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Mood and mode: does how we travel affect how we feel?

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Abstract How do emotions like happiness, pain, stress, sadness and fatigue vary during travel and by travel mode? Understanding the relationship between how we travel and how we feel offers insight into ways of improving existing transportation services, prioritizing investments and theorizing and modeling the costs and benefits of travel. Drawing on the American Time Use Survey's well-being module, which surveyed over 13,000 respondents about mood during randomly selected activities, we address these questions using pooled ordinary least squares and fixed-effects panel regression. Controlling for demographics and other individual-specific attributes, we find that, contrary to the common perception that travel is an onerous, derived demand, mood is generally no worse during travel than on average. However, compared to other influences, travel has only a small total impact on how we feel. The estimated relationship between mood and mode tends to be weak and often not statistically significant. Nevertheless, we find that bicyclists have the most positive affect. Next happiest are car passengers, and then car drivers, though when controlling for the pleasure typically derived from interacting with others drivers are at least as happy as passengers. Bus and train riders experience the most negative emotions, though a small part of this can be attributed to the fact that transit is disproportionately used for the unloved work trip. Our findings suggest that bicycle use may have benefits beyond the typically cited health and transportation ones, and that improving transit riders' emotional experience may be as important as improving traditional service features such as headways and travel speeds. Our findings are ambiguous as to whether the joy of driving will limit the appeal of autonomous vehicles.

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Introduction

The question of what contributes to human happiness is one of the most ancient areas of philosophical inquiry (Kesebir and Diener 2008), and of late happiness has been the subject of intense and increasing scrutiny in fields such as economics, psychology and sociology (as well as philosophy); see Dolan et al. (2008) for a review of research on factors such as demographic characteristics which have been linked to life satisfaction. However, transportation scholars have only recently begun to analyze the connection between travel and happiness.

Work has begun to appear which examines the relationship between overall life satisfaction, access to transportation resources (such as autos or transit) and travel behavior (mode choice, commute length, etc.). We explore a related but conceptually distinct phenomenon—transitory happiness felt "in the moment" while traveling. Do individuals tend to be in a positive or negative frame of mind while traveling? Moreover, does mood vary systematically by mode? Specifically, do drivers, car passengers, pedestrians, bicyclists, train/subway riders, or bus riders tend to be in better moods relative to each other and relative to their mood during other activities?

In addition to the subject's intrinsic interest, there are a number of practical implications and applications suggested by this inquiry. As Mokhtarian and Salomon (2001) point out, a finding that travel itself (excluding the utility reaped at the destination) is not particularly onerous would suggest that a common assumption in traditional travel demand modeling—that travel time is an unequivocal negative that travelers always seek to minimize—may be in error. Furthermore, is it possible that transportation cost-benefit analyses, which generally estimate consumer surplus as a function of travel-time savings and travelers' value of time (see Small 1999), overstate benefits? A finding that happiness varies by mode would also help to inform mode choice modeling, which either implicitly (in the constant or error term) or explicitly (with comfort variables, individual preference variables, etc.) attempts to capture difficult-to-observe factors that contribute to affect and may cause the individual traveler to be willing to accept increased travel times or costs in exchange for traveling on a preferred mode.

Another implication of this inquiry concerns efforts to promote non-auto travel, which will benefit from an understanding of alternate modes' effects on mood. Finally, a further question of interest concerns the pleasurability of the driving task. Accelerating automation of motorized vehicles is underway; it is unclear whether drivers will embrace the freedom from stress and monotony that autonomous vehicles will permit, or whether at least some drivers will resist a possible loss of positive feelings of control, power, and speed. Using ordinary least squares (OLS) and fixed-effects panel regression on data from a large-scale survey of individuals' self-reported daily activities and mood, we investigate these questions below.

Utility, mood and life satisfaction

Before proceeding, it is necessary to define what we mean by "mood" and "affect." There are four distinct constructs considered here which relate to individuals' well-being, broadly

speaking. The first is "utility," a concept frequently used in economics. Utility is a latent construct which sums all of the benefits and costs inherent in an activity. These include the opportunity costs of time spent doing the activity, the monetary cost of the activity, benefits from the activity both at the time it is undertaken and in the future, etc.

One contributor to utility is the "happiness" an activity creates. Prior research (beginning with Andrews and Withey 1976) has disaggregated happiness into three distinct, though interrelated, components. The first (second well-being construct here) may be called "life satisfaction." Determining life satisfaction involves asking respondents to choose a numerical score that sums up the total quality of their lives. Life satisfaction is not the focus of this research.

Our primary concern is "experienced utility," or "affect," a term which we will use interchangeably with "mood." "Affect" is a measure of an individual's transitory, moment-to-moment emotional state while an activity is undertaken. Positive and negative affect are considered distinct, semi-independent constructs (Diener and Emmons 1984), and thus are the third and fourth components of well-being we consider, but for the purposes of this paper we report a single affect score that amalgamates our measure of positive affect and our four measures of negative affect into a single figure which reflects "total affect," or "mood." We outline below how we calculate this.

Utility, life satisfaction and affect are interrelated but not identical. Affect during a trip is one contributor to its overall utility, since the impact of that trip on our feelings is one aspect of that trip's benefits or costs. But at the same time utility is also a function of many other factors. Thus happiness and utility may not always covary. Long commutes tend to make people unhappy (see below), but provide greater utility by allowing a household to locate in a better school district or a nicer house. Someone who takes the bus might be happier in a car, but may choose the bus in order to save money.

