How useful is travel-based multitasking? Evidence from commuters in Portland, Oregon

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Abstract

As research on travel-based multitasking—doing other things while traveling—becomes more common, some studies also investigate the quality or value of activity participation during travel. This idea of *travel usefulness* is a component of the positive utility of travel concept; understanding the benefits of travel-based multitasking is important for calculating accurate economic values trading-off travel time and other variables. This study analyzed travel usefulness and its potential determinants using a 2016 survey of about 650 commuters in the Portland, Oregon, area. Ordered logit models identified factors associated with subjective assessments of the overall usefulness of activity participation while on a recent commute trip. Around 90% of walk and bicycle commuters reported useful commutes, as did about half of transit commuters and auto passengers; however, half of auto drivers viewed their commutes as wasted time. Younger travelers, those with less frequent commutes, and people who reported "doing nothing" or more passive activities (window-gazing, daydreaming) on the trip were more likely to consider their commuting time to be a waste. Traveler perceptions were more closely associated with travel usefulness than socio-demographic characteristics. Results suggested that exercise and the physical activity benefits of walking and bicycling may be considered a useful form of travel-based multitasking. Overall, few common and traditionally-productive multitasked activities appeared to be useful. Instead, commuters may be doing things more to pass the time than to make productive use of it. These findings offer implications for understanding travel behavior interventions and the potential use of autonomous vehicles.

Introduction

Traditional transportation analysis methods, including those that underlie travel demand forecasting models and tools for transportation project appraisal, assume the demand for passenger transportation is derived from the demand for conducting activities in spatially distinct locations. A corollary of this axiom is that travel time is a disutility that travelers desire to minimize. As a result, the primary user benefit of large, mobility-enhancing transportation projects is the aggregate value of travelers' marginal travel time savings. Over the past two decades, scholars have questioned the universality of these assumptions, instead suggesting and providing evidence that some travel may be motivated by factors other than reaching activity destinations and that some people may benefit from the act of traveling itself. These perspectives are known as the *positive utility of travel* concept (*1*, *2*).

One major component of the positive utility of travel is *travel-based multitasking*: doing other activities while traveling (*3*). (A second aspect includes benefits from the experience of traveling itself, expressed by positive emotions or symbolic fulfillment from traveling.) People who do things while traveling presumably benefit from the activities. Foremost, they may be making productive use of their travel time (*4*) by doing traditional work, maintenance, or leisure activities: writing or reviewing documents, eating a meal, reading a novel, etc. For some, traveling (and commuting in particular) can be a time of transition (*5*), providing a buffer between home and work and allowing the traveler to mentally prepare for obligations at the destination, or a time to relax and escape from such obligations. People who use their commutes to snooze or sleep, think, daydream, or stare out the window at the passing (natural or urban) landscape may have some of these goals in mind. Still other activities may be less about productivity or mental health and more about making travel less onerous or more enjoyable: Checking social media, playing a game, and listening to music are all activities that can reduce the disutility of traveling.

An important question arising from the study of travel-based multitasking is about *travel usefulness*: How much do people value the activities they conduct while traveling? This question is especially relevant considering the importance of the value of travel time savings (VTTS) for transportation project appraisal (*6*). This measure of the willingness to pay for a marginal reduction in travel time is usually derived from travelers' revealed or stated preferences when faced with tradeoffs between travel time and cost, and it is an important input to the cost-benefit analysis of major mobility-enhancing infrastructure investments. If travelers value multitasked activities, then current VTTS estimates may be biased, yielding incorrect predictions of travel behavior shifts and calculations of user benefits. Work is underway to more formally consider activity participation during travel within microeconomic time use and allocation theories (*7*), and there is emerging research that suggests travel-based multitasking may indeed affect VTTS (*8*, *9*). Understanding the usefulness of travel activities is an important part of these efforts.

Research questions

The goal of this study is to further our understanding of the travel usefulness concept and its relationship with travel-based multitasking. Specific research questions include: How useful is travel-based multitasking? How much do people value the time they spend engaged in activities while traveling? Which activities are considered most useful? What trip and traveler characteristics are associated with travel usefulness?

These questions are answered through an analysis of the results of a 2016 survey of commuters in the Portland, Oregon, metropolitan area. The paper is structured as follows. First, a brief literature review summarizes travel-based multitasking, travel usefulness, and their

associated factors. Next, the data and methods are described. Results of ordinal logit models of travel usefulness are then presented. Finally, the paper closes with a discussion of the results and implications of this study, including limitations and future work.

