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# It's not all fun and games: An investigation of the reported benefits and disadvantages of conducting activities while commuting

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A B S T R A C T

Travel-based multitasking, or the performance of activities while traveling, is more feasible than ever before, as the expanding availability of shared ride services and increasing vehicle automation coincide with the ubiquity of portable information and communication technology devices. However, the question of *whether*, and if so, *how* these increasingly blurred boundaries between activities are truly helping rather than hurting us is not presently well-understood. Using an attitudinally-rich travel survey of Northern California commuters (N ≈ 2500), we develop a conceptual and empirically-based framework for studying benefits and disadvantages of travel-based multitasking. Through latent variable models of reported benefits and disadvantages of activities conducted on a recent commute, we identify constructs associated with *hedonic* and *productive* benefits, and with *affective* and *cognitive* disadvantages. This empirically-developed framework informs the definition of binary variables indicating the presence/absence of each construct for a given traveler on the commute in question. We then present two bivariate binary probit models that examine the effects of person and trip attributes such as personality traits, chosen mode, commute preferences, and activities conducted while traveling on the presence of those benefits and disadvantages, respectively. Notably, we find evidence that conditions/activities that may facilitate multitasking benefits can also simultaneously yield disadvantages; for example, several activities – conspicuously including talking on or otherwise using a phone – increase the probability of receiving benefits while also increasing the probability of experiencing cognitive disadvantages. This finding resonates with the general multitasking literature, and empirically corroborates the suggestion that travel-based multitasking may not uniformly increase trip utility.

## 1. Introduction

Not all time is equally useful, and the viability of a certain time window for the execution of "desired" activities strongly influences the value of that time (DeSerpa, 1971). The extrapolation of this time allocation principle to travel time has yielded a slowly percolating understanding that as travel time becomes either (a) inherently more enjoyable (Mokhtarian and Salomon, 2001; Ory and Mokhtarian, 2005), and/or (b) increasingly more viable for travel-based multitasking (i.e. conducting activities while traveling) (Lyons and Urry, 2005; Watts and Urry, 2008), the utility of travel time can increase, thereby diminishing the motivation to reduce it, i.e. reducing the value of travel time savings (VOTTS) (DeSerpa, 1973; Ettema and Verschuren, 2007). Consideration of these implications is increasingly critical due to the confluence of two technosocial trends: (a) the ever-expanding reach and capability of mobile information and communication technologies (ICTs), which support an unprecedented *feasibility* of travel-based multitasking; together with (b) the increasing "passengerization" of travel – exemplified by the onset of vehicular automation, coupled with growing (albeit demographically and geographically uneven) market penetration of ridesharing and transit – which presents unprecedented *opportunities* for travel-based multitasking (Ben-Elia et al., 2018; Fraunhofer IAO and Horvath & Partners, 2016; Hathaway and Muro, 2017; Mokhtarian, 2018).

Prior work in this field has primarily treated travel-based multitasking as an explanatory variable, examining its influence on traveler attitudes and behaviors such as trip satisfaction and mode choice. Here, we reframe the focus of attention by treating travel-based multitasking as a choice, with outcomes that may yield different types of benefits and disadvantages to travelers, and thus which has the potential to both increase *and* reduce the utility of travel time. We then seek to better understand those outcomes, by casting them as the *dependent* variables

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of interest. Specifically, we first extend the conceptual understanding of travel-based multitasking through latent variable models used to empirically identify a typology of constructs underlying benefits and disadvantages. Using the constructs so-ascertained to create variables indicating the presence or absence of each type of outcome, we then estimate two bivariate probit (BVP) models that account for the effects of sociodemographic characteristics and personality traits, chosen mode and mode attributes, commute preferences and expectations, time use patterns, general and multitasking attitudes, and onboard activities on the benefits and disadvantages (respectively) experienced due to travel-based multitasking.

We structure the remainder of this work as follows. First, we present an overview of the travel-based multitasking literature, where we have synthesized the major veins of thought in the field, laying a foundation for our conceptual approach to further understanding travel-based multitasking as a choice behavior. Next, we discuss the dataset utilized for the purposes of this analysis, and summarize key descriptive statistics needed to contextualize our findings. We then present and discuss the latent constructs identified, and models developed, for the benefits and disadvantages of travel-based multitasking. We follow the results with a discussion that integrates our findings and close with an overview of the limitations and contributions of this work.

## 2. Literature review

It is no accident that early, seminal works on time allocation in economics routinely featured a treatment of travel time (Becker, 1965; DeSerpa, 1971; Truong and Hensher, 1985; Winston, 1982), and that well-known economists would write the first dedicated works on travel time and its implications for behavior (de Donnea, 1972; DeSerpa, 1973). One reason for this special attention to travel time allocation is the ease of other activities being overlaid upon, as well as interleaved within, that time (Circella et al., 2012), especially when traveling as a passenger. Accordingly, there exists a robust (and growing) body of work on travel time allocation and travel-based multitasking, made all the more pertinent as the feasibility of, and opportunities for, travel-based multitasking continue to increase. Here we synthesize the main perspectives from which travel-based multitasking has been studied, respectively examining its effects on individuals' evaluations of travel (ex. travel satisfaction, trip pleasantness), travel preferences and choices (ex. mode choice), and valuation of time spent traveling.

### *2.1. Effects of travel-based multitasking on individuals' evaluations of travel*

Travel is an integral part of most people's lives, whether engaging in routine trips such as commuting to/from work or partaking in "special" trips such as vacation travel. As such, overall ***trip experiences/satisfaction*** can have substantial impacts on quality of life measures (De Vos et al., 2013; Mokhtarian, 2019; Mokhtarian and Pendyala, 2018; Olsson et al., 2013; Zhu and Fan, 2018), and can influence important decisions such as job/home location and vehicle ownership (Cao et al., 2009; De Vos et al., 2016). Consequently, the investigation of personal evaluations of travel is of great interest and value to transportation researchers and forecasters, and travel-based multitasking is increasingly being incorporated as a key explanatory variable within these studies (Mokhtarian and Pendyala, 2018). A sizeable body of work has found that travel-based multitasking improves travel satisfaction, travel experiences, and/or "experienced" utility across modes (Eiró and Martínez, 2014; Ettema et al., 2012; Mokhtarian et al., 2015; Rasouli and Timmermans, 2014; Rhee et al., 2013; Russell, 2012; Susilo et al., 2012); however, there are nuances to these findings that should be noted.

For example, Rasouli and Timmermans (2014) reported that activities conducted *before* the trip appear to influence the effects of travel-based multitasking on trip experience, while Ettema et al. (2012) found that trip *destination* (i.e. home versus work) can similarly influence the effects of activities on travel satisfaction. Ettema et al. (2012) also found that differing activities (ex. talking to other passengers versus entertainment) yielded varying effects on satisfaction with travel, and suggested that this may be due to activities such as entertainment and relaxation being unsuccessful at completely ridding travelers of boredom. Similarly, an analysis of the French National Travel Survey suggested that in some cases, travel-based multitasking (ex. listening to the radio/music) may be initiated with the intention of reducing trip unpleasantness, and as such it reduces fatigue, but may not make the overall trip experience pleasant (Mokhtarian et al., 2015). These findings are supported by Singleton (2018), who examined the concept of travel usefulness (i.e. how useful would you rate the activities done during the trip, ignoring the value of getting to your destination), finding that some commuters may be engaging in activities simply to pass the time, rather than to make productive use of the time. Further, Zhu and Fan (2018) reported that trip attributes such as traveling with family or friends influence overall travel experience, a finding that may allude to the effects of companionship on the types of activities conducted during travel.

