.80	.75	12.5*	16.9*	14.7*
	Worried				.80	.76	.72	15.3*	15.8*	15.5*
	Hurried				.90	.90	.89			
STS_CE		.93	.92	.84						
	Poorly				.78	.68	.63	9.2*	15.5*	10.9*
	Low standard				.79	.78	.74	9.2*	11.9*	12.1*
	Worst				.71	.87	.82			
STS from work										
STS_PA		.76	.92	.78				7.4*	9.0*	6.3*
	Bored				.79	.67	.68	8.3*	10.3*	8.3*
	Fed up				.79	.82	.93	8.7*	11.2*	8.4*
	Tired				.64	.68	.53			
STS_PD		.85	.85	.79				9.5*	12.3*	9.2*
	Stressed				.86	.77	.85	14.4*	20.1*	20.7*
	Worried				.78	.85	.82	16.7*	20.7*	19.0*
	Hurried				.89	.93	.90			
STS_CE		.95	.90	.92						
	Poorly				.88	.78	.70	13.4*	20.0*	12.8*
	Low standard				–[a]	.73	.78	–[a]	13.9*	14.0*
	Worst				.82	.89	.89			

Note: β = path coefficients corresponding to the relations between latent variables; γ = path coefficients corresponding to the relations from measurement variables to latent variables.
* $p < .05$.
[a] Variable excluded from the analysis.

An alternative approach was taken by averaging across scales to yield four STS indices corresponding to STS_Global, STS_PA, STS_PD and STS_CE. Table 7 reports the Cronbach's αs, means and standard deviations on all the four indexes for each urban area. All indexes have acceptable Cronbach's αs (⩾.70). Bonferonni-corrected independent *t*-tests were performed of the mean differences between urban areas. Stockholm had a lower mean on satisfaction with daily travel in general than Göteborg and Malmö. There were no differences between STS to and from work.

3.4. Construct equivalence and mean differences between travel modes

Analyses were also conducted to determine whether the factor structures of STS to Work and STS from Work were invariant across the different travel modes (public transport, car and slow modes) following the same procedure as described above. Since the differences in χ^2 compared to the baseline model also in this case were not significant at $p = .05$ (see Table 9), it is concluded that the factor loadings do not differ across travel modes.

Second-order factor models for STS to and from work were calculated separately for each travel mode (Table 10), with the results revealing a similar factor structure for all travel modes. Table 11 presents parameter estimates for each model. Inspection of the estimates reveals that the paths from STS_PA, STS_PD and STS_CE to STS_Global were positive and significant in all models.

Three models were then estimated separately for STS to Work by public transport, car and slow modes, and for STS from Work by public transport, car and slow modes. This enabled all possible comparisons: Model M1 for public transport versus

Table 7
Correlations, means (M), standard deviations (SD) and Cronbach's αs for STS overall, STS to work, and STS from work decomposed into STS_Global, STS_CE, STS_PA and STS_PD for total sample and for subsamples in three urban areas (Malmö, Göteborg and Stockholm).

	Total sample					Stockholm					Göteborg					Malmö				
	α	1	2	3	4	α	1	2	3	4	α	1	2	3	4	α	1	2	3	4
STS overall																				
1. STS_Global	0.92					0.91					0.93					0.94				
2. STS_CE	0.87	0.87				0.86	.87				0.88	.88				0.87	.88			
3. STS_PD	0.89	0.90	0.67			0.88	.87	.61			0.90	.90	.67			0.88	.93	.74		
4. STS_PA	0.84	0.88	0.67	0.69		0.81	.85	.64	.59		0.82	.89	.69	.70		0.89	.90	.67	.78	
M		0.75	1.07	0.74	0.43		0.64_{a}	1.00_{b}	0.62_{a}	0.30_{a}		0.81_{b}	1.12_{a}	0.87_{b}	0.44_{ab}		0.80_{ab}	1.10_{b}	0.74_{ab}	0.55_{b}
SD		1.00	1.07	1.25	1.08		0.94	1.04	1.22	1.01		0.98	1.03	1.23	1.03		1.09	1.14	1.29	1.20
STS to work																				
1. STS_Global	0.87					0.86					0.88					0.87				
2. STS_CE	0.78	.84				0.77	.82				0.80	.80				0.77	.87			
3. STS_PD	0.84	.86	.59			0.82	.87	.57			0.85	.86	.58			0.84	.85	.62		
4. STS_PA	0.73	.80	.55	.51		0.71	.81	.51	.57		0.71	.84	.56	.50		0.77	.80	.58	.50	
M		0.85	1.25	0.93	0.37		0.79_{a}	1.21_{a}	0.82_{a}	0.35_{a}		0.89_{a}	1.29_{a}	1.02_{a}	0.36_{a}		0.86_{a}	1.24_{a}	0.95_{a}	0.40_{a}
SD		0.95	1.08	1.29	1.04		0.91	0.98	1.25	1.04		0.97	1.10	1.36	1.05		0.97	1.09	1.27	1.10
STS from work																				
1. STS_Global	0.88					0.88					0.88					0.89				
2. STS_CE	0.83	.87				0.83	.85				0.82	.87				0.83	.88			
3. STS_PD	0.86	.85	.62			0.88	.86	.60			0.87	.83	.59			0.83	.87	.67		
4. STS_PA	0.73	.81	.58	.49		0.71	.79	.53	.49		0.73	.81	.62	.46		0.76	.82	7.58	.54	
M		0.79	1.08	0.98	0.32		0.76_{a}	1.08_{a}	0.93_{a}	0.27_{a}		0.80_{a}	1.07_{a}	1.03_{a}	0.31_{a}		0.81_{a}	1.09_{a}	0.96_{a}	0.38_{a}
SD		0.98	1.13	1.27	1.09		0.94	1.09	1.27	1.01		0.97	1.12	1.24	1.10		1.04	1.19	1.29	1.15