Literature review

Travel-based multitasking

Research on travel-based multitasking was rare before the first decade of the 21st century (*10*). Since then, a growing number of studies have investigated the things people do while traveling as well as factors potentially associated with this activity participation (*11*). Research often focuses on public transit passengers (e.g., *12*, *13*) because they may be better able to engage in a greater number and variety of activities while traveling. However, a growing number of multimodal studies find significant differences between passive or passenger modes and those requiring more active attention (*14–17*). For instance, car drivers are more likely to be listening to music; reading, writing, and resting are more common among transit or car passengers; and exercise is nearly exclusive to walking and bicycling. Other trip characteristics, including travel time and trip purpose, also appear influential. Gender and especially age are among the most consistently-associated socio-demographic characteristics: younger travelers do more technology-based activities, while older travelers may be more likely to read paper media. Some evidence suggests a link between attitudes or perceptions and travel-based multitasking (*14*), yet more research is needed (*11*).

Travel usefulness

Despite a widening examination of potential determinants of travel-based multitasking, most studies still only measure or model activity participation itself. Recently, the purview of scholars has expanded to reflect an interest in knowing not just the activities people do while traveling but also the quality of travel time use. In response, some travel-based multitasking questionnaires have begun to ask travelers to assess the value, worth, or usefulness of a trip.

Three surveys of rail passengers in Great Britain in 2004, 2010, and 2014 using questions designed by Lyons and Jain offer a longitudinal perspective into subjective valuations of travel time use (*13*, *18*, *19*). The questionnaires asked travelers to report if they "made very worthwhile use of my time," "some use of my time," or whether "my time spent on this train [was] wasted." Between 2004 and 2010, there was a significant increase in the percentage of people making "very worthwhile" use of travel time (24% to 31%) and a significant decrease in reports of "wasted time" (19% to 14%); few changes occurred between 2010 and 2014. Commuters were less likely and business travelers more likely to view their time as worthwhile. Peak period travelers had somewhat more wasted time than rail passengers traveling off-peak. Almost twice as many adults aged 65+ had worthwhile trips than did adults aged <35 (38% vs. 21%).

Susilo et al. (*20*) examined subjective assessments of travel time use from the 2010 Great Britain rail passenger dataset in more detail using multinomial logit models, offering a multivariate analysis of potential determinants. Engagement in traditionally-productive activities—studying or working, texting or calling for work, and checking emails—appeared to be more worthwhile, while participation in more passive activities—window-gazing or people-watching, sleeping or snoozing—was associated with reporting wasted time. Travel time negatively affected perceived travel time usefulness for leisure travelers but not for business travelers. Among traveler

characteristics, age differences were again the most substantial: younger travelers (under age 45) were more likely to report "wasted time" than older travelers.

A few multimodal studies are beginning to examine differences in perceived travel usefulness by users of different modes. In a 2011–12 study in Northern California, Circella et al. (*17*) asked commuters to report the subjective value of travel time use on a five-point scale from "mostly wasted time" to "mostly useful time." Overall, 20% of commuters said their travel time was mostly useful, while only 8% reported it to be mostly wasted. Car drivers had the most wasted and least useful commutes, followed by car passengers; transit, train, and bicycle commuters had the most useful commutes. Using ordered probit models, the authors then analyzed factors associated with travel usefulness. There was a positive association between usefulness and age as well as traditional paper and electronic activity participation, but only for "passive" (car, rail, or transit passenger) modes.

Rosenfield and Zhao (*21*) also investigated the quality of travel time use across various modes, asking a slightly different question about "[making] use of your commute time effectively." Overall, car drivers reported the poorest quality of time use, while people walking and bicycling had higher qualities; bus and rail passengers were somewhere in the middle.

Based on the results summarized above, in general, only 10–30% of travelers view traveling as mostly wasted time, whereas typically a greater proportion (roughly 20–30%) report travel time to be very worthwhile or mostly useful. Age differences seem significant: Younger travelers appear more likely to consider traveling to be wasted time. People doing traditional work-related activities (reading, writing, or emailing) are more likely to see travel time as being useful, and people doing more passive activities (window-gazing, people-watching) are more likely to report wasted time, although these results could vary by mode (*17*).

It is reasonable to assume that questions of travel usefulness are attempting to measure an overall assessment of the value of travel-based multitasking. However, when considering the usefulness of a trip, respondents may confound the intended benefits of multitasking (e.g., productive use of travel time, preparation for a destination activity) with enjoyment of the travel experience or the instrumental benefits of reaching a destination (*3*). This possibility should considered when analyzing travel usefulness.

Data and methods

This paper fits within a larger study investigating the positive utility of travel (PUT) concept and its effects on mode choice (*22*). The dataset used in this study included a 30-minute online questionnaire survey administered to working and commuting adults in the Portland, Oregon, region regarding their most recent commute trip from home to work. After answering detailed questions about travel-based multitasking—the subject of a separate companion paper (*16*)—respondents then answered a single summary question about travel usefulness. Participants were recruited primarily via email at workplaces between mid-October and mid-December 2016. Only 656 of the 791 people who started the survey completed enough questions to be used in these analyses. Singleton (*22*) provides more information on the data collection process.