Thus, while engaging in travel-based multitasking appears to generally increase overall trip satisfaction and/or experienced utility, both trip-related factors (Ettema et al., 2012; Mokhtarian et al., 2015; Rasouli and Timmermans, 2014) and the specific activities being conducted (Ettema et al., 2012; Mokhtarian et al., 2015) may interact with, and in some cases temper, these effects.

### *2.2. Effects of travel-based multitasking on travel preferences and choices*

Conventional transportation applications largely treat travel as a derived demand, and as such, treat travel time as a disutility to minimize whenever possible. This is still true despite the fact that a growing body of work has introduced both theoretical and empirical support for the possibility that travel time may be valued in its own right for varied reasons that include the intrinsic value of the trip and the potential for travel-based multitasking (Mokhtarian and Salomon, 2001; Redmond and Mokhtarian, 2001; Watts and Urry, 2008; see Section 2.1). This evolving perception of travel time as activity time has been helped in no small part by the introduction of ICT devices, which have revolutionized travelers' abilities to partake in a wider range of activities while traveling (Axtell et al., 2008; Gripsrud and Hjorthol, 2012; Kenyon and Lyons, 2007; Line et al., 2011; Lyons and Urry, 2005; Tang et al., 2018). Here, we focus on conditions that facilitate travel-based multitasking (i.e., what travelers want/need to be able to multitask), and consequently the decisions that travelers might make in order to obtain and benefit from these conditions (ex. to choose rail over automobile due to the increased ability to utilize a laptop on rail).

Transit has putatively provided the greatest opportunity for travelers to engage in multitasking, and accordingly, the majority of studies on travel attributes that facilitate travel-based multitasking have centered on transit users. While it has been shown that most transit users perceive travel time as useful (Frei et al., 2015; Gripsrud and Hjorthol, 2012; Lyons et al., 2007), differences in comfort (ex. standing versus sitting in trains with more space and privacy, etc.) (Axtell et al., 2008; Lyons et al., 2007; van der Waerden et al., 2009), length of in-vehicle time (Axtell et al., 2008; Eiró and Martínez, 2014), work hours (time period/time of day, etc.), and other mode attributes affect the tendency of travelers to participate in different types of activities while using transit (Bouscasse and de Lapparent, 2019; Guo et al., 2015; Lyons et al., 2007; Ohmori and Harata, 2008; Tang et al., 2018; van der Waerden et al., 2009). Similarly, it has been found that travelers are willing to pay money to obtain conditions (ex. space and privacy) that better facilitate travel-based multitasking (Ohmori and Harata, 2008). Additionally, preplanning is shown to be important in facilitating optimal travel-based multitasking (Axtell et al., 2008; Gripsrud and Hjorthol, 2012). We note that some of the studies cited here focus on low quality transit services (ex. local bus and metro rail services) that often tend to be more crowded and less conducive to travel-based multitasking, while other studies focus on high quality transit modes (ex. heavy rail intercity/commuter trains) that are more conducive to multitasking, and yet other papers combine these service types within an overarching "transit" category. As a result, for the purposes of this brief overview, we summarized travelers' preferences *in general*, with an eye toward understanding the types of conditions that would increase the likelihood of participating in travel-based multitasking. However, the study we present in this paper separates commuter rail from other transit, as is further discussed in Section 3.

Regarding mode choice, a study using the same dataset as the present paper found that engaging in productive activities influences mode shares for commuter rail, transit, car/vanpool, and drive-alone modes, with the drive-alone mode share retroactively predicted to increase if the opportunity to productively multitask (using a laptop/tablet in this particular study) on other modes had not been available (Malokin et al., 2019). This finding is supported by earlier work that showed internet access on board the train could similarly influence mode choice (Banerjee and Kanafani, 2008). Such effects are also seen for activities that are more pleasure-based than productive; for example, one of the reasons for choosing carpooling includes spending time with others, although this is (understandably) more important for non-commuters (Li et al., 2007). It has also been shown that train and bus travelers are more likely to engage in working or reading, while forms of engagement like talking to other passengers or listening to music are less differentiated among modes (Ettema et al., 2010).

Thus, the ability to engage in travel-based multitasking can influence mode choice decisions, and likewise mode attributes such as multitasking conduciveness can influence travel-based multitasking decisions – a case of the well-known endogeneity concerns inherent in the study of travelers' attitudes, preferences, and behaviors.

### 2.3. *Effects of travel-based multitasking on value of travel time*

***Valuation of travel time*** (VOTT, or its derivative, VOTTS) is a critical parameter that is most commonly measured as the tradeoff an individual is willing to make between time and money (e.g. in dollars per minute), and is used widely in cost/benefit analyses for infrastructure projects, travel demand models, social justice analyses, etc. (Mackie et al., 2001; Small, 2012; United States Department of Transportation, 2015). In a logical complement to the body of work on travel satisfaction discussed in Section 2.1, several studies have found that travel-based multitasking may reduce VOTTS (Banerjee and Kanafani, 2008; Bouscasse and de Lapparent, 2019; Ettema and Verschuren, 2007; Kouwenhoven and de Jong, 2018; Malokin et al., 2017; Varghese and Jana, 2018) and reduce sensitivity to changes in travel time (Zhang and Timmermans, 2010). It has also been shown that individuals' *attitudes* towards multitasking (i.e. monochronic versus polychronic individuals), as well as the types of activities conducted, can influence their appraisal of travel time (Ettema and Verschuren, 2007). Meanwhile, on the behavioral side, there is a much larger body of work that has established (with some degree of conflict and variability typically present for dependent variables like VOTTS) that factors such as trip purpose, mode, and attributes influence VOTT/VOTTS (Abrantes and Wardman, 2011; Gunn, 2001; Horowitz, 1978; Shires and de Jong, 2009; Zamparini and Reggiani, 2007). As discussed in Section 2.2, the viability of travel-based multitasking can be a cause and/or an effect of the aforementioned factors, thereby facilitating another avenue through which travel-based multitasking may influence VOTT.

Overall, we see that travel-based multitasking has implications not only for individuals' subjective evaluations of travel, but can also affect the conditions expected or desired by travelers, choices made regarding travel, and – perhaps most critically for large-scale infrastructure decisions – valuation of travel time. As such, given the significant potential implications of travel-based multitasking for transportation planning and decision making, this study examines travel-based multitasking as a choice that yields both benefits and disadvantages to travelers. We present a typology of types of benefits and disadvantages obtained as a result of travel-based multitasking, and seek to further understand characteristics and conditions that facilitate these benefits and/or disadvantages for travelers.

## 3. Overview of data

This study used data from a 2011 to 2012 University of California, Davis survey of Northern California commuters; respondents were recruited using an array of sampling methods that included mail-out, online-panel-based, mode-intercept, and email-based recruitment across both paper and electronic survey platforms. This multitude of approaches was utilized as the goal was to obtain enough users for each mode of interest to permit robust statistical analyses. Additional information on survey design and implementation can be found at Neufeld and Mokhtarian (2012). The purpose of the survey was to examine the effects of multitasking attitudes and practices on the travel-related behavior of commuters. To support this objective, the survey obtained general attitudes and personality traits, mode-specific attributes, time use patterns, and sociodemographic characteristics, in addition to the aforementioned multitasking and travel-related attitudes and behaviors (Malokin et al., 2019; Neufeld and Mokhtarian, 2012). The present analysis focuses on developing conceptual constructs and subsequent model frameworks to further understand benefits and disadvantages experienced as a result of travel-based multitasking (see Table 1, which also tabulates the responses to each item for the working sample of cases who answered either or both of the questions shown there).

