Analyzing travel captivity by measuring the gap in travel satisfaction between chosen and alternative commute modes

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Abstract

In this study, we investigated travel captivity from the perspective of travel satisfaction. Using survey data from 565 commuters in Portland, Oregon, we compared satisfaction with the most recent commute trip (using the chosen mode) and hypothetical commute satisfaction if using an alternative mode. The difference in travel satisfaction between the chosen and alternative mode – referred to as the travel satisfaction gap – was used as a fine-grained proxy measure of travel captivity. Results indicate that active mode (walk/bicycle) users would be less satisfied when the alternative modes were auto or transit, while auto and transit commuters would be slightly more satisfied if they commuted by walking or bicycling. These outcomes suggest that auto users are most captive, while active travelers are mostly choice users. Results also show that respondents would be more satisfied with an alternative mode if it would enable more talking to other passengers.

Keywords

Travel satisfaction, Travel captivity, Mode choice; Travel behavior

1 Introduction

Most travel behavior studies indicate that travel attitudes play an important role in the travel mode choice (Bagley & Mokhtarian, 2002; Kitamura et al., 1997). Overall, studies have found that a positive (or negative) attitude towards a certain mode stimulates (or discourages) the use of that mode (e.g., Beirão & Cabral, 2007; Heinen et al., 2011). Furthermore, positive reinforcement between attitudes and mode choice may exist, as some studies also found that the use of a certain mode results in a positive attitude towards that mode (e.g., Kroesen et al., 2017). However, these studies mostly regard mode choice as a free choice in which individuals can choose a mode from a range of alternatives. In practice, the choice of modes might be restricted. Not having a driving license, not owning a car, or living in a low-traffic neighborhood can prevent people from driving a car. Active travel can be seriously hampered by missing walking/cycling infrastructure, living in a low-density neighborhood with long travel distances, or by an individual's physical disabilities. Public transport use can be restricted by limited services (e.g., low frequency), long distances to public transport stops, and difficulties in understanding public transport routes and schedules. These limitations in travel options might result in people choosing a certain mode by necessity rather than by choice. This inability to travel using a desired travel mode is often referred to as travel captivity (Beimborn et al., 2003; Handy et al., 2005; Jacques et al., 2013; Krizek & El-Geneidy, 2007; Polzin et al., 2000). However, studies analyzing travel captivity have not yet created a precise and consistent definition nor an adequate measure to assess this captivity, and have mainly focused on car users and especially public transport users (assuming this latter group travels mostly by an undesired mode).

More recent studies have started focusing on the level of inconsistency between people's chosen travel mode and their attitude towards that mode, sometimes referred to as travel mode dissonance. De Vos (2018) and Stark et al. (2019), for instance, found that almost half of participants do not travel with a preferred mode and that the inconsistency between mode choice and mode-specific attitudes is lowest for active travelers and highest for public transport users. Other studies, however, found lower levels of travel mode dissonance and less clear differences in dissonance levels according to the chosen travel mode (Kroesen et al., 2017; Ton et al., 2020; Zarabi et al., 2019).[1] Variations in dissonance levels can partly be explained by different measurement methods. In sum, studies examining travel captivity and travel mode dissonance have not yet reached a consensus on the level – and nature – of captivity/dissonance, mainly because of a lack of adequate measurement methods.

Not being able to travel in a desired way can have implications for how people experience their travel. Besides independent effects of the travel mode itself (i.e., active travel being more satisfying than motorized travel) (e.g., Morris & Guerra, 2015; Olsson et al., 2013; Singleton, 2019a), studies have found that attitudes towards the chosen mode have strong impacts on travel satisfaction (De Vos et al., 2016; Mokhtarian et al., 2015; St-Louis et al., 2014; Ye & Titheridge, 2017). People traveling with a desired travel mode mostly have higher satisfaction levels compared to those forced to travel with an undesired mode (De Vos, 2018). It can be argued that the latter, dissonant mode users would have higher travel satisfaction scores

[1] Other processes, such as the post-hoc rationalization of less-than-desirable choices or cognitive dissonance formation/resolution (De Vos & Singleton, 2021), may be at play in empirical relationships between travel mode choices and attitudes.

when they would be able to use a more desired travel mode. In fact, analyzing differences in travel satisfaction between the actual used mode and an alternative non-used mode could provide valuable information on whether people are captive mode users or choice users.

In this study using 565 respondents from Portland, Oregon, we analyze travel satisfaction of a typical commute and compare it to travel satisfaction of a hypothetical commute with an alternative mode. Differences in travel satisfaction between the chosen and alternative mode – in this paper referred to as the travel satisfaction gap – will be used as a fine-grained measure of travel captivity. Doing so can provide us with detailed information on which mode users are often captive, and which mode they would like to switch to. A regression analysis with the travel satisfaction gap as the dependent variable provides further insights into potential determinants of travel captivity, which can help in creating policy recommendations aiming to reduce captivity and increase travel satisfaction and subjective well-being.[2] Overall, our study's contributions include: measuring satisfaction with both a recent commute trip (using a chosen mode) and with a hypothetical commute trip (using an alternative mode); conceiving of this travel satisfaction gap as a proxy measure of travel captivity; and identifying associations between the satisfaction gap and personal/trip characteristics, including in-travel activity participation.

This paper is organized as follows. In Section 2 we describe the used data and methodology, while the results are presented in Section 3. The discussion of this paper is described in Section 4.