Utility and the components of happiness (life satisfaction and affect) are all abstractions. The primary methods of quantifying and estimating them are similar but distinct. Perhaps the most notable difference is that the measure of utility is indirectly based on observed or reported choices, while measures of happiness are directly reported. Random utility models (RUMs) judge what people value by observing their choices. By construction, an individual always chooses the alternative that provides the greatest utility, and (ideally) the factors that contribute to this choice are included in the model specification.

Psychologists, economists and sociologists have studied happiness more directly, measuring it by asking subjects to quantify their life satisfaction and affect, and then constructing models including presumed contributors to happiness using OLS.[1] One of the primary advantages of studying reported happiness is this direct measurability in reporting. Since utility is indirect, it is always relative rather than absolute. We only know that the utility of a chosen option was higher than the others, because it was chosen. Without a price variable, this tells us nothing about whether the absolute utility was positive or negative. It also makes it extremely difficult—even impossible without detailed activity diaries and complex model specification—to compare the benefits of a travel alternative to other everyday activities, such as work or recreation. Furthermore, a policy or program that increases or decreases the benefit of all alternatives may have no influence on choices and thus little impact on observed utility. Direct reporting of happiness overcomes these problems. In addition, RUMs are based on what individuals choose to do based on their

[1] Alternately, they have employed ordered model methods, a form of RUM. Research into which technique is superior in this context has unearthed little systematic difference in findings (Ferrer-i-Carbonell and Frijters 2004).

anticipation of the outcome; they do not actually reflect the impact of the activity as experienced. Given issues of bias based on the unreliability of memory or faulty judgment, individuals may not in all cases select the course of action which would actually bring them the most happiness (Ettema et al. 2010).

Finally, happiness is commonly understandable, whereas utility is an economist's jargon. As such, consumers and voters may be more likely to respond to research that emphasizes happiness. Thus the study of transportation and happiness can add not only to our understanding of the travel experience, but to our public policy priorities in terms of the provision of transportation resources, above and beyond our already rich knowledge base amassed over several decades of RUM mode choice analysis.

Prior research

Transportation scholars have only recently begun to analyze the influence of transportation facilities and resources, mode choice and other aspects of travel behavior on happiness and well-being. For a review of recent work, see De Vos et al. (2013), but as the authors note this study is still in its infancy with many substantial gaps remaining to be filled. By contrast, transportation has had a prominent and foundational role in the development of RUMs (McFadden 2001), which are commonly used to predict the propensity to travel and to select specific modes or routes.

See Small and Verhoef (2007, Chap. 2) for common findings and RUM specifications. In brief, RUMs have found that travelers gain utility by spending less time and money on available travel options. The former finding does suggest that travel may be an unpleasant activity, but this may be due to the opportunity costs of travel time and not the fact that travel is associated with low affect. In terms of mode, RUMs have found that car ownership and use tend to rise with income. Of note for public transportation, people tend to dislike uncertainty, waiting and transfers. These contribute significantly to the disutility of travel by bus and rail transit, and are all related to affect as well as cost considerations. Also, studies have frequently found that individual preferences play an important role in mode choice. For example, those who prefer transit, walking and biking select into neighborhoods where these are viable alternatives (Bhat and Guo 2007; Brownstone 2008; Chatman 2009; Mokhtarian and Cao 2008). Individual preferences also matter more directly. Some people inherently prefer certain modes over others, independent of associated time and money costs. For example, though they do not employ a RUM, Van Acker et al. (2011) find that lifestyles (revealed by things such as attitudes towards leisure time, leisure travel preferences, and literary tastes) can indirectly influence mode choice, and that there is a two-way relationship between mode choice and attitudes towards modal characteristics (such as comfort, environmental and personal impacts). Van Wee et al. (2002) also find, perhaps unsurprisingly, that modal preferences shape mode choice, and that these preferences are in turn partially a function of demographic characteristics like household size, age, income and sex. These findings strongly suggest that affect-related factors do play a role in mode choice.

In terms of happiness, a small body of research has addressed whether access to transportation resources—for example, private vehicles and nearby transit service—is linked to life satisfaction and mental health (Ballas and Tranmer, 2012; Bergstad et al. 2011; Brereton et al. 2008; Ellaway et al. 2003; Macintyre et al. 2001; Macintyre et al. 1998; Morris 2013), but this is not a focus of this paper. Of greater direct relevance is the small but growing body of work on satisfaction with, and affect during, travel. Traditionally travel has been considered a "derived demand" which yields utility thanks to the

opportunity accessed at the destination, but not intrinsically from the activity of travel itself. However, as Mokhtarian and Salomon (2001) note, numerous authors find travel itself is enjoyable thanks to feelings it engenders, such as autonomy; status, the thrill of speed; adventure; control; aesthetic enjoyment of scenery; satisfaction at a sense of mastery; novelty; escape; satisfaction of curiosity; freedom from the stresses of work and home; and the enjoyment of activities conducted during travel like listening to music, talking on the phone, or reading (see also Ettema et al. 2012; Ory and Mokhtarian 2005; Salomon 1985). Hupkes (1982) speculates that perceptions of travel can be both positive and negative depending on trip duration, with the initial excitement and novelty of a trip fading as it drags on.