As noted, since the intent of the survey was to capture behavioral relationships for users of *all* transportation modes, the sampling process aimed to obtain sizable shares rather than *representative* shares across the travel modes (in practice, this meant undersampling drive-alone commuters and oversampling other modes). Accordingly, the dataset was weighted to be representative of regional commute mode shares prior to developing the analyses presented in Sections 4 and 5. Commuter rail was differentiated from transit for the purposes of this study, with commuter rail referring to intercity heavy rail trains, and transit referring to bus/express bus/light rail/metro rail (Bay Area Rapid Transit, or BART) services. For all descriptive statistics, both weighted and unweighted distributions are presented to facilitate an understanding of how the weights affected the dataset. Distributions of sociodemographic traits for the working sample of participants included in Table 1 (N = 2598) are presented in Table 2. As is shown, approximately 63% of the weighted sample is female, and the average age of all participants is 44 years. About half of the sample identify their occupation as professional/technical, with almost three-quarters reporting that they have received a college degree or higher. Additional details regarding survey variables are included in the Appendix.

## 4. Typology of travel-based multitasking benefits & disadvantages

Table 1 details the survey questions used to develop the typology of travel-based multitasking benefits and disadvantages from this dataset. Because responses were coded as binary variables (0/1), tetrachoric correlations and weighted least squares-mean and variance adjusted estimation (WLSMV) were used to estimate separate latent variable models for the benefits and disadvantages of travel-based multitasking (Fig. 1). Latent variable models, such as the confirmatory factor analyses (CFAs) executed here, require pre-developed hypotheses regarding the conceptual structure of the data, and for that reason, exploratory factor analysis and examination of the correlation matrices and response distributions were undertaken prior to the specification and refinement of the final models presented in Fig. 1. These diagrams follow latent model conventions: the single-headed arrows represent

**Table 1**
Reported travel-based multitasking benefits and disadvantages (N = 2598).

| Questions | Statements | Variable name | Un-weighted, Freq. (%) | Weighted, Freq. (%) |
|---|---|---|---|---|
| | *Benefits of travel-based multitasking*[†] | | | |
| *What **benefits**, if any, do you experience from any activities you do during your commute? Please check all that apply.* | I basically do nothing during my commute | –[a] | 0.7 | 1.1 |
| | I experience no benefits from the activities I do during my commute | – | 31.4 | 43.9 |
| | Makes an already-enjoyable trip more pleasant | ↑ trip enjoyment[b] | 22.4 | 17.9 |
| | Makes an unpleasant trip more tolerable | ↑ trip enjoyment | 16.2 | 14.7 |
| | Makes an unpleasant trip become pleasant | ↑ trip enjoyment | 14.2 | 10.7 |
| | Enhances my enjoyment of the activities (compared to doing them at another time) | ↑ activity enjoyment | 9.9 | 7.0 |
| | Allows me to get more work done | gets work done | 19.7 | 11.8 |
| | Helps me meet deadlines more easily | meets deadlines | 9.4 | 5.5 |
| | Allows me to save time by not having to do the activity at another time | saves time | 23.9 | 16.4 |
| | Allows me to do things I otherwise would not have the time to do | do new things | 26.6 | 17.3 |
| | Decreases my stress | ↓ stress | 38.5 | 28.5 |
| | Other | – | 2.0 | 0.5 |
| | *Disadvantages of travel-based multitasking*[†] | | | |
| *What **disadvantages**, if any, do you experience from any activities you do during your commute? Please check all that apply.* | I basically do nothing during my commute | – | 0.7 | 1.1 |
| | I experience no disadvantages from the activities I do during my commute | – | 58.7 | 60.0 |
| | Interferes with my enjoyment of the trip | ↓ trip enjoyment | 2.6 | 2.4 |
| | Makes an unpleasant trip even more unpleasant | ↑ trip unpleasantness | 1.4 | 1.9 |
| | Diminishes my enjoyment of the activities (compared to doing them at another time) | ↓ activity enjoyment | 2.5 | 2.4 |
| | Presents an unsafe distraction | unsafe distraction | 9.0 | 12.7 |
| | Fragments my attention too much | fragments attention | 6.9 | 8.3 |
| | Takes times away from things I'd rather be doing | takes time away | 10.8 | 11.6 |
| | Increases my stress | ↑ stress | 6.2 | 7.9 |
| | I'm not able to do the activities as well as I'd like | ↓ activity performance | 11.4 | 10.6 |
| | Other | – | 0.7 | 0.3 |

[†] Binary (yes/no) coding was used for each statement, with the exception of the specification of "other" outcomes. For these, respondents were presented with an "Other (please specify)" option, *most* of which were recoded into one or more of the pre-existing statements as appropriate, or otherwise not analyzed in the present study (the "other" percentages shown here are *after* reclassification).

[a] Dashes indicate that the corresponding variable was not used in the confirmatory factor analyses in this paper (Section 4).

[b] After initial exploration, the three *benefits* labeled "trip enjoyment" were combined into a single item, = 1 if any of the three were reported and = 0 else. 44.5% of the unweighted and 36.4% of the weighted sample reported experiencing this composite benefit.

**Table 2**
Selected sociodemographic characteristics of the sample (N = 2598).

| Variable | Sociodemographic characteristics | Frequency[a] | | | |
|---|---|---|---|---|---|
| | | Unweighted | | Weighted | |
| | | N | % | N | % |
| Gender | Male | 1014 | 39.0 | 929 | 35.7 |
| | Female | 1547 | 59.5 | 1634 | 62.9 |
| Age[b] | 18–24 years | 132 | 5.1 | 141 | 5.4 |
| | 25–34 years | 632 | 24.3 | 535 | 20.6 |
| | 35–44 years | 479 | 18.4 | 590 | 22.7 |
| | 45–54 years | 673 | 25.9 | 684 | 26.3 |
| | 55–64 years | 591 | 22.7 | 558 | 21.5 |
| | 65+ years | 72 | 2.8 | 72 | 2.8 |
| Annual household income | Less than US $50,000 | 517 | 19.9 | 526 | 20.2 |
| | US $50,000–100,000 | 982 | 37.8 | 996 | 38.3 |
| | More than US $100,000 | 981 | 37.8 | 963 | 37.1 |
| Education | High school diploma or less | 77 | 3.0 | 91 | 3.5 |
| | Some college or technical school | 609 | 23.4 | 672 | 25.9 |
| | College degree | 829 | 31.9 | 842 | 32.4 |
| | Some graduate school | 276 | 10.6 | 246 | 9.5 |
| | Graduate degree | 807 | 31.1 | 748 | 28.8 |
| Occupation | Full-time student | 234 | 9.0 | 197 | 7.6 |
| | Manager | 424 | 16.4 | 454 | 17.5 |
| | Professional/technical | 1330 | 51.2 | 1283 | 49.4 |
| | Clerical/administrative | 387 | 14.9 | 397 | 15.3 |
| | Other[c] | 215 | 8.3 | 263 | 10.1 |
| Household size | Single-person HH | 423 | 16.3 | 432 | 16.6 |
| | Two-person HH | 989 | 38.1 | 920 | 35.4 |
| | Three-person HH | 510 | 19.6 | 530 | 20.4 |
| | Four-person or larger HH | 656 | 25.3 | 697 | 26.8 |
| Mode shares[d] | Bicycle | 245 | 9.4 | 40 | 1.5 |
| | Commuter rail | 221 | 8.5 | 19 | 0.7 |
| | Transit: Express/local bus/ BART/ferry | 768 | 29.6 | 212 | 8.2 |
| | Shared ride (passenger, i.e. passenger of a carpool/ shuttle) | 214 | 8.2 | 180 | 6.9 |
| | Driver | 1149 | 44.2 | 2147 | 82.6 |

[a] Frequencies do not add up to 100% or the total N because of rounding errors, non-responses, or "other" categories.

[b] Average age: 44 years (median: 45 years); lowest age: 19 years; highest age: 91 years.

[c] Includes homemakers, service and repair, sales or marketing, and production or construction.