[2] Since travel satisfaction has a positive impact on life satisfaction and subjective well-being (De Vos, 2019; Friman et al., 2017), travel captivity can also negatively affect well-being through its negative influence on travel satisfaction.

2 Data and methods

2.1 Data

Data come from a 30-minute online self-administered questionnaire of adult commuters in the Portland, Oregon, region during Fall 2016. Most participants were recruited through direct emails at their places of employment (distributed by business associations, larger employers, and a City of Portland email list); although, some walk and bicycle commuters were intercepted with postcard handouts near downtown. Incentives for participation included a drawing for one of several $100 gift cards. 791 people started the survey, but only 565 answered enough questions to be included in this analysis. The sample was generally representative of the area's working population, but it contained a larger share of higher-income workers, likely due to the recruitment methodology. Also, non-auto commuters were oversampled by design, since a primary objective was to perform a mode choice analysis (Singleton, 2020a). See Singleton (2017) for more details about data collection.

For the purposes of this paper, several sets of survey questions are most relevant. First, unique among most cross-sectional travel behavior studies, the survey asked recall questions not only about a respondent's most recent commute trip from home to work (for the chosen mode), but also hypothetical questions about the same commute trip if using an alternative mode. Specifically, respondents were asked for their "most likely" alternative mode if their chosen mode was "not available." Thus, the survey provided data about travel attributes, situations, and experiences for both a chosen and an alternative commute mode for each respondent.

Second, the survey also included standard questions about personal/household socio-demographic characteristics, including age, gender, race/ethnicity, student status, educational attainment, household size, household income, housing type, work hours, and work schedule flexibility. Travel times and travel costs for both the chosen and alternative modes were calculated in a standardized way assuming shortest-path routes and including parking costs; see Singleton (2017) for details.

Third, travel satisfaction or subjective well-being associated with the commute trip was measured using the Satisfaction with Travel Scale (STS) (Ettema et al., 2011). The nine-item STS included in the survey – measured on a seven-point semantic differential scale – was adapted and slightly revised for the American context, but its adequate measurement properties have been validated using this dataset (Singleton, 2019b). Therefore, we constructed the STS score as the average (1-7) rating across all nine items. The STS was measured in the same way for both the chosen mode as well as the alternative mode.

Fourth, since previous studies have found that the activities performed during travel can impact travel satisfaction (e.g., Ettema et al., 2012)[3], questions were also asked about travel-based multitasking or activity participation during travel, again for both the chosen mode and the alternative mode. From among 23 distinct activities, respondents selected those that they

[3] We found three studies analyzing the effects of performed activities during travel on travel satisfaction, all focusing on transit. Lyons et al. (2007) found that especially working/studying, reading, and talking to other passengers was regarded worthwhile, while sleeping/snoozing, window gazing/people watching, and listening to music/radio during travel was often perceived as wasted time. Ettema et al. (2012) found that talking to other passengers had the most positive effect on satisfaction, while relaxing activities (e.g., sleeping, resting) and entertaining activities (e.g., reading, gaming) had the most negative effects (possibly since they might be attempts to abate boredom). Wang and Loo (2019), focusing on high-speed rail users, found that the use of ICT devices (such as e-working, e-communication, and e-reading) had a positive effect on travel satisfaction.

participated in (for their chosen mode) or would have participated (for their alternative mode) while on the commute trip. To simplify these data for analysis, we removed nine very uncommon activities (which were selected by only few respondents: e.g., personal grooming; smoking or vaping; singing or dancing) and combined the remaining 14 activities into four groups based on conceptual compatibility and insights from a prior exploratory factor analysis (Singleton, 2020b):

- Device-related activities (five): Texting, emailing or other messaging; Reading electronically (e-book, website); Using social media or apps; Reading print (newspaper, book, etc.); Playing game (Pokémon Go, puzzle etc.).
- Communication activities (three): Talking face-to-face with people you know; Talking face-to-face with strangers; Talking on the phone.
- Passive activities (five): Viewing scenery, watching people; Thinking or day-dreaming; Listening to music, radio, or other audio; Sleeping or snoozing; Doing nothing.
- Exercise activity (one): Exercising or being physically active.

The newly-constructed activity score was the sum of the number of activities selected in each category.

Table 1 presents descriptive statistics for the sample data, including information on socio-demographic characteristics as well as commute trip attributes – mode choice, travel time, travel cost, STS score, and activity score – for both chosen modes and alternative modes.

Table 1: Descriptive statistics (*N* = 565)

	Categorical		*Continuous*	
Variable	*#*	*%*	*Mean*	*SD*
Personal/household characteristics				
Age				
18-34	109	19.29		
35-44	143	25.31		
45-54	147	26.02		
55-64	131	23.19		
65+	35	6.19		
Race				
White, non-Hispanic	476	84.25		
Non-white/multiple/missing	89	15.75		
Gender				
Male	260	46.02		
Female	305	53.98		
Education				
No college degree	95	16.81		
Undergraduate degree	220	38.94		
Graduate degree	250	44.25		
Student				
Yes	44	7.79		
No	521	92.21		
Household size			2.62	1.21
# children (age ≤ 16)			0.48	0.87
# older (age 65+)			0.06	0.28
Housing unit type				
Single-family	450	79.65		
Multi-family	115	20.35		
# years lived in home				
0-5	236	41.77		
5+	329	58.23		
Household income (2016 USD)				
$0-49,999	46	8.14		
$50,000-74,999	95	16.81		
$75,000-999,999	130	23.01		
$100,000-149,999	158	27.96		
$150,000+	111	19.65		
Missing	25	4.42		
# automobiles			1.71	
# bicycles			2.54	
Car-/bike-share member				
Yes	137	24.25		
No	428	75.75		
Transit pass holder				
Yes	322	56.99		
No	243	43.01		
Work hours per week			41.88	8.32