In order to solicit subjective assessments of travel usefulness, the questionnaire approach to measuring travel-based multitasking was chosen. First, respondents selected from a list of 23 activities all the things they did between home and work on their most recent commute trip. Next, for each selected activity, participants reported the approximate percentage of time (0–100% in 10% increments) they spent doing that activity during the trip. Singleton (*16*) describes how these 23 activities were selected from a master list compiled from prior studies. For this analysis, five

activities were removed due to low response frequencies (< 15), and five other activities were combined into two activity groups using exploratory factor analysis; see Singleton (*16*) for details. The final activities used in this study, along with the percentage of commuters (by mode) reporting each activity, are shown in TABLE 1.

TABLE 1 Travel Activities and their Reported Prevalence by Commute Mode

	Commute mode				
Activity	*Walk*	*Bicycle*	*Auto, driver*	*Auto, passenger*	*Transit*
"Information and communications technology" (ICT)-related activities	30%	0%	9%	29%	69%
Texting, emailing, or other messaging	(30%)	(0%)	(7%)	(20%)	(56%)
Reading electronically (e-book, website)	(3%)	(0%)	(1%)	(17%)	(41%)
Using social websites or apps (Facebook, Twitter, LinkedIn, Tumblr, Instagram)	(13%)	(0%)	(2%)	(14%)	(34%)
"Passive" activities	83%	82%	49%	63%	62%
Viewing scenery; watching people	(67%)	(73%)	(29%)	(49%)	(50%)
Thinking or daydreaming	(63%)	(60%)	(37%)	(51%)	(48%)
Talking face-to-face with people you know	10%	15%	10%	71%	11%
Talking face-to-face with strangers	30%	10%	1%	6%	17%
Talking on the phone	13%	2%	11%	0%	4%
Reading print (newspaper, book, etc.)	0%	1%	0%	0%	33%
Listening to music, radio, or other audio	20%	16%	79%	66%	29%
Playing game (Pokémon Go, puzzle, etc.)	3%	0%	1%	3%	16%
Eating food; drinking beverage	17%	4%	33%	31%	14%
Personal grooming (shaving, makeup, etc.)	0%	0%	4%	14%	2%
Singing; dancing	3%	8%	8%	6%	0%
Exercising or being physically active	60%	89%	1%	0%	5%
Planning or navigating this trip	10%	11%	12%	6%	6%
Sleeping or snoozing	0%	0%	0%	11%	11%
Doing nothing	10%	6%	10%	14%	7%

After soliciting responses on activity participation and (percentage) duration, the survey asked about travel usefulness: "In terms of its value to you, overall, how useful would you rate the time you spent commuting? Ignore the value of getting to your destination, and think only about the things you did while commuting and the time you spent doing them." This language was borrowed from Circella et al. (*17*). Responses were on a five-point Likert-type scale: "Mostly wasted; Somewhat wasted; Neither wasted nor useful; Somewhat useful; Mostly useful." Restrictions on the survey length prevented additional detailed questions about the quality of travel-based multitasking (*21*) from being asked.

Since the travel usefulness question was measured on an ordinal scale and responses were not normally distributed (negatively skewed and platykurtic), an ordered logit model of travel usefulness was estimated. Other studies have used multinomial logit (*20*) or ordered probit (*17*) models to predict travel usefulness. Ordered logit and ordered probit models usually yield similar results with respect to tests of parameter significance. Model estimation was conducted using the MASS (*23*) and stats packages in R.

TABLE 2 summarizes the independent variables used in the models and their descriptive statistics. Variables included trip characteristics (commute mode, travel time, number of cotravelers), weather (temperature, precipitation), traveler demographics and socioeconomics (individual, household, transportation, and job attributes), and traveler perceptions (satisfaction

with typical commute travel time, self-reported ideal commute travel time, travel liking, and the teleportation test). These variables have been used in other travel-based multitasking studies and were available for most cases. Previous research on the positive utility of travel concept has employed the traveler perception questions (*24*, *25*). Independent variables were examined for multicollinearity issues before entering the model, and moderately-to-strongly correlated (> 0.40) ones were removed.