[d] Using this same dataset, Malokin et al. (2019) details a mode choice model that also considered five modes; however, instead of "passenger" and "driver" (the latter of which could be "alone" or "of a car/vanpool"), Malokin et al. used "shared ride" (whether driver or passenger) and "drive alone". For the purposes of the present paper, we considered the distinction between passenger and driver to be more important to the nature and experience of activities that could be conducted while commuting. Walk commuters were excluded from the mode choice model of Malokin et al. (2019) because of their small share (unweighted N = 40), and therefore also excluded from this study for consistency.

the effects of the latent constructs on their binary indicators, while the double-headed arrows represent correlations between the variables (Loehlin, 2004).

The benefits model, illustrated in Fig. 1a, consists of seven observed variables (see Table 1) identifying two latent factors. Five observed/ created variables (increases trip enjoyment, increases activity enjoyment, decreases stress, allows doing new things, saves time) were significantly associated with one factor, which we labeled "hedonic benefit". Four observed variables (do new things, saves time, meets deadlines, gets work done) were significantly associated with the second latent factor, which we labeled "productive benefit". Compatibly with these labels, the "do new things" and "save time" observed variables were associated with both latent constructs.[1] While some researchers have theorized about and/or discussed the existence of hedonic (i.e., pleasure-based or recreational) and productive aspects of increased utility due to travel-based multitasking (Gripsrud and Hjorthol, 2012; Rasouli and Timmermans, 2014; Singleton, 2018), to our knowledge this is the first empirical model that has clearly captured the existence of, and delineated the differences between, hedonic and productive constructs for travel-based multitasking benefits. The two constructs of hedonic and productive benefits yielded a moderate correlation of 0.490 with each other, indicating that, empirically, both types of benefits often occur (or are absent) together. This preferred model (N = 2576; results on the unweighted sample were substantively the same, but weighted results are reported for consistency with Section 5) yields excellent fit statistics (Loehlin, 2004), with a non-significant Pearson's model chi-squared test ($\chi^2 = 14.482$, df = 11, p = 0.21, $\alpha = 0.05$), root mean squared error approximation (RMSEA) value of 0.011, and comparative fit index (CFI) of 0.999.

The disadvantages model is shown in Fig. 1b and consists of eight observed variables identifying two latent factors, via a second-order factor analysis structure. Six observed variables (decreases trip enjoyment, increases trip unpleasantness, decreases activity enjoyment, decreases activity performance, increases stress, takes time away) were associated, in respective groups of two, with three latent constructs, which we interpreted as "trip dissatisfaction", "activity dissatisfaction", and "activity conflicts". These three constructs, in turn, associated with a single construct which we interpreted as "affective disadvantages". The two observed variables of "unsafe distraction" and "fragments attention"[2] associated with the other latent construct, which we interpreted as "cognitive disadvantages".

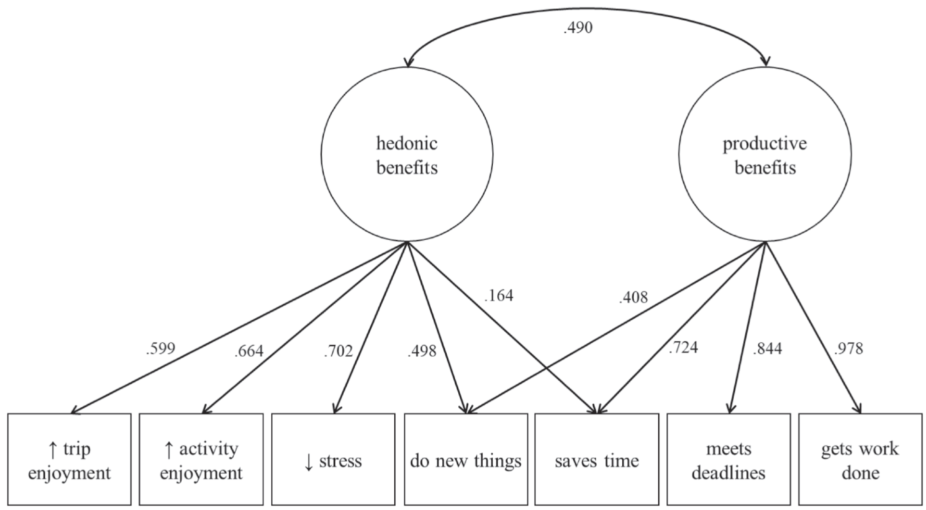
These construct names are loosely inspired by the "Satisfaction with Travel" (STS) scale, which specifies affective and cognitive components related to daily travel. In the STS scale, affective components are based on particular combinations of valence (positive or negative affect) and activation (high or low arousal) dimensions, which include feelings like stressed (negative activation), enthusiastic (positive activation), relaxed (positive deactivation), and tired (negative deactivation). The cognitive component of the scale deals with assessment of quality of the travel (Ettema et al., 2011). As such, we see some parallels between the affective and cognitive components of the STS scale and the observed variables that load on the two respective constructs in the model in Fig. 1b.

In our model, the two constructs of affective and cognitive disadvantages had a strong correlation of 0.634 with each other, again indicating a frequent joint presence (or absence[3]) of these

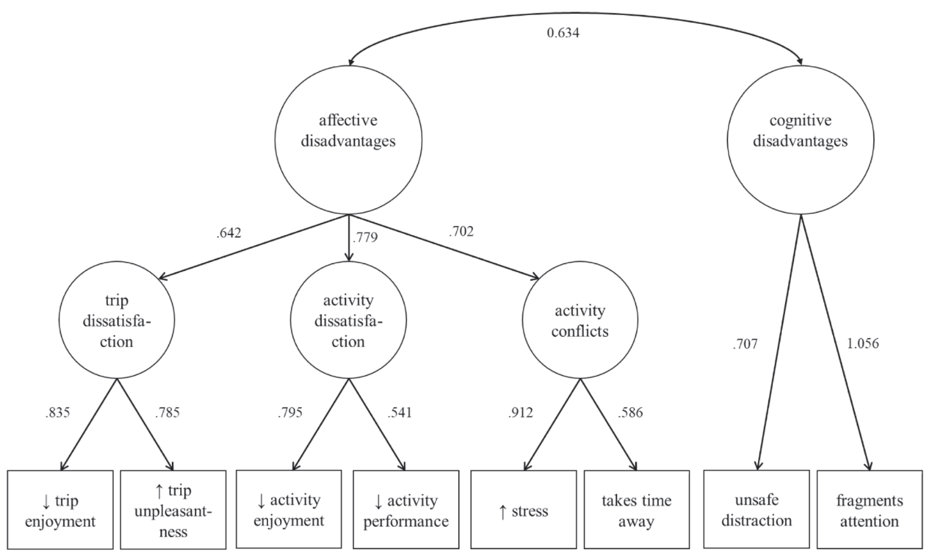
[1] When the common variables ("do new things" and "saves time") were forced to associate with just one of the latent constructs, the correlation between the constructs increased (to 0.833 when they were associated with the hedonic benefit construct and 0.653 when associated with the productive benefit construct), and neither of those models fit the data as well as the presented model.

[2] The loadings in the figure are standardized. As such, when factors are correlated (as is the case here) it is unusual, but not "wrong", for a loading to be larger than one in magnitude, as explained by Jöreskog (1999). In this instance, the loading in question is barely greater than 1, and therefore in any case poses no cause for concern.

[3] This could be partly an artifact of survey fatigue (the two questions of Table 1 appear on pp. 12 and 13 of the 14-page survey): respondents could have been less diligent about checking "all that apply" for the disadvantages than for the advantages. The incidences of the advantage and disadvantage constructs presented in the text show that the disadvantages are more often jointly absent than the advantages are (for 64% and 43% of the cases, respectively), but of course we are unable to determine the extent to which this is a matter of survey fatigue, as opposed to a genuine result that the advantages (of activities which, after all, respondents are generally choosing to perform – presumably to achieve *some* benefit) typically outweigh the disadvantages. What is clear, however, is that 260 fewer people answered the disadvantages question at all, than answered the benefits question.