Work schedule flexibility				
Very flexible	46	8.14		
Somewhat/Neither flexible or inflexible	460	81.42		
Very inflexible	59	10.44		
Ideal commute travel time			13.84	8.87
Teleportation preference				
Prefer to teleport	348	61.59		
Prefer to spend some time commuting	217	38.41		
Commute trip attributes				
Mode (chosen mode)				
Auto, driver	265	46.90		
Auto, passenger	29	5.13		
Walk	24	4.25		
Bicycle	98	17.35		
Transit	149	26.37		
Mode (alternative mode)				
Auto, driver	133	23.54		
Auto, passenger	151	26.73		
Walk	37	6.55		
Bicycle	80	14.16		
Transit	164	29.03		
Travel time				
Chosen mode			35.56	24.93
Alternative mode			40.57	29.68
Travel cost (2016 USD)				
Chosen mode			1.80	2.02
Alternative mode			2.14	2.18
STS score				
Chosen mode			4.72	1.02
Alternative mode			4.35	1.04
Activity score (chosen mode)				
Device-related (min = 0, max = 5)			0.56	1.01
Communication (min = 0, max = 3)			0.30	0.54
Passive (min = 0, max = 5)			1.60	0.94
Exercise (min = 0, max = 1)			0.19	0.39
Activity score (alternative mode)				
Device-related (min = 0, max = 5)			1.06	1.35
Communication (min = 0, max = 3)			0.53	0.75
Passive (min = 0, max = 5)			1.82	1.02
Exercise (min = 0, max = 1)			0.17	0.38

2.2 Methods

To analyze travel captivity and differences in travel satisfaction for chosen versus alternative modes, we first constructed a new respondent-specific variable called the travel satisfaction gap: the STS score for the chosen mode minus the STS score for the alternative mode. Thus, a positive "gap" score means that someone is more satisfied with their chosen mode and would become less satisfied if switching to an alternative mode. On the other hand, a negative "gap" score indicates that someone is less satisfied with their chosen mode and would become more satisfied if they could switch to their most likely alternative mode. Thus, we can assume that respondents with a negative "gap" score would represent people who travel with a certain mode by necessity (i.e., captive mode users), while those with a positive gap score would represent those who are able to travel with a preferred mode (i.e., choice users).[4]

Next, we performed several analyses of travel satisfaction and the travel satisfaction gap, focusing on modal differences and associated socio-demographic factors. These analyses included:

- Independent-sample t-tests of differences in average STS scores for people who chose each mode vs. other people who had that same mode as the most likely alternative.
- One-sample t-tests of the travel satisfaction gap (equivalent to paired-sample t-tests of differences in average STS scores) for people with each combination of chosen and alternative modes.
- Ordinary least squares linear regressions on average STS scores, with separate models of STS scores for the chosen mode and for the alternative mode, where independent variables were socio-demographics, activity scores, travel time and cost, and mode choice.

[4] It could be that some people with a positive satisfaction gap are also "captive" to their preferred or most satisfactory mode, such as people who do not own a car but prefer to commute by walking or bicycling. In this study, we classify these people as "choice" users because they travel with a more satisfactory mode.

- An ordinary least squares linear regression on the travel satisfaction gap, where independent variables were socio-demographics, differences in activity scores (chosen minus alternative), differences in travel time and cost (chosen minus alternative), and combinations of chosen and alternative modes.

3 Results

Since many of our analyses rely upon comparisons of satisfaction for chosen and alternative modes, it is instructive to first highlight the frequencies with which each mode was chosen versus selected as the most likely alternative mode. Table 2(a) presents a cross-tabulation of each of the five possible chosen modes and alternative modes. Since active modes (walk and bicycle) and driving modes (whether as a driver or passenger) share similar trip attributes (in terms of speed, travel time, or comfort, etc.), it could be useful to group those modes into a single category. Furthermore, some of the mode combinations had very small sizes. Therefore, we collapsed the 20 original mode combinations into eight grouped mode combinations, grouping walk and bicycle, as well as auto drivers and passengers, whereas the transit mode remained unchanged. Table 2(b) shows that automobile was the most frequent chosen mode (52%) and alternative mode (50%), followed by transit (26%, 29%) and walk/bicycle (22%, 21%).

Table 2: Cross-tabulations/frequencies of chosen versus alternative modes (*N* = 565)

(a) Original mode combinations

	Alternative mode					
Chosen mode	*Auto, driver*	*Auto, passenger*	*Walk*	*Bicycle*	*Transit*	*Total*
Auto, driver	0	119	8	47	91	265
Auto, passenger	12	0	2	2	13	29
Walk	1	0	0	10	13	24
Bike	36	5	10	0	47	98
Transit	84	27	17	21	0	149
Total	133	151	37	80	164	565

(b) Grouped mode combinations

	Alternative mode			
Chosen mode	*Auto*	*Walk/bicycle*	*Transit*	*Total*
Auto	131	59	104	294
Walk/bicycle	42	20	60	122
Transit	111	38	0	147
Total	284	117	164	565

3.1 Independent-sample t-tests of differences in average STS scores

An independent-sample t-test was conducted for differences in average STS scores for people who chose each mode vs. other people who had that same mode as the most likely alternative. The results shown in Table 3 indicate that satisfaction scores were significantly ($p < 0.05$) higher for every chosen mode (and chosen modes overall) than for alternative modes. In other words, overall, people were more satisfied with their chosen mode than they would have been using an alternative mode. We also observed that the difference in satisfaction was larger for transit and auto modes, and relatively smaller for active modes. For both chosen modes and alternative modes, people selecting walk/bicycle modes had higher-than-average STS scores, while those selecting auto or transit modes were less satisfied than the average commuter.