TABLE 2 Descriptive Statistics

	Categorical		*Continuous*	
Variable	*#*	*%*	*Mean*	*SD*
Trip characteristics				
Mode: Walk	30	4.3		
Bicycle	114	16.5		
Transit	175	25.4		
Auto, passenger	35	5.1		
Auto, driver	336	48.7		
Travel time (minutes)			35.66	21.27
# cotravelers			0.24	0.70
Temperature (°F) Δ from average			2.71	5.15
Day precipitation ≥ 0.10 in	155	22.9		
Traveler socio-demographics				
Age: 18–34 years	142	19.4		
35–44 years	190	25.9		
55–64 years	174	23.7		
65+ years	48	6.5		
Gender: Female	403	55.4		
Race/ethnicity: Missing	24	3.3		
Hispanic/non-white/multiple	101	13.7		
Disability	54	7.3		
Student	54	7.3		
Education: No college degree	131	17.9		
Graduate degree	318	43.4		
# children (age ≤ 16)			0.41	0.81
# workers			0.51	0.71
# seniors (age 65+)			0.06	0.28
Income: $0–50k	64	8.7		
$50–75k	125	17.0		
$100–150k	196	26.6		
$150k+	135	18.3		
Missing	55	7.5		
Multifamily home	148	20.6		
Lived in home: 0–5 years	306	42.6		
# cars			1.74	1.03
# bicycles			2.46	2.03
Car-share member	173	23.8		
Bike-share member	70	9.6		
Transit pass	307	42.2		
# commute days			4.62	0.89
# hours worked			42.34	10.25
Flexible work schedule	451	62.8		
Self-employed	33	4.6		
Traveler perceptions				
Typical travel time: Dissatisfied	239	34.2		

Variable		*Categorical* #	*Categorical* %	*Continuous* *Mean*	*Continuous* *SD*
Ideal travel time (minutes)				13.70	8.76
Teleportation: No		261	37.5		
Travel usefulness:	Mostly wasted	81	11.8		
	Somewhat wasted	128	18.7		
	Somewhat useful	176	25.7		
	Mostly useful	157	22.9		
Travel liking:	Disliked	106	15.6		
	Somewhat liked	238	35.1		
	Strongly liked	189	27.8		

Results

Travel usefulness by mode

FIGURE 1 displays responses to the travel usefulness questions, summarized by commute mode. Overwhelmingly, most people walking (87%) and bicycling (94%) reported having at least somewhat useful commutes, with the most useful commutes experienced by people bicycling (68% mostly useful). Slightly more than half of transit commuters (57%) and auto passengers (54%) reported useful commutes, while about half of auto drivers felt like their commuters were at least somewhat wasted time (50%). There appear to have been significant modal differences in reported travel usefulness.

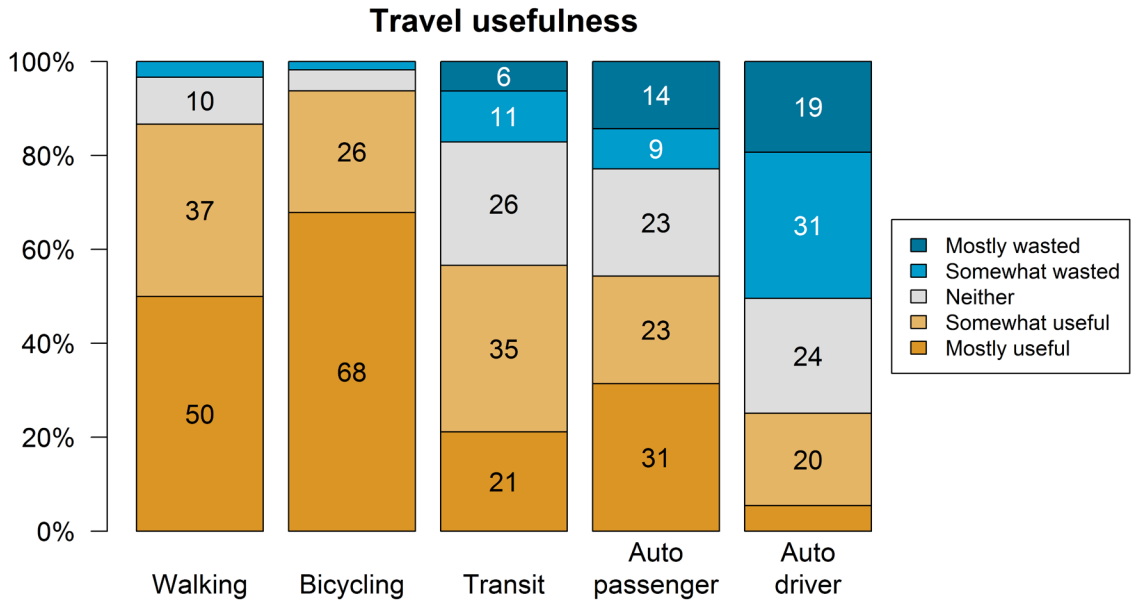

FIGURE 1 Travel usefulness by commute mode.