**(a) Confirmatory factor analysis model of travel-based multitasking benefits**




**(b) Confirmatory factor analysis model of travel-based multitasking disadvantages**

**Fig. 1.** Confirmatory factor analysis model of travel-based multitasking benefits (weighted N = 2576) and disadvantages (weighted N = 2337).

disadvantages for a given person. The overall model (weighted N = 2337; again, results on the unweighted sample were substantively the same) has good fit, with RMSEA of 0.034 and CFI of 0.939. The chi-squared test was significant ($\chi^2 = 59.928$, df = 16, p less than 0.001, $\alpha = 0.05$), but (a) the test statistic is not particularly large, and (b) the large sample size makes it easier to "fail" the test. Although we obtained the desired insignificance for the benefits model which involved a similar sample size, there may well be more heterogeneity and measurement error with respect to the incidence of disadvantages, and accordingly it may be more difficult to capture their relationship patterns with a simple model. Overall, the significance of the chi-squared statistic is of little concern given the otherwise excellent RMSEA and adequate CFI fit indices, and in any case the model's advisory role for the next stage of the analysis is unhindered.

We used the four latent constructs identified here to create the binary observed outcome variables for our models (the $Y_{Bi}$ and $Y_{Di}$ of Section 5): if any of the observed individual benefits/disadvantages associated with a given construct are reported as present, then the outcome variable denoting that construct is set to unity, and zero else. Of the 2598 participants (weighted N) who responded to either of the dependent variable questions in Table 1 (and for whom weights could be calculated), 56% reported hedonic benefits and 29% reported productive benefits (57% collectively, indicating that nearly all those with productive benefits also had hedonic benefits, whereas only half of those with hedonic benefits also had productive benefits). On the negative side, 27% reported affective disadvantages and 16% reported cognitive disadvantages (36% collectively, with the 7% common to both groups indicating that nearly half of those who had cognitive disadvantages also had affective ones, whereas only a quarter of those with affective disadvantages also had cognitive ones).

It is of interest to analyze how the incidence of benefits and disadvantages differs by the primary commute mode. Table 3 summarizes the unweighted and weighted shares of respondents reporting each type of outcome (hedonic benefits, productive benefits, affective disadvantages, and cognitive disadvantages), segmented by primary mode (bicycle, commuter rail, transit, shared ride passenger, and driver). All numbers discussed in this paragraph refer to the incidences by mode (first number in each cell in Table 3; with the second set of numbers in the table provided to facilitate comparisons of mode shares conditional on obtaining a given benefit or disadvantage). As would be expected,

**Table 3**
Incidence of benefit and disadvantage constructs by primary commute mode (weighted/unweighted), %.

| | Hedonic benefits (1462/1780) | Productive benefits (747/1064) | No benefits (1083/773) | Affective disadvantages (688/668) | Cognitive disadvantages (410/323) | No disadvantages (1506/1485) |
|---|---|---|---|---|---|---|
| Bicycle (N = 44/245)[a] | 68.2[b] (2.1/10.4)[c] | 22.7 (1.3/5.5) | 22.7 (1.0/7.6) | 11.4 (0.7/4.8) | 6.8 (0.7/5.6) | 56.8 (1.7/10.4) |
| Commuter rail (N = 19/221) | 89.5 (1.2/11.1) | 78.9 (2.0/16.5) | 5.3 (0.1/1.9) | 26.3 (0.7/9.1) | 5.3 (0.2/4.6) | 52.6 (0.7/7.8) |
| Transit (N = 212/768) | 84.9 (12.3/36.6) | 58.3 (16.6/42.1) | 14.2 (2.8/14.2) | 26.4 (8.1/30.5) | 10.8 (5.6/25.4) | 55.1 (7.8/28.5) |
| Passenger (shared ride) (N = 180/214) | 71.7 (8.8/8.6) | 50.1 (12.2/10.2) | 26.7 (4.4/7.4) | 31.7 (8.3/10.2) | 2.2 (1.0/1.5) | 57.2 (6.8/8.2) |
| Driver (N = 2147/1149) | 51.5 (75.6/33.3) | 23.7 (68.0/25.6) | 46.3 (91.8/68.8) | 26.3 (82.0/45.2) | 17.7 (92.4/62.8) | 58.3 (83.1/45.1) |

[a] Weighted/unweighted mode shares (%): bicycle (1.7/9.4); rail (0.7/8.5); transit (8.5/29.6); shared ride passenger (6.9/8.2); driver (82.6/44.2).

[b] The first number of each cell represents the weighted % of mode users who experienced each of the various benefits/disadvantages. The frequencies for the unweighted data are substantively the same (and thus omitted), but not identical due to rounding required by the weighting process. The summation of these numbers across benefit categories may exceed 100% because there was often an occurrence of both types of benefits at the same time. Conversely, for the disadvantages, there were numerous missing cases that result in summations less than 100%.

[c] The second, parenthesized, set of numbers in each cell represents the weighted/unweighted percentages of those experiencing each type of benefit/disadvantage who use the various modes. As such, these numbers will sum to 100% across modes (i.e. down the column). Both weighted and unweighted measures were included for these frequencies due to the substantial differences between the weighted and unweighted numbers.

the incidence of various benefits and disadvantages differs markedly by mode. Among those who bike or use rail, transit, or shared ride modes, two-thirds or more experienced hedonic benefits, while only about half of those who drive reported them. With respect to productive benefits, drivers and cyclists are "in the same boat", so to speak, with 79% of commuter rail users, 58% of transit users, and 50% of carpoolers reporting them, while respectively only 23% and 24% of the drivers and bicyclists accrued them. On the other hand, drivers and cyclists part company when it comes to disadvantages. Drivers were most likely to report cognitive disadvantages (18%, compared to 2–11% for users of the other modes), while bicyclists were least likely to accrue affective disadvantages (~11%, compared to 26–32% for the others). Finally, we see that in line with the above results, approximately half of all drivers experienced no benefits from multitasking during their commute, a notable number relative to the 27% or less of other mode users who reported no benefits. However, the share of those reporting no disadvantages was somewhat consistent across modes (55–58%).

## 5. Model estimation and analysis

Two binary BVP models were developed on the weighted sample, one for the hedonic and productive benefits of multitasking, and the other for the affective and cognitive disadvantages of multitasking. A quadrivariate binary probit model for predicting all four dependent variables simultaneously was also considered, but ultimately not implemented due to its increased complexity of estimation and interpretation, with low perceived marginal benefit relative to the model specifications discussed here.