Table 3: Average STS scores for people with each chosen mode and alternative mode

	Chosen mode		*Alternative mode*		*t-test*	
Mode	*STS*	*N*	*STS*	*N*	*t*	*p*
Auto	4.456	294	4.147	284	4.049	0.000
Walk/bicycle	5.516	122	5.236	117	2.394	0.017
Transit	4.597	149	4.076	164	4.571	0.000
All	4.721	565	4.352	565	5.750	0.000

3.2 One-sample t-tests of the travel satisfaction gap

As shown in Table 2, there were eight possible combinations of chosen and alternative modes that the respondents selected (respondents with transit as their chosen mode were forced to select a non-transit alternative mode). Within each of those eight combinations, we first calculated the travel satisfaction gap (chosen mode STS minus alternative mode STS) for each individual. Then, one-sample t-tests investigated whether the mean satisfaction gap for each mode combination was significantly ($p < 0.05$) different from zero. Thus, the results displayed in Table 4 indicate whether people choosing each mode reported being less satisfied (a positive gap) or more satisfied (a negative gap) if they switched to an alternative mode.

Table 4: Average satisfaction gap scores (within-person STS score differences) for people with each combination of chosen and alternative modes

	Alternative mode			
Chosen mode	*Auto*	*Walk/bicycle*	*Transit*	*Overall*
Auto	-0.005	**-0.443**	**0.462**	0.072
Walk/bicycle	**1.754**	-0.067	**1.104**	**1.136**
Transit	**0.487**	-0.126	n/a	**0.331**

Note: **bold** = $p < 0.05$, n/a = not applicable

Results show that the satisfaction gap differs depending on choices of chosen and alternative modes. Those who walked or bicycled had positive satisfaction gaps when the alternative modes were auto or transit, suggesting that satisfaction scores would decrease for active mode users if they used auto or transit modes. However, shifting within active modes (e.g., from walk to bicycle or bicycle to walk) would result in no significant change in satisfaction. Similarly, transit users whose alternative mode was auto reported a significant positive satisfaction gap (indicating a higher satisfaction with transit than with auto). But the average negative satisfaction gap for transit users whose alternative mode was walk/bicycle was not statistically significant. People with auto as their chosen mode and transit as their alternative mode had a positive satisfaction gap (indicating a decrease in satisfaction if switching from auto to transit), while there was no satisfaction gap for switching between auto driver and passenger roles. Interestingly, the only significant negative satisfaction gap was for auto users who selected an active alternative mode. In other words, these auto users reported that they would be most satisfied if they could shift to walking or bicycling instead of commuting by automobile.

Figure 1 displays the distribution of travel satisfaction gap scores across each combination of chosen and alternative modes. A histogram with kernel density overlay (in pink color) is plotted against satisfaction gap scores (x-axis). A vertical blue line passing through zero separates positive and negative satisfaction gap scores, the percentages of which are displayed in text within brackets. (Recall that a positive satisfaction gap arises when someone reports being more satisfied with their chosen mode than with their most likely alternative mode, whereas a negative satisfaction gap refers to higher satisfaction levels for an alternative mode than for the chosen mode.) The graphical results offer similar results as the t-tests, indicating that most (>90%) active mode users had positive satisfaction gap when alternative modes were transit and auto. 73% of auto-users who reported walk/bicycle as the alternative mode had negative satisfaction gap, whereas 60% auto-users selecting the transit alternative had positive satisfaction gap. For transit users, 63% had a positive satisfaction gap when the alternative mode was auto, but 53% were found to have a negative satisfaction gap when walk/bicycle was the preferred alternative mode. The distribution of positive and negative satisfaction gap for shifting within active modes and auto was balanced (around 50%).