Note: Different subscripts indicate that the mean differences are significant in *t*-tests at $p = .05$.

Table 8
Mean differences on latent constructs across urban areas separately for STS overall, STS to work and STS from work.

Model	Urban area	Statistics	STS overall	STS to work	STS from work
	Stockholm (reference)		0.0	0.0	0.0
M1	Göteborg	$\chi2$	126.2, df = 59**	133.3, df = 57**	130.7, df = 59**
		NFI	0.97	0.94	0.94
		CFI	0.98	0.97	0.97
		RMSEA	0.04	0.05	0.05
		Mean estimate (ME)	0.15	0.12	0.60
		Standard error (SE)	0.07	0.09	0.09
		Test statistic (TE)	2.30*	1.39	0.65
M2	Malmö	$\chi2$	176.5, df = 74**	165.8, df = 74**	177.0, df = 72**
		NFI	0.95	0.92	0.93
		CFI	0.97	0.95	0.96
		RMSEA	0.05	0.05	0.05
		ME	0.14	0.08	0.04
		SE	0.07	0.09	0.10
		TE	1.98*	0.88	0.40
	Göteborg (reference)		0.0	0.0	0.0
M3	Malmö	$\chi2$	144.9, df = 59**	135.4, df = 57**	94.2, df = 59**
		NFI	0.97	0.94	0.96
		CFI	0.98	0.96	0.99
		RMSEA	0.05	0.05	0.03
		ME	−0.03	−0.06	−0.03
		SE	0.07	0.09	0.10
		TE	−0.42	−0.63	−0.26

* $p < .01$.
** $p < .01$.

Table 9
Goodness-of-fit statistics for tests of multigroup invariance across travel modes.

Concept	Model	Comparison	X^2	DF	Δx^2	Δdf	Statistical significance
STS to work							
	M1. Baseline model (no equality constraints imposed)	–	293.68	87	–	–	–
	M2. Measurement weights (factor loadings constrained equal)	M2 versus M1	303.36	93	9.7	6	NS
STS from work							
	M1. Baseline model (no equality constraints imposed)	–	191.24	72	–	–	–
	M2. Measurement weights (factor loadings constrained equal)	M2 versus M1	206.68	84	15.4	12	NS

Note: Δx^2 = Difference in X^2 values between models; Δdf = difference in number of degrees of freedom between models.

Table 10
Overall model fits for STS to work and STS from work by car, public transport and slow modes (walking or cycling).

Travel mode	STS to work	STS from work
Car users	x^2 = 37.1, df = 20, p = 0.01, NFI = 0.97, CFI = 0.99, RMSEA = 0.05	x^2 = 35.8, df = 22, p = 0.03, NFI = 0.97, CFI = 0.98, RMSEA = 0.05
Public transport	x^2 = 32.5, df = 18, p = 0.02, NFI = 0.97, CFI = 0.98, RMSEA = 0.05	x^2 = 38.8, df = 22, p = 0.03, NFI = 0.97, CFI = 0.99, RMSEA = 0.05
Slow modes	x^2 = 27.2, df = 21, p = 0.10, NFI = 0.95, CFI = 0.99, RMSEA = 0.05	x^2 = 36.2, df = 21, p = 0.02, NFI = 0.96, CFI = 0.98, RMSEA = 0.06

car users, model M2 for public transport versus slow-mode users, and model M3 for car versus slow-mode users. Table 12 shows that car and slow-mode users scored significantly higher on STS_Global than public-transport users. The results also revealed a significant difference between car users and slow-mode users. Commuters travelling by bike or walking scored higher than those using other modes.