The specification for the BVP benefits model is as follows (where person-specific subscripts are suppressed for simplicity):

$$Y_{Bi}^{*} = \beta_{Bi}^{'} X_{Bi} + \varepsilon_{Bi},\ i = 1(\text{hedonic benefits}),\ 2(\text{productive benefits});$$
$$Y_{Bi} = 1\ \mathit{if}\ \ Y_{Bi}^{*} \geq 0;\ \ \text{otherwise } Y_{Bi} = 0.$$

Similarly, the specification for the BVP disadvantages model is:

$$Y_{Di}^{*} = \beta_{Di}^{'} X_{Di} + \varepsilon_{Di},\ \ i = 1(\text{affective disadvantages}),\ 2(\text{cognitive disadvantages});$$
$$Y_{Di} = 1\ \mathit{if}\ \ Y_{Di}^{*} \geq 0;\ \ \text{otherwise } Y_{Di} = 0.$$

$Y_{Bi}^{*}$ and $Y_{Di}^{*}$ are unobserved latent variables that represent the propensity of each person to experience hedonic and productive benefits, and affective and cognitive disadvantages, respectively, while their unstarred counterparts, $Y_{Bi}$ and $Y_{Di}$, are the observed binary variables indicating whether the respective outcome was experienced or not. $X_{Bi}$ and $X_{Di}$ are vectors of observed characteristics that are hypothesized to influence the travel-based multitasking benefits and disadvantages experienced by each person, while $\beta_{Bi}^{'}$ and $\beta_{Di}^{'}$ are vectors of unknown but to-be-estimated coefficients that reflect the effects of the associated $X_i$ characteristics on $Y_i^{*}$. Finally, the error terms$\varepsilon_{Bi}$ and $\varepsilon_{Di}$ capture the influence of unobserved variables on the associated outcome$Y_i^{*}$, and given that this is a probit model, the error terms are assumed to be normally distributed with mean 0 and variance fixed to 1 for identifiability. $\varepsilon_{B1}$ and $\varepsilon_{B2}$ are allowed to be correlated with each other, as are $\varepsilon_{D1}$ and $\varepsilon_{D2}$.

The explanatory variables were entered into the model in the following order: sociodemographic characteristics; mode and mode attributes; propensities/attitudes towards multitasking, waiting, commute expectations/preferences, and time use patterns; activities conducted on the last commute; items generally brought along while commuting; general attitudes; and personality characteristics. Insignificant variables in each block were removed for succeeding stages, but ultimately some were re-tested. Some significant variables were excluded as inexplicable, although in view of the exploratory nature of this study we retained a number of variables about whose impacts we had no strong prior hypothesis. Table 7 (in the Appendix) details the indicators for the latent construct explanatory variables (i.e. items that were factor-analyzed to reveal underlying attitudinal constructs). In this section, we

**Table 4**
Bivariate probit model of benefits of travel-based multitasking.

| Variable[a] | Hedonic benefits | Productive benefits | Variable[a] | Hedonic benefits | Productive benefits |
|---|---|---|---|---|---|
| **Sociodemographic characteristics** | | | **Personality traits** | | |
| *Household income* | –[b] | 0.0927*** | *Frustrated* | – | −0.124*** |
| *Number of bikes (household)* | 0.0690*** | 0.0865*** | *Explorer* | – | 0.0945*** |
| *Number of vehicles (household)* | – | −0.108*** | | | |
| **Mode and mode attributes** | | | **Activities conducted/items carried on commute** | | |
| *Chosen mode: Shared ride (passenger)* | – | 0.278** | *Grooming* | 0.628*** | 0.534*** |
| *Chosen mode: Transit* [c] | 0.344*** | 0.293** | *Talked on the phone* | 0.258*** | 0.298*** |
| *Chosen mode: Bike* | 0.548** | – | *Used smartphone* | 0.186** | 0.323*** |
| *Commute allows multitasking* | 0.293*** | 0.286*** | *Thought/planned* | 0.238*** | 0.248** |
| *In-vehicle travel time* | 0.00846*** | 0.00470*** | *Daydreamed* | 0.152** | 0.143* |
| | | | *Used internet* | – | 0.255** |
| **Commute preferences & expectations**[†] | | | *Wrote/sent text/email* | – | −0.273*** |
| *Has to work on commute* | 0.212*** | 0.212*** | *Read paper document* | – | 0.355*** |
| *Expected to socialize or do recreational activities* | – | 0.0999** | *Carries laptop/netbook* | – | 0.257*** |
| *Would like to socialize or do recreational activities* | 0.147*** | 0.193*** | *Carries newspaper* | 0.365** | – |
| *Would like to work on commute* | – | 0.136*** | *Carries book* | 0.444*** | – |
| | | | *Carries paper writing materials* | 0.180* | 0.321*** |
| **Time use patterns, preferences, & expectations** | | | | | |
| *Would like to be available to family, friends, clients* | −0.119*** | −0.115*** | **Constant** | −1.465*** | −2.518*** |
| | | | **Correlation of error terms** | 0.769*** | |
| **General attitudes & preferences** | | | **Model attributes** | | |
| *Travel is waste* | −0.188*** | – | Number of observations [d] | 2031 | |
| *Commute is good* | – | 0.107*** | $\mathscr{L}(0)$ | −2815.564 | |
| *Real time pressure* | – | 0.128*** | $\mathscr{L}(\boldsymbol{c})$ | −2298.266 | |
| *Prefer time pressure* | 0.131*** | – | $\mathscr{L}(\hat{\boldsymbol{\beta}})$ | −1679.570 | |
| *Preference for mixed dense urban environments* | 0.136*** | – | $\rho^2(\mathscr{L}(0)$ base) | 0.403 | |
| *Prefer to make as few trips as possible* | 0.111*** | – | Adjusted $\rho^2$ ($\mathscr{L}(0)$ base) | 0.385 | |
| *Never get very far behind on things* | −0.111*** | – | $\rho^2(\mathscr{L}(\boldsymbol{MS})$ base) | 0.269 | |
| *Main benefit of my job is to give me money* | – | −0.0844** | | | |
| *Getting stuck in traffic doesn't bother me* | – | −0.107*** | | | |

*** Significant at 1%.
** Significant at 5%.
* Significant at 10%.
[a] The effect of a given variable is represented by an estimated coefficient and asterisks indicating its p-value (significance) category.
[b] Dashes indicate coefficients that were constrained to be zero after they were found to have significance > 0.10.
[c] In this study, "transit" represents bus/express bus/light rail/metro rail (BART), but not intercity trains, which are the separate "(commuter) rail" mode.
[d] Weighted sample market shares (MS) for model (N = 2031): HP: 39.6%, H'P: 0.9%, HP': 29.1%, H'P': 30.3%, where H = hedonic benefit present; H' = not present, etc.
[†] These variables are based on statements asking participants what they feel they "have to, or are expected to do" and what they would "like to do" ***on their commute*** (see Table 7 in the Appendix), and as such, should be read in the context of the commute.

present selected results of the bivariate models for benefits and disadvantages separately, and in Section 6 we discuss comparisons between the models.

### 5.1. Benefits of travel-based multitasking

The BVP model developed for the hedonic and productive benefits of travel-based multitasking is summarized in Table 4; it has an adjusted pseudo-R$^2$ ($\bar{\rho}^2$ with equally likely base) of 0.385, which is considered good fit for a four-alternative discrete behavioral outcome model such as the one described here. The correlation of error terms between hedonic and productive benefits is both significant and large in magnitude (0.769), indicating that many of the unobserved variables that tend to increase (respectively, decrease) the propensity to experience hedonic benefits also tend to increase (decrease) the propensity to experience productive benefits. Since much the same can also be said of the observed explanatory variables, this result is not surprising. Thirty-six variables in total are significant across either the hedonic and/or the productive benefits equations in this model (28 for productive benefits, 21 for hedonic benefits), and of these, 13 (approximately one-third) are common to both constructs. All common variables share the same sign, indicating (as mentioned above) that they influence the propensity to experience hedonic and productive benefits in the same direction. Here, we interpret important and/or interesting patterns in the model, but do not exhaustively detail all results for economy of presentation.