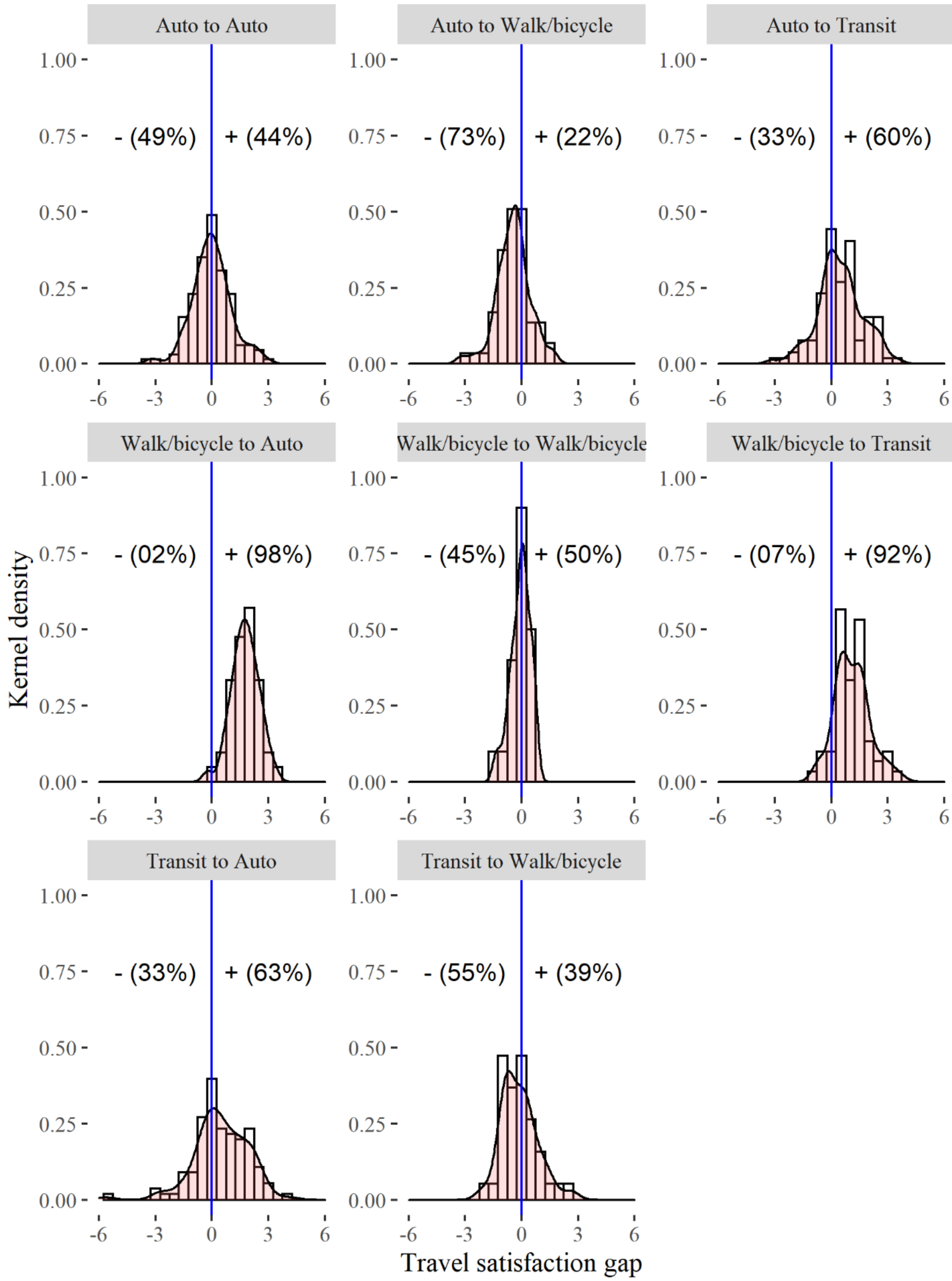

Figure 1: Satisfaction gap score distribution for each combination of chosen and alternative modes

(Note: Percentages of positive and negative satisfaction gap scores are enclosed in brackets; Percentages do not add up to 100%, as some people have a satisfaction gap score of zero.)

3.3 Regressions on average STS scores, separately for chosen and alternative modes

To examine factors associated with ratings of satisfaction with travel scores, two linear regression models were estimated each for the chosen mode and the alternative mode, using the same predictors. The dependent variable for both cases was average STS scores for each mode. In addition to personal/household characteristics, the commute trip attributes used in the models – including travel time, travel cost, and activity scores – were specific to the chosen and the alternative modes in each respective mode. Any differences in significant predictors between the two models could indicate some factors that might influence the satisfaction gap or inform travel captivity. Analysis of the satisfaction gap (and the combined influence of chosen and alternative modes) is conducted in the following section. The results of the linear regression models displayed in Table 5 indicate that the predictors were able to explain around 29% of the variance in STS scores.

Table 5: Results of linear regression models of average STS scores for chosen and alternative modes

	STS score, chosen mode (R^2 = 0.286)			*STS score, alternative mode (R^2 = 0.297)*		
Variables	*B*	*SE*	*p*	*B*	*SE*	*p*
Intercept	**4.951**	**0.323**	**0.000**	**3.575**	**0.338**	**0.000**
Personal/household characteristics						
Age (ref. = 45-54)						
18-34	—	—	—	—	—	—
35-44	—	—	—	—	—	—
55-64	*0.200*	*0.115*	*0.082*	—	—	—
65+	*0.361*	*0.186*	*0.053*	—	—	—
Race: Non-white (ref. = White)	—	—	—	*0.206*	*0.116*	*0.076*
Gender: Female (ref. = Male)	**-0.170**	**0.085**	**0.045**	—	—	—
# children (age ≤ 16)	*0.120*	*0.069*	*0.083*	—	—	—
# years lived in home: 0-5 years (ref = 5+ years)	*0.156*	*0.090*	*0.084*	—	—	—
Household income (ref. = $75,000-99,999)						
$0-50k	—	—	—	*0.290*	*0.166*	*0.081*
$50-75k	—	—	—	—	—	—
$100-150k	—	—	—	—	—	—
$150k+	—	—	—	**0.288**	**0.125**	**0.021**
Work hours per week	*-0.009*	*0.005*	*0.072*	—	—	—
Work schedule flexibility (ref. = Somewhat/neither flexible nor inflexible)						
Very inflexible	—	—	—	*-0.261*	*0.148*	*0.078*
Very flexible	—	—	—	—	—	—
Ideal commute travel time	—	—	—	**0.014**	**0.005**	**0.002**
Teleportation preference: Prefer to spent some time commuting (ref. = Prefer to teleport)	**0.266**	**0.086**	**0.002**	—	—	—
Commute trip attributes						
Mode (ref. = Auto)						
Walk/bicycle	**0.992**	**0.204**	**0.000**	**0.989**	**0.204**	**0.000**
Transit	—	—	—	—	—	—
Travel time	**-0.005**	**0.002**	**0.005**	**-0.005**	**0.002**	**0.002**
Travel cost	*-0.041*	*0.024*	*0.088*	**-0.051**	**0.024**	**0.035**
Activity score						
Device-related	—	—	—	—	—	—
Communication	—	—	—	**0.227**	**0.063**	**0.000**
Passive	—	—	—	*0.076*	*0.041*	*0.064*
Exercise	—	—	—	*0.301*	*0.174*	*0.085*