A small body of research has conducted empirical inquiry into questions concerning travel, travel mode, and affect. Mokhtarian and Salomon (2001) note that there are many types of undirected, non-utilitarian travel, from recreational running, hiking and biking to skiing to amusement park rides. Here the enjoyment of travel, and its benefits such as exercise, are the primary attractions. Even for utilitarian travel there may be a strong affinity for the travel experience itself. This may help motivate the trip, perhaps even pushing it over the threshold that determines whether the trip is undertaken at all; also, in many cases travelers report engaging in more travel than absolutely necessary to reach a desired destination, for example by taking an indirect route for aesthetic reasons. Mokhtarian and Salomon administered a survey on travel enjoyment, including, of particular interest here, by mode. In general, they find that 13 % of their sample reported disliking one-way travel under 100 miles, with 32 % reporting liking such travel and with the remainder being neutral. Nearly 70 % disagreed with the statement that "the only good thing about traveling is arriving at your destination." Only 20 % disagreed with the statement "getting there is half the fun." The authors also find that trip purpose matters (even when respondents are told to ignore the utility received at the destination), with trips to more pleasant destinations being reported as being more pleasant. Of particular interest for this paper, Mokhtarian and Salomon find that walking and cycling are the best-liked modes, with 66.7 % of the sample liking them and 8.9 % disliking. The majority of respondents expressed the wish that they would walk and/or bike more. Next comes auto travel, with 58.1 % liking and 11.7 % disliking, then train/subway/light rail travel (31.4 % like and 28.9 % dislike). Bus travel is the least-liked (8.3 % like and 63.4 % dislike).

In another investigation of affect and mode, Hiscock et al. (2002) find that in the aggregate auto owners have greater psycho-social satisfaction from travel than those who are dependent on public transportation, thanks to feelings of protection, autonomy, prestige, shelter from the elements, convenience, reliability and the ability of the driver to project positive qualities like mastery and skill onto him/herself. Mann and Abraham (2006) find "journey-based affect" to be generally higher in auto passengers than transit passengers thanks to things like a lack of crowding, climate control, a personal stereo, enjoyment from operating the vehicle and greater comfort. The authors also find that autos provide more protected personal space, autonomy (i.e., freedom to decide where and when to travel), and sense of personal identity (expressed by auto ownership). Gardner and Abraham (2007) find that auto travelers have more positive affect than transit travelers due to perceived (if not always actual) reliability, punctuality, effortlessness, etc. Ory et al. (2004) find that those who travel by bus are significantly less likely to like their commute trips. Stradling et al. (2007a, b) find many negative attitudes that discourage bus riding, including concern over safety, indirect routing, crowding, lack of control, cost, discomfort and feelings of poor self-esteem. Other authors reach similar conclusions about the affective superiority of the auto and the relatively low affect associated with transit (Jensen

1999; Ellaway et al. 2003; Tertoolen et al. 1998). Ettema et al. (2011) find that satisfaction with travel, and affect, in their sample was significantly higher for car travelers than for bus riders, though the difference was smallest in optimal conditions for bus travel (short trips and high accessibility of stops). It should be noted, however, that this study dealt with the presentation of hypothetical travel options and not the study of actual behavior. Olsson et al. (2013) also find that those traveling by auto are more satisfied with travel than transit riders, though walking and biking produce significantly more positive emotions than either. The finding that walkers and bicyclists are happier than those traveling in motorized vehicles, perhaps due to the benefits of exercise, is also echoed by Duarte et al. (2010). On the other hand, Ory and Mokhtarian (2005) do not find bus or rail use for the commute, or commute duration, to be significant in predicting individuals' overall liking for travel, and Abou-Zeid (2009, as cited by De Vos et al. 2013) finds transit users are happier with their commutes than auto travelers. To an extent, inferences about mode and affect can be gleaned from work on the factors influencing mode choice. At the end of an experiment in Switzerland where car drivers switched to transit temporarily, happiness with car travel in most cases actually substantially increased as a result of the experience, suggesting transit travel was unpleasant; also, no drivers switched to transit when the experiment ended (Abou-Zeid et al. 2008, 2012). On the other hand, in a similar experiment at MIT there was some switching (Abou-Zeid and Ben-Akiva 2012). In a meta-review conducted in 2008, Gardner and Abraham explore the issue of why people choose to drive rather than take transit. They find that habit, attitudes, norms, and perceived control all play a part, and that negative feelings towards transit play a more important role than positive feelings toward the auto.

Among studies that find that car travel is preferred to transit use, there is some debate about whether this is due to affective or utilitarian (e.g., travel time and monetary cost) reasons. Wardman et al. (2001, as cited in Mann and Abraham 2006) find that affective benefits are independent of utilitarian ones, while Mann and Abraham (2006) find that they are commingled; e.g., a faster journey is also a more emotionally satisfying one.

Some work flips the analysis and studies how personality traits, including happiness levels, impact mode choice. Duarte et al. (2010) find the happy are slightly more likely to commute by metro and train in Europe than travel by car, though bus riders are likely to be considerably less happy. The happiest walk and bike to work. Jensen (1999), and Heath and Gifford (2002), find that personality type and psychological factors are important determinants of mode choice. Van Acker et al. (2011) do not study psychological traits like baseline affect directly, but do make the important point that the causal relationship between ideas and travel behavior likely flows in both directions. This is of relevance here because it is possible that those who are intrinsically happy may be more or less likely to choose a particular mode in addition to the effects flowing in the opposite direction. Our research design enables us to address this issue.