Determinants of travel usefulness

To understand factors associated with ratings of travel usefulness, several ordered logit models were estimated using a variety of specifications. Model estimation results are shown in TABLE 3 for two different models: the primary model (A) using activity participation (yes vs. no), and an alternate model (B) using activity duration (minutes). The activity duration model is shown because it offers different interpretations of travel time and activity engagement during travel than

the activity participation model. The dependent variable in both models is the ordered categorical travel usefulness variable, with "Mostly useful" as the most positive category. (The reference category for commute mode is "Auto, driver," and the reference category for travel liking is "Neither disliked nor liked.")

Because specific activities are difficult or unlikely on certain modes, and because modal characteristics likely affect the quality of activity participation, the travel activity variables were tested for significant interactions with commute mode. Each activity was interacted with a variety of possible modes or modal groupings; although, to reduce the possibility of finding spurious associations (and to ensure that models were estimable), groupings had to include a minimum 15 observations of those mode users reporting that activity. (Thus, walk/bicycle commuters and auto drivers/passengers were often grouped together.) If modal interactions were not significant for a given activity, that activity was included in the model with no interaction terms.

TABLE 3 Results of Ordered Logit Models of Travel Usefulness

	Model A with activity participation			*Model B with activity duration*		
Variable	*B*	*SE*	*p*	*B*	*SE*	*p*
Trip characteristics & weather						
Mode: Walk	1.899	0.929	0.041 *	1.779	0.518	0.001 *
Bicycle	3.448	0.847	0.000 *	2.481	0.418	0.000 *
Auto, passenger	2.303	0.810	0.005 *	1.423	0.476	0.003 *
Transit	1.236	0.534	0.021 *	1.898	0.362	0.000 *
Travel time (minutes)	–	–	–	−0.009	0.007	0.225
Travel time × Walk	0.041	0.023	0.070 ~	–	–	–
Bicycle	0.024	0.016	0.152	–	–	–
Auto, driver	-0.008	0.007	0.275	–	–	–
Auto, passenger	-0.045	0.021	0.031 *	–	–	–
Transit	-0.005	0.008	0.503	–	–	–
Day precipitation ≥ 0.10 in				−0.379	0.198	0.056 ~
Travel activities (participation or duration)						
Passive activities × Walk & Bicycle	-1.793	0.664	0.007 *	–	–	–
Transit	–	–	–	-0.015	0.006	0.019 *
Talking with people you know × Auto, driver & Auto, passenger	0.807	0.379	0.033 *	0.035	0.018	0.057 ~
Personal grooming × Auto, driver	–	–	–	-0.071	0.033	0.031 *
Singing; dancing × Auto, driver	1.097	0.413	0.008 *	0.086	0.024	0.000 *
Exercising; being physically active × Walk & Bicycle	–	–	–	0.030	0.012	0.013 *
Planning or navigating this trip × Bicycle & Auto, driver	-0.665	0.306	0.030 *	–	–	–
Doing nothing × Auto, driver & Auto, passenger	-1.429	0.419	0.001 *	-0.079	0.035	0.025 *
Traveler socio-demographics						
Age: 18–34 years	-0.531	0.289	0.067 ~	-0.567	0.295	0.055 ~
# children (age ≤ 16)	0.189	0.110	0.087 ~			
Income: $100–150k				-0.408	0.236	0.084 ~
# commute days	0.214	0.105	0.042 *	0.219	0.106	0.040 *
Traveler perceptions						
Typical travel time: Dissatisfied	-0.391	0.202	0.053 ~	-0.435	0.204	0.034 *
Teleportation: No	0.592	0.179	0.001 *	0.600	0.179	0.001 *
Travel liking: Disliked	-0.603	0.278	0.030 *	-0.681	0.284	0.017 *

Variable	*Model A with activity participation*			*Model B with activity duration*		
	B	*SE*	*p*	*B*	*SE*	*p*
Somewhat liked	0.962	0.219	0.000 *	1.037	0.224	0.000 *
Strongly liked	2.324	0.272	0.000 *	2.298	0.274	0.000 *
Model fit statistics						
Sample size (*N*)	642			619		
Deviance (thresholds model), *df*	2,021.7	638		1,944.8	615	
Deviance (full model), *df*	1,476.1	570		1,423.8	553	
Likelihood ratio test (ΔG^2), Δdf, *p*	545.7	68	0.000 *	521.0	62	0.000 *
McFadden's pseudo-R^2	0.270			0.268		
Trip characteristics only	0.155			0.145		
Travel activities only	0.109			0.101		
Socio-demographics only	0.042			0.042		
Perceptions only	0.162			0.162		

Statistical significance: * = $p \leq 0.05$, ~ = $p \leq 0.10$.
Coefficients with $p > 0.10$ for all variables (except travel time) not shown.
– Independent variable not included in model. Threshold parameters not shown.