Notes: **bold** = $p < 0.05$, *italics* = $p < 0.10$, — = $p > 0.10$
Variables not significant ($p > 0.10$) in both models: education, student, # older (65+), housing unit type, # automobiles, # bicycles, car-/bike-share member, transit pass holder.

The model results suggest that just a few personal/household characteristics were significant predictors of STS scores. For chosen mode, satisfaction ratings were found to marginally increase with age: i.e., older adults (>54) were more satisfied with their commute experience than younger commuters. Similarly, women generally reported lower satisfaction ratings than men. Work hours were found to be inversely associated with satisfaction scores. The commuters who responded that they would like to commute instead of teleport could derive satisfaction from travel-related aspects (Humagain & Singleton, 2020b) and hence were found to report higher STS scores. Furthermore, commuters with more children and living less years in their home also reported higher levels of travel satisfaction.

Interestingly, none of the personal/household characteristics significant for chosen mode satisfaction were similarly significant for alternative mode satisfaction. Non-white commuters reported higher satisfaction for the alternative mode than people of white non-Hispanic race/ethnicity. Likewise, household income and work flexibility were significantly associated with travel satisfaction: people with the highest incomes and those with inflexible work schedules were more satisfied and less satisfied with their commutes, respectively. Ideal travel time – which represents a commuter's desire to travel (Humagain & Singleton, 2020a) – was positively associated with STS scores, as expected.

In both models, the influences of trip attributes were mostly similar. Specifically, commuters selecting walking/bicycling as either chosen or alternative modes were found to be more satisfied than auto users. However, transit users did not have significantly higher STS scores than auto users, in both models. Both travel time and cost coefficients had negative associations with travel satisfaction, which is expected as travel utility generally decreases with an increase in travel time and cost. A major difference between the models was that activities were only found to be significantly associated with satisfaction scores for the alternative mode. People reporting that they expected to conduct more passive activities, communicating, or exercising also reported higher expected levels of travel satisfaction.

3.4 Regression on the travel satisfaction gap

Although models of satisfaction scores guided us about determinants of travel satisfaction for chosen and alternative modes, our final analysis considers influences on the travel satisfaction gap: i.e., the difference between STS scores for each respondent's chosen mode and alternative mode. Such a model is likely more informative about factors affecting travel captivity than the previous single models of satisfaction. The predictors of the travel satisfaction gap are the same personal/household characteristics, plus differences (chosen minus alternative) in commute trip attributes (travel time, travel cost, and activity score), as well as chosen – alternative mode combinations. The most frequent grouped mode combination (see Table 2b) was auto – auto (about 131), which is a reference group. The results of a linear regression model on the travel satisfaction gap, with significant and marginally significant variables shown, are presented in Table 6.

Table 6: Results of regressions on average STS score difference, using differences in chosen vs alternative mode variables

	Travel satisfaction gap (R^2 = 0.286)		
Variables	*B*	*SE*	*p*
Intercept	—	—	—
Personal/household characteristics			
# bicycles	*-0.054*	*0.029*	*0.065*
Transit pass holder: Yes (ref. = No)	*-0.183*	*0.111*	*0.100*
Teleportation preference: Prefer to spent some time commuting (ref. = Prefer to teleport)	**0.284**	**0.104**	**0.007**
Commute trip attributes			
Mode combinations (ref. = Auto – Auto)			
Auto – Walk/bicycle	**-0.791**	**0.242**	**0.001**
Auto – Transit	*0.320*	*0.180*	*0.077*
Walk/bicycle – Auto	**1.754**	**0.283**	**0.000**
Walk/bicycle – Walk/bicycle	—	—	—
Walk/bicycle – Transit	**1.112**	**0.258**	**0.000**
Transit – Auto	**0.466**	**0.223**	**0.037**
Transit – Walk/bicycle	—	—	—
Activity score difference			
Device-related	—	—	—
Communication	**0.126**	**0.064**	**0.049**
Passive	—	—	—
Exercise	—	—	—

Notes: **bold =** *p* <0.05, *italics* = *p* < 0.10, — = *p* > 0.10
Variables not significant ($p > 0.10$): age, race, gender, education, student, # children (age ≤ 16), # older (age 65+), housing unit type, # years lived in home, household income, # automobiles, car-/bike-share member, work hours per week, work schedule flexibility, ideal commute travel time, travel time difference, travel cost difference.

A positive model coefficient represents an increase in the satisfaction gap associated with a unit increase in that variable. In the model, the only influential socio-demographic characteristics were found to be household bicycles and transit pass holding: households with more bicycles and travelers with a transit pass had less positive or more negative satisfaction gaps. Commuters who preferred to commute instead of teleporting reported greater (more positive) differences in satisfaction scores between chosen and alternative mode. In contrast to results of the previous models of satisfaction (Table 5), travel time differences and travel cost differences were not found to influence the travel satisfaction gap. Controlling for the effect of modal combinations and household/personal characteristics, only one type of activity (related to communication) was significantly associated with the travel satisfaction gap. Specifically, people who reported more communication activities during their chosen mode than during an alternative mode had a more positive satisfaction gap.