Much of the work on travel and happiness has focused on the commute trip, with mixed conclusions being drawn. Some find the commute to be a major source of unhappiness. Choi et al. (2012), Stutzer and Frey (2008), and Morris (2013) find that workers with longer commutes report lower life satisfaction, all else equal. As for affect, Kahneman and Krueger (2006) find that in a sample of 19 activities, the evening and morning commutes are 17th and 19th in terms of mean net affect (work is 18th; "intimate relations" is first).

On the other hand, Redmond and Mokhtarian (2001) and Ory et al. (2004) find that in the aggregate people prefer modest commutes over both long and very short ones. Redmond and Mokhtarian's survey sample reported a mean desired commute of 16 min, a figure which the authors find varies based on factors such as actual commute time, liking

for travel in general, lifestyle, and demographics. Redmond and Mokhtarian attribute the fact that the mean ideal commute is not zero (only 3 % wanted a commute between 0 and 2 min) to the fact that the travel may have the positive benefits outlined above. Also, Olsson et al. (2013) find that subjects in Sweden are relatively happy while commuting, and that attitudes toward commuting contribute to overall life satisfaction. Taking a position in the middle ground, White and Dolan (2009) find that commutes are neither particularly enjoyable nor particularly unenjoyable: their results show commuting brings more pleasure than work or housework, though less than exercise, rest, television or eating; commute trips are about on a par with cooking, shopping and time spent with children.

In sum, prior research is equivocal about whether travel in general contributes to positive or negative affect, but reaches a fairly strong consensus that walking, biking and car travel are associated with better mood than transit travel. It is to these questions that we now turn.

Conceptual framework/methodology

This paper models the mood of travelers versus non-travelers, with a special focus on travel mode. Two types of models are used: pooled OLS and fixed-effects panel regressions. The former primarily captures variation in affect by activity across travelers. The latter captures the variation in affect within individuals across the three activity observations that the American Time Use Survey (ATUS, our data source) collected from each respondent.

Our final, most highly specified OLS models are of the form:

$$Y_i = a + \beta_1 TM_i + \beta_2 W_i + \beta_3 I_i + \beta_4 D_i + \beta_5 A_i + \varepsilon_i,$$

where Y reflects total affect, a is a constant, TM is a set of dummies for travel in general (where all travelers regardless of mode are aggregated) or, in separate models, where travelers are disaggregated by mode (bus riders, train riders, etc.), W reflects work-related travel, I reflects whether the respondent was interacting with others during the activity, D is a vector of controls for individual demographic and geographic characteristics, and A represents activity type.

The fixed-effects models are of similar form, but replace individual-level control variables with individual-specific constants. The advantage of these constants is that they capture individual-specific variation in unobserved attributes that may also covary with mode, such as reporting preferences, baseline affect, or net wealth (as opposed to reported income). In effect, they permit us to control for all aspects of the individual that do not vary on the study day. The fixed-effects models retain variables that differ by activity and which may be expected to shape affect (i.e., travel and travel mode, work travel, human interaction, and activity type).

The dependent variable Y is our measure of total affect, which, as has been noted, represents the transient emotional state, or mood, of the subject. We observe five distinct emotions from the survey: happiness (an example of positive affect) and sadness, tiredness, pain and stress (all examples of negative affect). Each of these was self-reported on a 0–6 scale, with 0 meaning the emotion was not experienced at all and 6 meaning the emotion was felt very much.

We use two alternate means of aggregating these emotions and calculating total affect. The models reported here follow the example of Bradburn (1969) and Kahneman and

Krueger (2006); these consider the difference in the mean of positive-affect variables (in our case, the happiness score) and the mean of negative-affect variables (our four negative emotions). Bradburn finds this "Affect Balance Scale" to be a good predictor of overall self-ratings of happiness. As a robustness test, we also constructed and tested a dependent using factor analysis. This did not materially alter our findings.

The independent variables of interest here reflect travel in general and travel mode. Some models below examine whether respondents have positive affect during all travel, using a single binary variable reflecting participation in this activity. In additional inquiry on the effects of mode, the models include a set of dummies that include the modes of car driver, car passenger, pedestrian, bicycle rider, train or subway rider, and bus rider. We limit our sample of bicycle riders and pedestrians to utilitarian travelers, excluding those biking or walking purely for pleasure or exercise.

In our most highly specified models we include two dummy variables that reflect conditions experienced during an activity. The first is whether a trip was for work-related travel. As has been discussed, scholars disagree on whether the commute is positive or negative for affect, but in any event its potential impact is strong enough for its inclusion; we hypothesized it may be of importance since, for example, transit is disproportionately used for the work trip.

We also include a variable for whether the activity was conducted while interacting with others. We hypothesized that we would find that affect is higher for social activities, and that this would help to explain any perceived differences between, for example, driving (which is generally done alone in our sample) and riding in the auto as a passenger, which is in the large majority of cases (but not exclusively) a social activity. Ettema et al. (2012), for example, find that of the various activities that can be performed during travel (such as relaxing or enjoying entertainment), talking to another passenger produces the highest satisfaction with travel, and Goulias et al. (2013) find that interacting with another while traveling produces positive emotions, while traveling alone produces a mix of positive and negative ones.

Next, our full OLS models include a suite of control variables on demographic and geographic circumstances. Most of these have been shown to affect life satisfaction (Dolan et al. 2008), or at least to be strong candidates for doing so, though some (such as income and unemployment[2]) have been shown to have less of an influence on affect than on life satisfaction (Kahneman et al. 2006; Knabe et al. 2010).