The STS scales were summed and averaged to yield four STS indices for each travel mode corresponding to STS_Global, STS_PA, STS_PD and STS_CE. Table 13 reports Cronbach's αs, means and standard deviations on all the four indices for each travel mode. Cronbach's αs were acceptable (⩾.67). Bonferonni-corrected independent *t*-tests were performed on the mean differences between travel modes. For STS to work public transport users had a significantly lower mean than car users and slow-mode users on all four indexes. Also for STS from work, public transport users reported less STS_PA than car users and slow-mode users. All users differed in STS_PA for the commute from work: public transport users had lower mean and slow-mode users higher mean than car users.

Table 11
Parameter estimates and *t*-statistics for structural models for STS to work and STS from work by car, public transport (PT) and slow modes (walking or cycling).

Latent variables	Variables	β			γ			T		
		Car	PT	Slow modes	Car	PT	Slow modes	Car	PT	Slow modes
STS to work										
STS_PA		.72	.81	.77				7.8*	5.4*	5.9*
	Bored				.74	.68	.67	9.7*	6.8*	6.6*
	Fed up				.81	.87	.86	10.0*	7.0*	7.7*
	Tired				.64	.45	.75			
STS_PD		.85	.69	.77				9.7*	7.5*	6.4*
	Stressed				.80	.69	.76	17.1*	11.0*	10.6*
	Worried				.80	.65	.78	17.2*	10.4*	10.8*
	Hurried				.92	.90	.84			
STS_CE		.87	.84	.95						
	Poorly				.78	.71	.56	13.7*	10.5*	6.3*
	Low standard				.67	.70	.72	11.8*	10.3*	7.4*
	Worst				.85	.75	.67			
STS from Work										
STS_PA		.67	.67	.74				7.04*	7.04*	6.2*
	Bored				.65	.65	.64	6.6*	6.6*	7.3*
	Fed up				.82	.82	.88	6.8*	6.8*	8.2*
	Tired				.48	.48	.59			
STS_PD		.71	.71	.84				5.27*	5.27*	7.6*
	Stressed				.77	.77	.80	14.3*	14.3*	12.1*
	Worried				.78	.78	.68	14.4*	14.4*	10.4*
	Hurried				.88	.88	.87			
STS_CE		.92	.92	.90						
	Poorly				.75	.75	.76	12.4*	12.4*	10.7*
	Low standard				.72	.72	.76	12.1*	12.1*	11.0*
	Worst				.83	.83	.80			

Note: β = path coefficients corresponding to the relations between latent variables; γ = path coefficients corresponding to the relations from measurement variables to latent variables.
* $p < .05$.

Table 12
Mean differences on latent constructs across travel modes separately for STS to work and STS from work.

Model	Travel mode	Statistics	STS to Work	STS from Work
	Public transport (reference)		0.0	0.0
M1	Car users	$\chi 2$	137.9, df = 50**	123.9, df = 46**
		NFI	0.94	0.96
		CFI	0.96	0.97
		RMSEA	0.06	0.05
		Mean estimate (ME)	−0.40	−0.52
		Standard error (SE)	0.08	0.10
		Test statistic (TE)	−4.84*	−5.49*
M2	Slow modes	$\chi 2$	128.5, df = 56**	137.8, df = 58**
		NFI	0.92	0.93
		CFI	0.95	0.96
		RMSEA	0.05	0.05
		ME	−0.78	−0.82
		SE	0.10	0.10
		TE	−8.08*	−8.08*
	Car users (reference)		0.0	0.0
M3	Slow modes	$\chi 2$	160.9, df = 69**	128.9, df = 56**
		NFI	0.92	0.95
		CFI	0.95	0.97
		RMSEA	0.05	0.05
		ME	−0.31	−0.30
		SE	0.10	0.09
		TE	−3.25*	−3.24*

* $p < .05$.
** $p < .01$.

3.5. Discussion

The main purpose of the present study was to evaluate the psychometric properties of the satisfaction with travel scale (STS). Consistent with the theoretical model proposed by Ettema et al. (2010) and research on subjective well-being (Busseri and

Table 13
Means (M), standard deviations (SD) and Cronbach's αs on STS to work, and STS from work decomposed into four indexes (STS_Global, STS_CE, STS_PA, STS_PD) for car users, public transport users and users of slow modes (walking or cycling).