Bicycle ownership, bicycle usage, and a preference for mixed-use dense environments all increase the likelihood of experiencing hedonic benefits – likely because these variables are associated with the primary commute mode being bicycle, which is often chosen precisely *because* of its hedonic benefits. Correspondingly, preference for mixed-use dense residential environments has positive correlations with bicycle use, preferences towards biking and walking, higher education levels, reduced family responsibilities, and decreased vehicle ownership. These results support previous findings that travelers who use active modes are less dissatisfied with their commute (Singleton, 2018) and also happen to be those who like to live in neighborhoods that foster a sense

**Table 5**
Bivariate probit model of disadvantages of travel-based multitasking.

| Variable[a] | Affective disadvantages | Cognitive disadvantages |
|---|---|---|
| **Sociodemographic characteristics** | | |
| *Age* | −0.00993*** | −0.00941*** |
| *Education* | 0.0525* | –[b] |
| *Household income* | – | 0.105*** |
| *Number of vehicles (household)* | – | −0.0775** |
| **Mode and mode attributes** | | |
| *Chosen mode: Shared ride (passenger)* | 0.291** | −1.106*** |
| *Chosen mode: Transit* [c] | – | −0.427** |
| *Cost* | 0.0791*** | – |
| *Perceived comfort of chosen mode* | −0.168*** | −0.175*** |
| *Perceived convenience of chosen mode* | −0.140*** | −0.0965* |
| **Commute Preferences & Expectations** [†] | | |
| *Expected to socialize or do recreational activities* | – | 0.134** |
| **Time use patterns, preferences, & expectations** | | |
| *Likes to multitask on job* | −0.113*** | – |
| *Perceived time spent traveling* | – | −0.163*** |
| *Perceived time spent on nonwork ICT* | – | 0.143*** |
| **Attitudes and propensities** | | |
| *Travel is waste* | −0.0855** | – |
| *Commute is good* | −0.0935*** | −0.155*** |
| *Real time pressure* | 0.144*** | 0.143*** |
| *Prefer time pressure* | – | 0.100** |
| *Would pay money to reduce travel time* | – | −0.166*** |
| *Do not mind waiting* | −0.126*** | – |
| *Early tech adopter* | 0.096*** | – |

| Variable[a] | Affective disadvantages | Cognitive disadvantages |
|---|---|---|
| **Personality traits** | | |
| *Extravert* | 0.103*** | – |
| *Organized* | −0.120*** | – |
| **Activities conducted/items carried on commute** | | |
| *Navigated trip* | 0.321*** | – |
| *Used non-electronic game* | −0.555** | – |
| *Used electronic reading device* | 0.405*** | – |
| *Grooming* | 0.303** | 0.326** |
| *Talked on the phone* | – | 0.333*** |
| *Used smartphone* | – | 0.349*** |
| *Thought/planned* | – | 0.259** |
| *Carries food* | – | 0.263** |
| *Carries e-reader* | 0.405*** | 0.301* |
| *Carries iPad* | – | 0.505*** |
| *Carries GPS* | – | 0.347*** |
| **Constant** | −0.717*** | −1.466*** |
| **Correlation of error terms** | 0.154*** | |
| **Model attributes** | | |
| Number of observations[d] | 1812 | |
| $\mathscr{L}(0)$ | −2511.965 | |
| $\mathscr{L}(\boldsymbol{c})$ | −1780.019 | |
| $\mathscr{L}(\hat{\boldsymbol{\beta}})$ | −1569.585 | |
| $\rho^2(\mathscr{L}(0)$ base) | 0.375 | |
| Adjusted $\rho^2$ ($\mathscr{L}(0)$ base) | 0.358 | |
| $\rho^2(\mathscr{L}(\boldsymbol{MS})$ base) | 0.118 | |

*** Significant at 1%.
** Significant at 5%.
* Significant at 10%.
[a] The effect of a given variable is represented by an estimated coefficient and asterisks indicating its p-value category.
[b] Dashes indicate coefficients that were constrained to be zero after they were found to have significance > 0.10.
[c] In this study, transit represents bus/express bus/light rail/metro rail (BART), but not intercity commuter trains, which are a separate mode.
[d] Weighted sample market shares (MS) for model (N = 1812): AC: 5.5%, A'C:8.0%, AC': 22.6%, A'C': 64.1%, where A = affective disadvantages present; A′ = not present, etc.
[†] These variables are based on statements asking participants what they feel they "have to, or are expected to do" and what they would "like to do" ***on their commute*** (see Table 7 in the Appendix), and as such, should be read in the context of the commute.

**Table 6**
Overview of significant effects contributing to both benefits and disadvantages.

| | Hedonic benefits | Productive benefits | Affective disadvantages | Cognitive disadvantages |
|---|---|---|---|---|
| Household income | | (+)*** | | (+)*** |
| Number of vehicles (household) | | (−)*** | | (−)* |
| Chosen mode: shared ride (passenger) | | (+)* | (+)** | (−)*** |
| Chosen mode: transit | (+)*** | (+)** | | (−)*** |
| Travel is waste[a] | (−)*** | | (−)** | |
| Commute is good[a] | | (+)*** | (−)*** | (−)*** |
| Have real time pressure[a] | | (+)*** | (+)*** | (+)*** |
| Prefer time pressure[a] | (+)*** | | | (+)** |
| Expected to socialize on commute[a] | | (+)* | | (+)*** |
| Grooming[b] | (+)*** | (+)*** | (+)** | (+)** |
| Talked on phone[b] | (+)** | (+)*** | | (+)*** |
| Used smartphone[b] | (+)*** | (+)*** | | (+)*** |
| Thought/planned[b] | (+)*** | (+)** | | (+)** |

*** Significant at 1%.
** Significant at 5%.
* Significant at 10%.
[a] These variables represent attitudinal or expectation type statements in the survey (see Table 7 in the Appenidx).
[b] These variables represent activities reported as being conducted on the recent commute in question.

of community (ex. mixed-use developments) (Páez and Whalen, 2010). By contrast, number of vehicles owned reduces the probability of experiencing productive benefits – this may reflect a stronger orientation toward commuting by car, which is not conducive to productive types of travel-based multitasking such as laptop usage (Malokin et al., 2019). On the other hand, the model shows that, as expected, passive modes, such as transit and being a passenger in shared rides (i.e. taxi/carpool/vanpool/employer shuttle), increase the propensity to realize productive benefits.

Fourteen attitudes/preferences (encompassing commute preferences and expectations, time use patterns, and general attitudes) are significant, with three in common between constructs. Overall, those holding work-oriented attitudes/lifestyles such as "would like to work on commute," and "has to work on commute," are more likely to experience benefits of travel-based multitasking. Correspondingly, those who are less work-oriented, such as having a propensity to "see one's job merely as a source of income", have reduced chances of obtaining productive benefits, likely due to having a lower desire to work while traveling. Similarly, those who are oriented towards socializing or engaging in recreational activities during the commute have increased chances of seeing benefits, while those who appear to be oriented toward being available to family are less likely to obtain benefits. We see that viewing "travel as a waste" decreases the chance of experiencing hedonic benefits, while those who view "commute as good" and have "real time pressure" to complete tasks have an increased chance of experiencing productive benefits. These latter effects are consistent with the understanding that those who value and/or need their commute time are more likely to experience benefits from travel-based multitasking (and vice versa). Although it is difficult to separate cause and effect in the case of the "commute is good" attitude (it is likely the *effect* of experiencing benefits from the commute as well as the *cause* of doing so), we left it in the model because it can represent a *general* orientation or determination to wring benefits out of one's commute time, which in turn could legitimately influence the way one uses the time and thence the benefits experienced on the *specific* recent commute being analyzed. Those who report that getting stuck in traffic doesn't bother them have reduced chances of experiencing productive benefits, perhaps suggesting a more relaxed attitude toward the passage of time, and therefore less motivation to use their travel time efficiently.