Finally, our full OLS models include controls for activity type. These are based on the ATUS' major activity categorizations and are listed in Table 1. Inclusion of these variables raises the predictive power of the models (for example, in the case of the OLS model from an R^2 of 0.116 to 0.140). The most complete fixed-effects models also control for these.

Data

The ATUS (United States Department of Labor, Bureau of Labor Statistics 2013) is a joint project of the Bureau of Labor Statistics and the Census Bureau. The ATUS focuses

[2] Knabe et al. (2010) find that the unemployed are generally less happy than the employed while engaging in any specific activity, but in the aggregate they are no less happy because they engage in more pleasant activities while the employed are working.

Table 1 Descriptive statistics of activities and mean affect during activities

Name	Mean	Std. dev.	Affect during activity	
Total affect	2.93	2.37	Mean	Std. dev.
Travel-related variables (mode share as a proportion of all activities)				
Traveling	0.24	0.43	3.04	2.26
Work-related travel	0.06	0.23	2.69	2.22
Car driver	0.174	0.38	3.02	2.21
Car passenger	0.040	0.20	3.19	2.37
Walking (utilitarian)	0.016	0.12	2.98	2.57
Bicycle (utilitarian)	0.001	0.03	3.17	2.05
Bus	0.004	0.06	2.60	2.38
Train	0.002	0.04	2.36	2.19
Non-travel activities				
Interacting with another person	0.56	0.50	3.10	2.28
Working	0.08	0.28	2.31	2.32
Personal care	0.01	0.07	0.14	3.41
Household activity	0.17	0.37	2.67	2.43
Care for household member	0.04	0.20	3.44	2.14
Care for non-household member	0.01	0.10	3.46	2.23
Education	0.01	0.11	1.86	2.09
Shopping	0.04	0.19	2.79	2.42
Personal service	0.01	0.08	1.85	2.85
Household service	0.00	0.03	2.64	2.47
Government service	0.00	0.02	3.08	2.58
Eating or drinking	0.16	0.36	3.23	2.32
Socializing	0.18	0.38	3.06	2.36
Sports and recreation	0.02	0.13	3.14	2.31
Religious activity	0.01	0.09	4.07	2.40
Volunteering	0.01	0.08	3.61	1.96
Phone call	0.01	0.10	2.76	2.70

primarily on measuring the amount of time Americans spent performing different activities on the day prior to the survey.

The ATUS classifies activities in 17 primary categories including those listed in Table 1 (note that interacting with another is not among the 17 primary activity categories). The survey further subdivides activities into second- and third-tier types. The 463 third-tier categories provide highly precise information on how people spend their time. For example, the sports, entertainment and recreation category includes codes for activities as obscure as fencing; equestrian sports; rugby; and climbing, spelunking and caving.

Travel is one of the 17 primary categories; it includes an additional 70 subcategories based on trip purpose and destination. Furthermore, ATUS respondents are asked where they performed each activity. Twenty-three different locational coding categories include all of the noteworthy travel modes outlined above.

To link transportation and mode with mood, we examine a subset of the ATUS data which includes those who participated in a well-being module conducted from January

through December, 2010. This module sampled three activities per respondent on the study day and asked about the five emotions, how meaningful the activity was, and whether it involved interaction with others. This method of measuring affect during activities is similar to the commonly used Day Reconstruction Method (DRM) (see Kahneman et al., 2004a, b). The limitation of observing only three activities per respondent reduces our sample size, increasing the magnitude of our standard errors, but should not affect our estimated coefficients. Table 1 provides sample means, standard deviations, and mean reported affect for all reported activities and travel characteristics. Note that the "mean" of an activity is the number of incidences of that activity as a share of all observed activities. Online Appendix A provides sample means and standard deviations for the socioeconomic and demographic controls used in the OLS models.

The ATUS queries individuals who are 15 and older—excluding military personnel and those living in institutions such as nursing homes and prisons—by telephone, with special provisions to reach those without phones. Interviews are conducted in English and Spanish and have a conversational as opposed to a highly structured format. The ATUS samples approximately 27,000 households each year and has a response rate above 50 %. The 2010 well-being module includes 13,260 responses which provide information on approximately 38,000 activities. The sample is stratified based on such characteristics as race/ethnicity and family structure. To deal with item nonresponse, the BLS employs relational, longitudinal and hotdeck imputation. The ATUS generates weights for each person record to ensure that various groups are correctly represented, to correct for the fact that the survey oversamples weekend days, and to adjust for differential response rates by demographic segment.

Results

Table 2 presents the results of four pooled OLS regressions of the influence of travel and mode on total affect. We cluster standard errors by individual. Due primarily to unreported income levels, 1,885 cases were dropped from the models including socioeconomic variables (Models 2 and 4).

Our first research question is whether travel is an onerous activity. Models 1 and 2 indicate that, contrary to expectations, travel is not particularly trying. In fact, people who are traveling tend to be in a better mood than people participating in other reported activities in the aggregate. This relationship weakens but remains statistically significant and positive after controlling for personal characteristics (Model 2). For the interested reader, Online Appendix B provides the parameter estimates and T-statistics for the three dozen control variables not reported here.