Differences between the two models were also found for travel time. In model A with mode-specific travel times, longer commutes were more wasteful for auto passengers but more useful for people walking; the travel time coefficient for bicycling was also positive but not significant. In model B, the generic travel time coefficient was negative but not significant. When this interaction was specified (model not shown), the coefficient for auto drivers was negative and marginally significant, and the positive coefficient for walking approached significance. More interestingly, adding this interaction made the coefficient on the exercising activity no longer significant, suggesting high correlations between times spent walking or bicycling and time spent exercising or being physically active.

After controlling for mode-specific activity participation, travel time (by mode), and traveler characteristics, modal differences remained. Bicycling and walking commuters as well as auto and transit passengers all found their commutes to be more useful than did auto drivers; bicycling remained the most useful mode. Commuters traveling on a day with rain reported slightly lower levels of usefulness, although this was not significant in model A.

Few socio-demographic characteristics were significant predictors of travel usefulness in both models. Age appeared to be positively associated with travel usefulness: Younger travelers (aged 18–34) were more likely to report their travel time as being less useful. Those who commuted more frequently viewed their travel time as being more useful.

Instead, traveler perceptions were more strongly associated with travel usefulness. Travelers who were more satisfied with their typical commute travel time and those who would rather not teleport to work reported more useful commutes. Notably, travel liking and travel usefulness on a recent commute trip were strongly and positively related. Given these significant associations, models were also estimated without traveler perceptions variables; results (not shown) were similar with some key exceptions. In both models, mode-specific constants had a larger magnitude, as did travel time coefficients: In model A, travel time was a negative and significant variable for all motorized modes; in model B, the generic travel time coefficient was negative and significant. For travel activities, there were no changes to the significance or signs of modal interaction terms. For traveler socio-demographics, in both models, people living in low-income households, owning fewer bicycles, and those with flexible work schedules were more likely to report making better use of their travel time.

Discussion

Determinants of travel usefulness

This research provides insights into subjective assessments of the usefulness of time spent traveling. Consistent with recent studies, about 12% of commuters viewed their travel time as mostly wasted, while about twice as many (23%) thought their commutes to be mostly useful. Modal differences in travel usefulness were similar to those found in one previous multimodal study (*17*): Most *active mode* (walk, bicycle) travelers rated their commutes as useful, and more than half of *riding mode* (transit, auto passenger) users had at least somewhat useful commutes; but around half of auto drivers considered their commutes to be wasted time. These conclusions held even after controlling for travel time, activity participation, and traveler characteristics.

Few traditional traveler attributes were associated with travel usefulness: A model with only socio-demographic characteristics had very low goodness-of-fit ($R^2 = 0.04$). As in previous research, age was a positive factor: Younger travelers were more likely to consider their commutes to be wasted time. The lack of significance of most demographic and socioeconomic traveler characteristics foretells difficulties in predicting how useful people will consider their commutes to be without asking them directly.

Instead, traveler attitudes and perceptions seem more closely tied to subjective valuations of travel time, as has been found in the past (*17*). People who were more dissatisfied with their typical commute travel time reported more wasteful commutes, while people who did not want to teleport to work had more useful commutes. The inclusion of these variables in the model raises questions about endogeneity: Are people less satisfied with their typical travel times because they do not make productive use of them? Do people prefer not to teleport because they find some aspects, like activity participation, to be useful? A more complex analysis utilizing (for instance) longitudinal structural equation modeling could help to illuminate these potential bidirectional effects but is beyond the scope of this paper and this dataset.

Despite these valid concerns, there are reasons why including such perceptions into a model of travel usefulness may be an appropriate choice. First, a large amount of the variation in travel usefulness (roughly 75% of the thresholds-only model deviance) remained unexplained by the independent variables, suggesting that the association with these perceptions is not strongly deterministic. Second, the perception questions (about travel time satisfaction and the teleportation test) asked specifically about a general condition (a traveler's *typical* commute), while the travel usefulness question asked about a specific case (a traveler's *most recent* commute trip to work). The consideration of time precedence (*26*) suggests that the general condition might cause the specific case but not the other way around. Of course, with cross-sectional data, the endogeneity issue may empirically remain. In fact, it could be likely that, for a frequently repeated travel behavior like commuting, people have the opportunity to equilibrate their prior perceptions about the usefulness of travel and their satisfaction with travel time such that their perceptions fall more in line with their day-to-day experiences. These issues suggest the need to conduct longitudinal studies examining changes in perceptions of travel usefulness.