	Car users					Public transport					Slow modes				
	α	1	2	3	4	α	1	2	3	4	α	1	2	3	4
STS to work															
1. STS_Global	.89					.83					.86				
2. STS_CE	.81	.86				.76	.81				.69	.82			
3. STS_PD	.88	.88	.65			.79	.84	.52			.84	.86	.56		
4. STS_PA	.75	.79	.54	.51		.67	.76	.46	.44		.75	.83	.57	.52	
M		0.92_{a}	1.32_{a}	1.01_{a}	0.45_{a}		0.55_{b}	0.91_{b}	0.70_{b}	0.05_{b}		1.18_{c}	1.66_{c}	1.14_{c}	0.74_{c}
SD		0.96	1.11	1.30	1.00		0.89	1.04	1.28	0.99		0.88	0.90	1.22	1.02
STS from work															
1. STS_Global	.90					.84					.90				
2. STS_CE	.83	.87				.80	.84				.82	.84			
3. STS_PD	.89	.89	.67			.85	.82	.55			.82	.84	.56		
4. STS_PA	.74	.83	.60	.59		.68	.71	.46	.31		.73	.83	.56	.53	
M		0.87_{ab}	1.18_{ab}	0.98_{b}	0.44_{a}		0.47_{a}	0.69_{a}	0.75_{a}	-0.04_{b}		1.14_{b}	1.47_{b}	1.29_{b}	0.67_{c}
SD		1.01	1.14	1.31	1.05		0.88	1.04	1.28	1.01		0.92	1.07	1.14	1.10

Note: Different subscripts indicate that the mean differences are significant at $p = .05$.

Sadava, 2011; Diener et al., 2009), the findings revealed that a one-factor second-order measurement model with three separate constructs (cognitive evaluation, positive activation–negative deactivation, and positive deactivation-negative activation) provided a satisfactory fit to the data. Furthermore, this measurement model was shown to be invariant across the three urban areas and across the three travel modes of car, public transport and walking or biking. Therefore, STS may be general enough to be used to test specific hypotheses about satisfaction with travel by different travel modes in different urban contexts.

In addition to showing that the STS has an invariant factor structure across urban areas and travel modes, the findings revealed that car and slow-mode users scored higher than public transport users on the aggregated STS measure (STS_Global). A positive car commute offers comfort, driving pleasure and a feeling of self-control (Jakobsson Bergstad et al., 2011a). The downside is traffic congestion. A positive commute by public transport is characterized by the ability to do other things during the trip (such as talking to other passengers) (Ettema et al., 2012). Cycling or walking commuters are more satisfied with their commute than people using other modes of transport. There are several possible explanations for this. One is that these commuters live closer to work, which makes the work commute less time-consuming. Another explanation is that short walks and biking are perceived as healthy activities (Lawrence et al., 2006). A third explanation is that short commutes serve as a buffer between the work and private spheres (Lyons, 2008). In addition, differences were observed between urban areas on the latent means for indices describing global satisfaction with all daily travel the last month. Specifically, participants living in Stockholm had lower satisfaction with travel than participants living in Göteborg and Malmö. A possible explanation for this finding is that the number of public transport users are more and users of slow modes fewer in Stockholm than in Göteborg and Malmö.

Although the present study provides valuable information about the factor structure of STS, a degree of caution should be exercised in drawing conclusions. There is first of all a need to assess the test–retest reliability of STS. Travel in rural areas and during different seasons may also need to be studied to further demonstrate the generalizability of the factor structure. Future research should furthermore include other countries differing in urban structures, car availability, and public transport systems.

In applying STS, the four indexes – STS_Global, STS_PA, STS_PD and STS_CE (see Tables 7 and 13) – would provide useful detailed information for a broad range of policy decisions. Firstly, STS should reveal negative and positive features of the travel context affecting commuters' satisfaction. For instance, measures of satisfaction with daily travel provide an alternative way of evaluating annoyance due to increased traffic volumes. Cross-country comparisons with STS would enable assessments of what is the best practice in regional or city transport planning.

The use of STS can also be relevant for policy makers when they set priorities for different travel modes within a city or region. An urgent question is how much should be invested in public transport, bike lanes or infrastructure for car traffic. A sustainable future will most likely require a change in everyday travel that reduces its environmental impacts. The key is to develop sustainable travel modes such that users experience satisfaction with travel. If people switch to sustainable travel modes, they may not maintain switches if they do not experience satisfaction with what they have chosen. Similarly, the appropriate collection and use of STS data would allow policy makers to evaluate the effects of various transportation interventions such as combined mobility services where public transport works in synergy with other modes, like car-sharing, bike parking at stations, bike-sharing schemes, shared taxis, and carpooling.

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