Model 3 breaks travel into six utilitarian modes and adds a full range of two-digit activity codes from the ATUS survey, excluding the travel activity. We also tested the modes without activity variables, but do not report this model since the modal parameter estimates do not change meaningfully. Car drivers, car passengers, bicyclists and pedestrians tend to report more positive total affect, while transit users, including train and bus riders, exhibit a less positive mood. Of all the modal variables, however, only car passengers are in a statistically better mood than the mean for travel in general at the 95th percent confidence level. Both car drivers and passengers have significantly more positive affect than bus and rail riders. (We calculate whether the difference in estimates between any two modes is statistically distinguishable from 0 using a Wald test.) As reflected by the magnitude of the coefficient, bicyclists in the aggregate exhibit a very positive mood, but due to the relatively small number of

Table 2 Pooled OLS regressions of the influence of travel and travel mode on total affect

	Model 1	Model 2	Model 3	Model 4
Traveling	0.141***	0.0969**	–	–
	(3.74)	(2.61)		
Car driver	–	–	0.122	0.249*
			(1.16)	(2.33)
Car passenger	–	–	0.288*	0.200
			(2.19)	(1.53)
Bus	–	–	−0.306	−0.0849
			(−1.11)	(−0.34)
Train	–	–	−0.537	−0.493
			(−1.71)	(−1.63)
Walking (utilitarian)	–	–	0.0879	0.0679
			(0.47)	(0.37)
Bicycle (utilitarian)	–	–	0.263	0.618
			(0.44)	(1.06)
Work-related travel	–	–	–	−0.375***
				(−4.53)
Interacting with another person	–	–	–	0.338***
				(9.05)
Socioeconomic and regional controls	No	Yes	No	Yes
Activity controls	No	No	Yes	Yes
Constant	2.899***	0.840*	2.902***	0.610
	(111.17)	(2.49)	(29.18)	(1.77)
N	37841	35986	37841	35986
Adj. R^2	0.001	0.108	0.028	0.139

T-statistics in parentheses. Standard errors clustered by individual. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

bicyclists in the sample (35 observations) they are not statistically distinguishable from travelers in general or from other mode users.

In the fourth and final OLS model, we include the dummy variables for commute and social interaction. As has been noted, these were added because some modes are more likely to be used for the commute than others (e.g., 30 % of the instances of transit travel in our sample were work related, as opposed to 14 % of the observed cases of auto travel), while some modes are more likely to involve social interaction (e.g., car passenger). As expected, the commute is a particularly onerous trip. Since a higher share of transit users are commuting to work than the average for other modes, particularly car drivers, including the commute variable reduces the perceived negative influence of transit use on total affect, but not, in the case of train travel, by a large amount.

Accounting for interaction with another person, which we find is associated with significantly more positive mood in general, reduces the positive influence of being a car passenger, suggesting that some of the enjoyment of being a car passenger comes from the pleasure of interacting. Only 16 % of car passengers reported they were not interacting with another person. Including the additional activity controls increases the apparent appeal of driving and makes its influence on mood positive and statistically significant in

relation to generalized travel and train travel at the 95th percent confidence level. The coefficient for bicycling also increases fairly dramatically but the small sample size and lack of variation (8 of 35 observations reported interacting) limit interpretation. In terms of overall model fit, demographic, personal and geographic conditions, and activity classes, are much more effective at predicting total affect than mode. Mode choice has only a limited influence on the overall variation in reported affect. In the fully specified model (Model 4), only one mode choice parameter estimate, car driver, is statistically different from zero. Removing all modal variables from the final model only decreases the adjusted R^2 by 0.001.

In Table 3, we include individual-specific constants in the model in fixed-effects panel regressions. As noted above, these have the advantage of accounting for unobserved individual-specific variation in total affect, due to such things as personal reporting preferences, varying conceptions of the meaning of the mathematical scales that measure affect, and general state of happiness. The fixed-effects estimator, also known as the "within estimator," focuses on variation within a panel and estimates the average reported difference in individuals' happiness reported across different activities, including travel by specific modes. Online Appendix C provides the parameter estimates and T-statistics for the activity controls not reported here.

Unlike in the OLS models, travel in general no longer has a statistically significant correlation with total reported affect in relation to all other activities. Car drivers and car passengers continue to have above average reported levels of total affect, but the difference from travel in general is no longer statistically significant at the 95th percent confidence level. Bus use is significantly correlated with lower total affect. By contrast, train use no longer has a significant difference from travel in general. An additional difference between model types is that utilitarian walking is no longer associated with greater happiness levels. Bicycling is associated with the highest mean affect of any mode, a finding which attains statistical significance relative to travel overall at the 90th percent confidence level in our most complete model. Commuting to work continues to be strongly associated with lower levels of total affect, and interacting with people with higher levels. Again, mode and travel in general tend to have only a small total influence on reported levels of total affect. Unobserved factors account for a large majority of differences in mood both within and across individuals.

Discussion/Conclusion

The first observation that flows from our findings is that whether one is traveling or not, and one's choice of mode when doing so, are but small contributors to affect. Indeed, the activity in which an individual engages is, in general, of surprisingly limited efficacy in predicting mood, as is suggested by the low R^2 statistics in the models. White and Dolan (2009) also found low predictive power—an R^2 of 0.09—when modeling the pleasure felt during daily activities.

Thus in one sense our findings might be interpreted to mean that the effects of travel and mode are quite limited. However, we also find that the impact of travel on mode is not trivial, and in many cases our findings are that the impacts of the travel activity and travel mode are statistically distinguishable from zero. Hence, provided the caveats in the previous paragraph are kept in mind, travel and mode do measurably impact mood, and implications for scholarship and policy interventions based on these findings should be investigated.