The travel liking variable was included in the model as a control variable and to specifically address a concern noted in the literature review: that self-reports of the productive time use benefits of travel-based multitasking may have been confounded with enjoyment of the travel experience, as measured by travel liking. In short, people may have reported a useful commute in part because they liked it. Indeed, the model results provide evidence that this may have been the case: Travel

liking was positively and significantly related to travel usefulness. Further, the positive effect of singing or dancing—activities that have perhaps the least instrumental or traditionally-productive value to travelers—suggests that travelers may have been conflating travel usefulness with travel enjoyment. Nevertheless, this issue may be somewhat exaggerated. Conflation could have happened in the opposite direction too: People may have considered the value of their activity participation when considering how much they liked the trip. This bidirectional effect is perhaps likely, given that the travel usefulness question was asked prior to the travel liking question and prior to all other questions about the travel experience. Improvements to the way in which travel usefulness (and liking) questions are asked could help to further distinguish the two concepts.

The usefulness of travel-based multitasking

The issues raised in the preceding paragraphs suggest the need for more research on travel usefulness and other subjective assessments of travel-based multitasking. Different question wordings or orders could be tested to examine which one best measures the desired construct (the value, worth, or usefulness of activity participation during travel). The finding that many common activities did not significantly predict travel usefulness may suggest that different kinds of questions are needed, perhaps those asking more about the quality of people's effective time use (*21*). The questionnaire used in the current study specifically eschewed the term "productive" based on the assumption that people may not consider valid examples of travel-based multitasking or travel time use (e.g., listening to music, reading for pleasure) to be traditionally productive activities: i.e., associated with work or job responsibilities. This assumption could be revisited.

This discussion raises broader but related questions: To what extent is travel-based multitasking valued as a productive use of travel time vs. as a way to make otherwise wasted time more tolerable? How much of a positive utility of travel is travel-based multitasking? The many activities (whether measured by participation or duration) that were not associated with travel usefulness suggest that instances of travel-based multitasking may not considered to be good or productive uses of time, and that the answers to the questions above depend on the activity. Doing some sort of activity appears to be useful: People who reported and spent more time "doing nothing" considered their time to have been less useful. Nevertheless, the activities positively associated with travel usefulness—talking with other people and singing/dancing—could be ways just to pass the time. Other activities may be more about coping with commuting and less about making productive use of travel time (*16*): The significant negative mode-specific effects of passive activities on travel usefulness suggests that thinking/daydreaming and looking at scenery and people are not considered useful activities. Additionally, the positive association of commuting frequency with travel usefulness suggests that travelers who commute more often (thus, having a larger commute burden) may have a greater incentive to make use of their travel time.

However, even if commuters are really doing most things just to kill time on the commute, these are still instances of a positive utility of travel. Activity participation presumably makes travel utility more positive, even if it does not completely outweigh the disutilities of travel time, cost, or effort. Even reducing a small amount of the commuting burden by viewing scenery or talking with a passenger presumably means that travelers are still better off than if they had been doing nothing. From a policy perspective, although travel-based multitasking may be unlikely to generate travel, it may instead diminish commuters' incentives for reducing travel (*3*, *27*). In addition, perhaps travelers truly do benefit from the transition time or time out (*5*) provided by

conducting antiactivities like thinking/daydreaming or sleeping/snoozing, but do not fully acknowledge the usefulness of those activities.

One travel activity that appears to be useful—exercising and being physically active—warrants further discussion. As an activity, exercising is unique because it is so highly correlated with active travel modes: Most reports of exercising were among people walking and bicycling, and most walk and bicycle commuters reported being physically active for most of the time (*16*). This study provides evidence to suggest that exercising is likely considered a useful form of travel-based multitasking. Notably, people walking and bicycling had the most useful commutes. According to the activity duration model of travel usefulness, people spending more time exercising or being physically active were more likely to have useful commutes. While exercising was not significant in the activity participation version, the travel time coefficient for walking was positive and there were positive residual associations for both walking and bicycling modes. As noted in the results section, the high covariance between these factors makes representing active travel modes and the exercising activity in a model of travel usefulness more challenging.