As expected, people with different modal combinations had larger or smaller travel satisfaction gaps, compared to those with auto as both chosen and alternative modes. Recall from Table 4 that there was effectively no satisfaction gap for this group of commuters. Overall, these findings from Table 6 (controlling for the influence of other factors) confirm the t-test results of Table 4 (that only considered mode combinations). The satisfaction gap was more positive for walk/bicycle commuters who selected either auto or transit alternative modes, but more negative for auto commuters who selected walk/bicycle alternative modes. These results suggest that active mode users would become less satisfied when having to use other modes, and that auto commuters would become more satisfied if they could walk or bicycle. Two other significant (and marginally significant) positive associations with modal combinations indicate that the satisfaction gap would increase for commuters switching from transit to auto modes but also for commuters switching from auto to transit modes.

4 Discussion

In this study, using survey data from 565 commuters from Portland, Oregon, we investigated the topic of travel captivity by comparing satisfaction with the most recent commute trip (using the chosen mode) and hypothetical commute satisfaction if using an alternative mode (assuming the chosen mode were not available). We proposed the travel satisfaction gap—the individual difference in satisfaction (STS score) between trips using the chosen and alternative modes—as a proxy measure of travel captivity: a negative "gap" score would suggest that someone would be more satisfied commuting with an alternative mode. Our study involved several analyses, including: t-tests of modal differences in chosen mode vs. alternative mode satisfaction; t-tests of the travel satisfaction gap for chosen and alternative mode combinations; separate regressions on satisfaction with the chosen mode and with the alternative mode; and a regression on the travel satisfaction gap. Overall, our study makes several contributions:

- Measuring travel satisfaction with both a recent commute trip (using a chosen mode) and with a hypothetical commute using a most-likely alternative mode;
- Using the travel satisfaction gap as a proxy measure of travel captivity;
- Considering potential effects of in-travel activity participation on travel satisfaction; and
- Exploring associations of personal/household characteristics, travel time and cost, activities, and transportation mode with the travel satisfaction gap.

In the remainder of this section, we highlight and discuss our key findings, note study limitations, and mention potential policy implications.

Overall, we found that self-reported travel satisfaction is higher for actual commute trips than for hypothetical trips using an alternative mode (Table 3). In other words, on average, there is a positive travel satisfaction gap (Table 4), and people in general would be less satisfied if forced to commute using a different mode. If we assume satisfaction plays a role in mode choice, this is not a surprising finding, since presumably some people are able to act on those preferences when selecting a commute mode. We also found that, for each mode (auto, walk/bicycle, and transit), travel satisfaction is higher when that mode is chosen compared to when it is the alternative mode (Table 3). This suggests that there is a positive relation between mode choice and the liking of that mode (Singleton, 2020a), and may indicate that satisfying trips with a certain mode positively affect the (future) choice of that mode (Abou-Zeid & Ben-Akiva, 2012; Beirão & Cabral, 2007; De Vos et al., 2019). However, our analyses of the travel satisfaction gap identified significant differences for different modal combinations (Figure 1, Table 4, Table 6).

Most notably, both auto commuters and transit commuters would be slightly more satisfied if they commuted by walking or bicycling, as indicated by negative travel satisfaction gaps (Table 4, Table 6); although, the gap for transit commuters with walk/bicycle alternative mode was not significant. Everyone else would be less satisfied if forced to use an alternative mode or similarly satisfied if switching within the same group (between auto driver and passenger, or between walk and bicycle), although the gap for walk/bicycle commuters switching to transit or auto was more positive than for other mode combinations (Table 4, Table 6). These outcomes suggest that auto users are most captive (as they would be more satisfied with active travel), while active travelers are mostly choice users (as they would be less satisfied with alternative modes).

These findings also reflect the fact that commuters using active transportation modes (walk/bicycle) were more satisfied than commuters using other modes (Table 5). Our results are in line with previous studies (e.g., De Vos et al., 2016; Morris & Guerra, 2015; Singleton, 2019a) indicating that active travel results in higher levels of travel satisfaction compared to traveling by car or transit. Notably, according to our results (Table 5), this finding holds true not just for the performed commute, but also for a hypothetical commute using an alternative mode. In other words, even auto drivers considering walking/bicycling think they would be more satisfied with an active commute.

Results for transit are slightly different. Transit users would be less satisfied if commuting by auto and slightly (but not significantly) more satisfied if walking and bicycling (Table 4, Table 6). Given this overall positive travel satisfaction gap for transit, we cannot conclude that most transit users (in our sample) are captive, at least from a satisfaction perspective. These outcomes partly conflict with previous studies since these mainly focus on public transport users as captive users (e.g., Beimborn et al., 2003; Krizek & El-Geneidy, 2007; Polzin et al., 2000). Overall, satisfaction scores for transit were not significantly different from satisfaction scores for auto (Table 3, Table 5), as found in previous research in Portland (Singleton, 2019a; Smith, 2017), which may explain these differences. Complicating matters, as with transit users considering auto commutes, auto users considering transit also perceive they would be less satisfied (Table 4, Table 6). Perhaps commuters with both auto and transit options have been able to select the mode that brings them more satisfaction. Alternatively, these findings might reflect a tendency of people to rationalize their own choices and situations (cognitive dissonance: De Vos & Singleton, 2021).