Table 3 Fixed-effects panel regressions of the influence of travel and travel mode on total affect

	Model 1	Model 2	Model 3	Model 4
Traveling	−0.00117		–	–
	(−0.04)			
Car driver	–	0.0189	0.0989	0.163
		(0.55)	(1.14)	(1.86)
Car passenger	–	0.0668	0.188	0.119
		(1.10)	(1.87)	(1.18)
Bus	–	−0.513**	−0.435*	−0.387*
		(−2.97)	(−2.32)	(−2.07)
Train	–	−0.100	−0.0735	0.0110
		(−0.45)	(−0.32)	(0.05)
Walking (utilitarian)	–	−0.231*	−0.136	−0.107
		(−2.06)	(−0.98)	(−0.77)
Bicycle (utilitarian)	–	0.278	0.335	0.401
		(1.34)	(1.57)	(1.79)
Work-related travel	–	–	–	−0.194**
				(−2.85)
Interacting with another person	–	–	–	0.233***
				(7.55)
Activity controls	No	No	Yes	Yes
Constant	2.933***	2.933***	2.841***	2.749***
	(413.31)	(421.03)	(34.81)	(32.76)
N	37841	37841	37841	37841
Rho	0.667	0.667	0.671	0.67
R^2	0.001	0.001	0.037	0.042

T-statistics in parentheses. *Rho* is fraction of variation due to individual-specific constants

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Is travel enjoyable? Contrary to traditional thinking, the results outlined above suggest that it is hardly an unequivocally unpleasant chore that is of value only due to the broader utility reaped at the destination. Our OLS models suggest that, across individuals, travel itself is actually associated with more positive affect than the average of all other activities. Our fixed-effects models, by contrast, show that individual travelers enjoy approximately the same level of affect that they do on average at other times, but it is still noteworthy that they do not show travel to be unenjoyable. People tend to be in a significantly better mood when traveling than when working or attending school. By contrast, they are in a significantly less positive mood than when socializing, eating and drinking, volunteering or attending religious services (See Online Appendix C).

These findings suggest three further noteworthy points. First, the difference between the OLS and fixed-effects models implies that happier people are more likely to travel than the unhappy. The OLS tells us that if we pick a random individual who is traveling, that person (controlling for other factors) is statistically significantly likely to be relatively happy. The fixed-effects model tells us that if we pick a random individual, that person is likely to be almost exactly as happy while traveling as he/she is while participating in his/her other activities on average. If travelers are, as a group, happy, and yet travelers are no more

happy while they are traveling than when participating in their other activities, it implies that travelers are self-selected and are disproportionately happy. One possible explanation for the relationship between mood and travel across individuals is that intrinsically happier people tend to engage in more out-of-home activities. (Intrinsic happiness is a characteristic we fail to directly observe, and a significant omission from the OLS models, since recent studies find that perhaps one-third or even 50 % of the observed variance in life satisfaction is genetic and inherited; De Neve et al. 2012; Nes et al. 2006.) We find the explanation that the intrinsically happy are more likely to travel quite plausible. Another possible explanation is that people who are traveling are disproportionately likely to be happy because they engage in more activities outside the home, that these activities elevate mood, and that this positive mood spills over into the times they are traveling (a halo effect).

The second implication is that our design allows us to weigh in on the direction-of-causality issue that frequently bedevils work using regression. By estimating the differences in reported happiness across activities for each individual, the fixed-effects models control for the each individual's mean state of happiness during reported activities, as well as all other time-invariant, individual-specific characteristics. Thus it is irrelevant in these models whether intrinsically happy individuals are more likely to travel, or choose a particular mode, only whether individuals, happy or not, enjoy better mood during travel rather than outside it. This model strengthens the case for a direct causal path from travel to happiness (or at least a lack of unhappiness). Although an individual may choose to travel based on a particularly positive or negative transitory mood, this is only likely to account for a small fraction of our sample. Nearly all travel was undertaken to get to work, shopping, church, school or some other activity that is generally planned well in advance of fluctuations in mood. Plans, of course, may change based on mood, but the theoretical causal pathway from travel to mood is significantly more straightforward and convincing than the pathway from mood to travel.

The third implication confirms findings that travel is not an entirely derived demand but has value in and of itself. This includes utilitarian as well as recreational travel. Given that travel clearly has considerable costs to the individual—in terms of money, time, danger of physical harm, psychological stress, etc.—the finding that travel is not particularly emotionally deleterious suggests that there must be positive aspects of travel itself which offset some of its burdens. In fact, it is possible that, at least in some circumstances, the desire to travel might induce the demand for out-of-home activities; one might decide he/she wants to get out of the house on Saturday night and then seek to come up with a suitable destination. While it is undoubtedly rare that the desire to travel ever wholly motivates a trip and its associated activity, it is very likely that in many cases the desire to travel changes behavior in cases at the margin—for example people who are close to undertaking a trip/activity, but are slightly below the threshold for undertaking it, may in some cases be pushed over that threshold by some positive aspects of the trip itself.

Some possible causes for the happiness created by travel have been posited by other researchers, as outlined above. If this is the case, it suggests revisiting the assumption made in traditional travel demand modeling that travel time is an unalloyed source of disutility that is in all cases minimized by the traveler. Future research should investigate what circumstances contribute to a more or less emotionally satisfying trip and potentially include them in mode and route choice modeling. For example, if the thrill of speed is found to be a source of positive affect, it suggests that circuitous routes with less congestion may be chosen by many motorists even if there is another, congested, route with a lower travel time. If the enjoyment of scenery is of importance, perhaps aesthetics could be

captured in modeling, with more attractive routes being assigned more traffic than the minimization of travel time and cost would dictate.