An additional (conceptual and empirical) issue with the exercising activity is the difficulty distinguishing the useful benefits of travel-based multitasking from the enjoyable benefits related to travel liking, and distinguishing both types of benefits from the traveling itself (walking, bicycling). In the commuting survey, most people walking and bicycling reported useful commutes but also that they liked their commutes. Singleton and Mokhtarian (*3*) discuss some of the arguments for and against classifying exercising as a travel activity instead of a beneficial part of the travel experience. For instance, exercising on the commute can substitute for nontravel physical activity like going to the gym. On the other hand, walking and bicycling can be a fun activity or a way to improve physical and mental health. More broadly, exercising and doing other activities (e.g., listening to music, viewing scenery, daydreaming) also can help to facilitate the affective enjoyment of the travel experience. Together, these activities could be contributing to the travel usefulness vs. travel liking conflation discussed earlier. One conceptual solution to the dilemma is to say that the doing (exercising) is the multitasked and useful activity, and that any positive emotions, fulfillment, or liking that may result are part of the travel experience. Nevertheless, if it is difficult for scholars to conceptually distinguish the two, how should we expect survey respondents to make such a distinction? Future research should tackle the empirical challenges of measuring and modeling the subjective usefulness of exercising and physical activity.

Limitations and future work

Several limitations of this study are about the data collection effort itself—not studying multiple trip purposes, distinguishing wait and access/egress activities, surveying long-haul transit commuters, or including more detailed questions—and have been discussed elsewhere (*16*). From an empirical perspective, more research is needed to examine whether activity participation or duration (or some other measure of quantity) is more closely linked to the usefulness of travel. Fundamentally, issues with the travel usefulness question suggest a need to continue searching for better measures of this subjective concept of the productivity, usefulness, quality, worth, or value of travel-based multitasking. Notably, questions about the quality and effectiveness of travel time use for different activities (*21*) are promising and would have nicely complemented the travel usefulness question, but they could not be included due to limitations on the survey's length. Utilizing natural or stated preference choice experiments paired with econometric analysis techniques could yield utility-based estimates of a traveler's underlying tradeoffs and willingness-to-pay for multitasking potential. Some research is trying to do this with respect to the effects of

travel-based multitasking on mode choice behavior (*22*, *28*), yet studies of this type are still in their infancy.

Implications

This study offers several implications for transportation design, planning, and policy, especially considering advances in transportation technologies. It demonstrates that people walking and bicycling may indeed view as useful the time they spend exercising while commuting. This finding suggests that interventions to increase the use of these nonmotorized modes could make people healthier and more productive in their time use. Even shifting commuters from single-occupancy vehicles to public transit or carpooling could enhance their well-being, allowing people to make more use of time spent traveling, even if that time is spent on less traditionally productive activities like technology use or people-watching.

The results of this study also shed light on the value of travel-based multitasking aspects of the positive utility of travel concept. People do not appear to consider engaging in most activities (beside exercise) to be a useful way to spend commuting time. Instead, they may be doing things (talking, reading, listening to music, using smartphones, looking out the window, etc.) more to pass the time than to be productive, at least in a region with few long-distance transit commuters. This suggests that attempts to increase public transit ridership by leveraging travelers' proclivities to multitask with on-board or station-area amenities like tray tables, charging stations, and WiFi may be less effective than anticipated. Certainly, transit commuters have reaped the benefits of recent advances in ICT. However, attempts to harness these ongoing technological changes to modify commuting behavior may not necessarily succeed. In summary, a PUT from travel-based multitasking may be more likely to diminish incentives for reducing travel time (i.e., by switching from riding transit to driving) than to actually overcome an increase in travel time through a travel behavior change (i.e., switching from driving to riding transit). From the perspectives of utility and the value of travel time savings, travel-based multitasking may reduce the disutility of travel (reducing the magnitude of VTTS estimates) without necessarily generating an absolute positive utility of travel (switching the sign of VTTS estimates) (*3*).

Insights into travel usefulness also have long-term implications, particularly for our understanding of travel behaviors surrounding the adoption of autonomous vehicles (AVs). Many observers have suggested that, by removing the need to drive (at least part of the time), AVs offer the potential to make traveling much more productive and useful. Auto drivers may be transformed into travelers that look and act more like auto passengers or transit riders, engaging in more frequent and varied types of travel-based multitasking. Travel modelers have begun to create simulations (e.g., *29*) on the assumption that AVs will make traveling more productive and reduce values of travel time savings, thus increasing travel demand and potentially vehicle miles traveled, all while reshaping where and how people live and get around. However, the results of the present study suggest that this sort of productivity-based multitasking may not be highly valued by commuters. Instead, travelers might use their travel time more to do social activities, catch up on rest, or simply zone out. Thus, VTTS reductions from travel-based multitasking may be more modest than projected (*30*). Furthermore, the people who find exercising while commuting to be useful may not want to use AVs at all. Overall, this study's findings related to travel-based multitasking and travel usefulness suggest a need to reconsider the potential impacts of widespread vehicular automation.

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Author contribution statement

The author confirms contribution to the paper as follows: study conception and design: PAS; data collection: PAS; analysis and interpretation of results: PAS; draft manuscript preparation: PAS. All authors reviewed the results and approved the final version of the manuscript.

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