Our inclusion of in-travel activities (travel-based multitasking) in models of satisfaction provided some additional insights to the limited literature on this topic (Ettema et al., 2012; Lyons et al., 2007; Wang & Loo, 2019). Specifically, communication activities were positively associated with satisfaction for alternative mode commutes (Table 5), and people who reported more communication activities during their chosen mode than during an alternative mode had a more positive travel satisfaction gap (Table 6). This finding is relevant with past studies in denoting that talking to others or people you know significantly increases the travel satisfaction during the trip (e.g. Ettema et al., 2012; Lyons et al., 2007). Furthermore, this finding suggests that people may be more satisfied with the alternative mode if it provides ample opportunities for them to talk to other people. Interestingly though, activity participation was not linked to satisfaction with current commutes (chosen mode) (Table 5), and people reported more device-related, communication, and passive activities for alternative modes than for chosen modes (Table 1). This could be a reflection of more modes that facilitate multitasking (transit and auto passenger) being chosen as the alternative (Table 2), or effects of wishful thinking during answering survey questions (Moudrá et al., 2019) about how much a different mode might facilitate in-travel activity participation.

Few other personal/household characteristics or commute trip attributes seem to affect the travel satisfaction gap (Table 6) or explain satisfaction-based travel captivity. The two influential socio-demographic characteristics—household bicycles and transit pass holding—were negatively associated with the satisfaction gap. Perhaps the presence of these non-auto mobility tools gives people a better chance of having multiple somewhat-satisfactory modes from which to choose (a smaller positive satisfaction gap), while their absence forces people to select an unsatisfactory alternative mode (a larger satisfaction gap). Commuters preferring to commute rather than teleport tend to have a more positive satisfaction gap between their chosen and alternative modes. It is likely that the non-teleportation preference for these travelers (Humagain & Singleton, 2020b) is a function of their ability to choose a more satisfactory mode, rather than the opposite direction of causation. Finally, travel time and cost differences did not influence the travel satisfaction gap, perhaps because these commute trip attributes had similar magnitudes of negative influence on satisfaction for both chosen and alternative modes (Table 5), in line with previous studies (e.g., Olsson et al., 2013).

5 Conclusion

In summary, our study explored the concept of travel captivity using the travel satisfaction gap between satisfaction with a chosen commute mode and potential satisfaction if using an alternative mode. Through multiple analyses, we found strong modal differences in satisfaction and in the satisfaction gap. Results indicate that active mode (walk/bicycle) users would be less satisfied when the alternative modes were auto or transit, while auto and transit commuters would be slightly more satisfied if they commuted by walking or bicycling. These outcomes suggest that auto users are most captive, while active travelers are mostly choice users. Results also show that respondents would be more satisfied with an alternative mode if it would enable more talking to other passengers.

We do acknowledge that the current study has some limitations. First of all, we asked respondents for their most likely alternative mode if their chosen mode were not available, and not the most preferred – and possibly non-available – alternative mode. Asking information regarding trips with the latter (preferred) types of modes might have resulted in higher satisfaction levels, potentially higher than the travel satisfaction of the performed commutes. Also, for our analyses, we reduced the mode choice combinations from 20 into just eight (see Table 2), which limits potential explanations of the satisfaction gap for those modes (especially auto drivers vs. passengers, people walking vs. bicycling, and different forms of transit). Second, recall bias might make it difficult for respondents to recall satisfaction levels with a commute using the alternative mode, or it might even be possible that respondents have never commuted with the alternative mode, making the satisfaction levels of these trips very hypothetical. Incorporating levels of experience using different modes into our analysis could have yielded insights into the impact of this limitation. We encourage future studies to create new strategies for capturing satisfaction with a non-used – yet desired – travel mode, minimizing recall bias. Third, our models reflect cross-sectional relationships between mode choices and travel satisfaction at one point in time. The true relationships between travel choices, satisfaction, and attitudes are complex and likely cyclical (De Vos et al., 2021) – mode choice generates different levels of satisfaction, and repeated positive experiences could improve one's attitude towards a mode, making that mode choice more likely – requiring longitudinal methods. Fourth, we are using a useful yet limiting proxy measure of travel captivity, based on our inference of satisfaction differences. Asking a direct question about such a satisfaction gap or perceived travel captivity could be a more straightforward way for future studies to investigate this topic. Furthermore, qualitative methods such as interviews and focus group studies might be better suited for understanding the mechanisms involved and confirming the relationship between travel captivity and the travel satisfaction gap found in our study.

The results of this study can give valuable insights for policy makers to reduce the level of travel captivity, increase people's travel satisfaction, and consequently improve their subjective well-being. Since car users (and to a limited extent transit users) would have a higher travel satisfaction in case of walking/cycling, it is important that transport planners make active travel more convenient. This could be done by creating more and better infrastructure for pedestrians and cyclists (e.g., broad, well-lit sidewalks, safe zebra crossings, and bike lanes separated from car traffic), or by developing compact, mixed use neighborhoods, resulting in shorter distances (which can easily be covered by walking and cycling). Furthermore, policy makers and transit operators should try to make transit more satisfying, e.g., by improving transit service and quality factors that have an important influence on passengers' satisfaction, such as comfort, cleanliness, punctuality, frequency, waiting conditions, accessibility, and on-board information (e.g., van Lierop et al., 2018). Doing so, active travelers can use transit as an alternative mode in case of long distances without having to compromise on satisfaction levels, while car users could potentially increase their satisfaction by switching to transit in some cases.

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