In terms of mode, our results are not unexpected. We find that bicyclists are the happiest travelers, particularly when we control for the fact that bicycling is a solitary activity. However, there are two caveats. First, we do not observe enough cases of bicycling for its effect to be statistically distinguishable from travel in general. However it is important to note that despite the relatively small number of observations, bicycling is significantly associated with higher affect than walking and bus riding, despite the fact that the standard error varies inversely with the square root of the sample size. That biking is statistically more positive than two other modes is a testament to the large magnitude of biking's estimated coefficients. This suggests that a study with a larger sample size of bikers would also find biking to be associated with a demonstrably more positive mood than auto travel. Hence our findings on biking should be viewed with caution, but this caution should primarily stem from the fact that, at least in terms of statistical significance, we likely understate the positive effects of biking on mood, not vice versa. In any event, further research should address the question of whether biking does indeed powerfully elevate the mood of riders by employing larger sample sizes.

The second caveat involves self-selection. Although we exclude purely recreational trips from our analysis, bicyclists tend to be enthusiasts for their mode as well as people physically capable of relatively strenuous activity. Hence we emphatically do not claim that putting a randomly selected individual on a bicycle would result in levels of mood as elevated as we observe in our sample. Nevertheless, our findings do suggest that there are people on the margin of choosing to bike who would be enjoying this activity if society made it somewhat more easy to undertake, for example through the provision of more bike lanes. In all, our findings suggest that promoting or facilitating bicycle use may have additional benefits beyond public health, transportation and the environment. Future research should examine whether this apparently enjoyable, as well as sustainable, mode improves mood for current non-cyclists as well as current cyclists, perhaps by focusing on cities like Copenhagen where much higher and more diverse shares of the population cycle and which suggest that the right suite of public policies could dramatically increase the bicycling share here in the US.

In all, we find that auto travel is the second most enjoyable mode. In our preferred model, both driving and riding as a passenger are significantly associated with more positive affect than walking and bus riding. This finding is unsurprising in light of the literature outlined above, as well as the revealed preferences of Americans, for whom car ownership is nearly universal except for the poor (Pucher and Renne 2003). The novel finding here is that car passengers have higher affect than drivers. However, the pleasure of interacting with another person—or perhaps the displeasure of being around someone without interacting—helps explains the observed difference. When interaction with others is controlled for, drivers are somewhat happier than passengers. That said, the difference between parameter estimates for drivers and passengers is not statistically significant in any model. Together, these findings suggest that the feeling of mastery, thrill of speed or other aspects of driving may at least in part offset the more tedious aspects of operating a vehicle. Hence driverless cars will likely have to provide advantages above and beyond freeing the driver from the task of driving to be successful; riding as a passive passenger as opposed to being an active driver might not be as enjoyable as some autonomous vehicle advocates assume.

We find that walkers do not have particularly positive affect. In our fixed-effects models, walking exerts a modest negative influence on affect, and the mode is significantly

less pleasant than auto travel or biking. We suspect, however, that utilitarian walking masks important differences by traveler, conditions and purpose. For the poor who lack the means to own autos, walking might be an onerous chore that involves long and draining trips, while on the other hand discretionary walkers who could drive or take taxis but instead walk for the exercise or aesthetic enjoyment might very much enjoy this mode. Prior work has found that satisfaction with walking does vary greatly by traveler type (Manaugh et al. 2012); future research should attempt to further examine the relationship between happiness and walking, taking trip duration, weather, neighborhood characteristics, socioeconomics, attitudes, and vehicle availability into account. (Note that Table 2 shows that the standard deviation of affect scores among walkers is higher than for any other mode, suggesting our hypothesis is correct.)

In general, in concord with prior research we find that transit travelers are the least happy. Train travel fares poorly in the across-individual models, and bus travel is significantly associated with negative affect compared to auto travel, biking, and travel in general in the within-individual models. We find that some, but only a small amount, of these negative feelings can be explained by the fact that transit is disproportionally used for the unloved work trip. It is true that we find that a large majority of what contributes to mood is unrelated to mode, or even the activity an individual happens to be undertaking. So it is possible that, to the extent that transit may under certain circumstances have benefits to society (e.g. the environment), our findings may be interpreted to suggest that it is worth inflicting the relatively small amount of unpleasantness we uncover here in pursuit of broader societal goals.

Still, individuals must be persuaded to use transit by free choice, so understanding, and rectifying, the factors that cause the transit experience to be associated with negative feelings is critical for those who wish to promote transit travel as a substitute for the automobile. Prior literature suggests possible sources of low affect which might be addressed include unreliability, uncertainty, large headways, long travel times, uncomfortable and unpleasant vehicles, enforced standing and exposure to the elements and potential crime at stops and stations (Iseki et al. 2012; Stradling et al. (2007a, b); Weinstein 2000). Feasible and low-cost solutions for some of these problems, such as next vehicle message boards which improve the traveler's affective experience by reducing uncertainty, should be explored and implemented.

Finally, it is important to acknowledge that the state of existing modal facilities is likely to influence mood. Public transit users may be significantly happier in places where service is much better than in the US, while drivers may be less happy when, for example, parking is not ubiquitously and almost entirely freely provided. Nevertheless, the findings here send a hopeful message about the potential for greater bicycle use in the US, while reminding us that our current public transportation system is leaving a lot of unhappy customers and that, for all the rhetoric about long trips and increasing congestion, driving is not so unpleasant.

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