The model also shows that both conducting various specific activities and carrying certain items aboard during a commute increased the probability of obtaining benefits from multitasking. A wide array of activities such as: grooming, talking on the phone, and daydreaming were seen to increase the likelihood of having both hedonic and productive advantages; while others, such as using the internet, writing emails, and reading documents, were only significant for productive advantages. Lastly, it was seen that the *active execution* of activities like reading was significant for productive benefits, while the mere *act of carrying aboard reading materials* was significant for hedonic benefits. This could suggest that those who are equipped for the commute but do not utilize those items are enjoying the commute in other ways, or may simply delineate an attitudinal difference between those who view the commute as a place to *potentially* do activities versus those who *actually* execute activities on the commute.

### 5.2. Disadvantages of travel-based multitasking

Table 5 summarizes the model developed for the affective and cognitive variables that underlie the disadvantages of travel-based multitasking. The model has an adjusted pseudo-$R^2$ (with equally likely base) of 0.358. The 0.154 correlation of error terms indicates that the *unobserved* variables influencing the two types of disadvantages have relatively little in common with each other, in contrast (based on the 0.634 correlation of the measures overall, as shown in Section 4) to the explanatory power of the common *observed* variables. Sixteen variables are significant for the affective disadvantages equation, while 19 variables are significant for the cognitive disadvantages equation (at the five percent significance level). Seven of these variables are common to both equations, and of those, all have the same sign with the exception of the variable indicating the mode choice of "passenger in a shared ride", which increases the probability of experiencing affective disadvantages but decreases the probability of experiencing cognitive disadvantages. This might suggest that since participants are not required to be in control of the vehicle, their attention is less fragmented and they are thus less distracted, but they may still be unhappy with another aspect of the trip and/or with the quality of the activity they are conducting (resulting in the increased affective disadvantages).

Regarding the other mode attribute variables, we see that (similar to the shared ride variable), choosing the transit mode also decreases the probability of experiencing cognitive disadvantages, but (unlike for shared ride) does not have a significant influence on the affective disadvantages. This may suggest that transit users are happier with their travel-based multitasking experience relative to shared ride passengers. Finally, we also see that as participants' perceptions of comfort and convenience of their chosen mode increases, both affective and cognitive disadvantages decrease.

In terms of sociodemographic variables, age, education level, number of vehicles, and household income are significant. Higher household income increases the likelihood of experiencing cognitive disadvantages. Income is positively correlated (low to moderate magnitudes around 0.20) with increased vehicle ownership, commute time and distance, and smartphone usage and presence on the commute; as such, it is conceivable that this effect is being influenced by smartphone use while driving alone, or serving as a proxy for the complex interrelated effects of all these variables. Age is another sociodemographic variable of significance, and has negative signs for both equations, indicating that the likelihood of experiencing disadvantages due to travel-based multitasking decreases with age. This may be attributable to habituation to the commute as one gets older, but may also indicate a stronger tendency to use ICT tools for amusement and/or productivity, and a greater facility at multitasking but also a greater sense of distraction or wasting time, among younger commuters.

A total of ten attitudes or propensities were significant for this model, with two in common between the affective and cognitive disadvantages. Not surprisingly, those who like to multitask on their job, do not mind waiting, and believe that their commute is good are all less likely to experience affective disadvantages. On the other hand, those who have "real" or "preferred time pressure" have increased probabilities of experiencing cognitive disadvantages from travel-based multitasking, possibly due to stress or the desire to be doing another activity instead. Similarly, those who feel that that they are "expected to have recreation" on the commute are also more likely to experience cognitive disadvantages, perhaps attributable to expectations falling short of their experience, or being at odds with their desires.

Lastly, we draw attention to the fact that across different variable categories (attitudes *and* activities conducted), smartphone/ICT usage appears to consistently increase the likelihood of experiencing cognitive disadvantages due to travel-based multitasking. Of note is a related finding from the literature that younger and middle-aged travelers, who fall in the most active group of mobile media users, have higher expectations regarding their transport experiences, presumably due to greater need for uninterrupted trip experiences that facilitate their use of ICT (Julsrud and Denstadli, 2017), and thus may be more likely to report disadvantages associated with commute multitasking. Overall, while there are likely multiple factors at play regarding *why* ICT users tend to experience disadvantages, the trend is clearly present both here and in the literature, and is worth noting, particularly in view of the general understanding of ICT as primarily a positive contributor to travel time utility.

## 6. Discussion

The growing prevalence of, and potential for, travel-based multitasking mirrors the trend of increased multitasking behaviors across numerous (some might say, *all*) realms of modern life. Accordingly, multitasking in general has been and continues to be examined as a critical topic with regard to its (multidimensional) impacts on various population segments (ex. children, elderly adults, drivers, women, etc.), as well as its effects on the quality of the tasks/activities being executed (ex. activities performed while traveling, activities performed while providing childcare, etc.; Circella et al., 2012; Kenyon, 2010). An in-depth examination of cognitive requirements is outside the scope of this paper, but researchers have largely found that general multitasking can allow for certain advantages such as the use of "dead" time, and the ability to "fit" more into a day, but it can also be detrimental to both wellbeing and activity performance (Circella et al., 2012; Mark et al., 2008; Ophir et al., 2009). This study finds similar effects for the specific subcategory of travel-based multitasking. For example, Table 6 illustrates that grooming, talking on or otherwise using a phone, and thinking/planning while traveling all increase the probability of receiving benefits, while also increasing the probability of experiencing cognitive disadvantages. Additionally, for the disadvantages model (Section 5.2), almost all of the activities conducted/items carried yielded increased probabilities of experiencing cognitive or affective disadvantages, with the exception of non-electronic games.

As such, we see a pattern emerging, namely that certain factors constitute a "two-edged sword", generating positive as well as negative outcomes. The latter may stem from dissatisfaction with the activities being performed themselves, dissatisfaction with the quality with which they are being performed, dissatisfaction with the way the time is being used, or fragmented attention, to name a few possibilities. Some evidence supporting this effect is present in the literature; for example, Guo et al. (2015) showed that only about 30% of passengers with ICT devices used them during travel although a significant portion (60%) of the users engaged in active multitasking. This could suggest that certain devices/activities are less preferred due to the disadvantages (ex. cognitive) that accompany any benefits that would be obtained. Such findings may also be related to the use of activities for ameliorating trip disutility, but not completely eliminating the disutility (Ettema et al., 2012; Mokhtarian et al., 2015; Singleton, 2018). Along similar lines, we see that having "real time pressure" or "expectations for recreation on the commute" increases the propensity of experiencing productive benefits, but also appears to increase the likelihood of disadvantages.

Comparisons across models also yield interesting results with regards to mode choice. In Table 6, we see that passengers in shared rides (such as taxi or carpool) are both more likely to experience productive benefits and less likely to experience cognitive disadvantages, which is intuitive given that they are not responsible for directing the vehicle and so are more "free" to engage in other tasks. However, these individuals may experience unhappiness with the quality of the task they are performing or with the overall trip, because they are *more* likely to experience *affective* disadvantages. Transit users have increased probabilities of experiencing both types of benefits from multitasking, with decreased likelihood of cognitive disadvantages, and also tend to be less likely to experience affective disadvantages than shared ride passengers (since the transit user variable is not significant in that model but the shared ride variable is significant with a positive coefficient).

While these findings support the empirical and conceptual literature regarding the increased ability of transit users to engage in travel-based multitasking, and ultimately to reap increased benefits and reduced disadvantages from activities conducted while traveling, they seem at odds with the frequent finding that transit users consistently report the lowest levels of travel satisfaction among mode users (e.g. De Vos, 2018). This is a particularly critical question to consider, given that the literature has shown that multitasking conduciveness increases the utility of travel time, which in turn increases the overall level of travel satisfaction; and in fact, this is one of the core motivations of studies such as the one presented in this paper.

We cannot definitively resolve this paradox in the present study, since our data do not include measures of travel satisfaction. However, we suspect that the answer lies largely in the heterogeneity of the mode "transit", alluded to in the literature review, and correspondingly in the heterogeneity of transit *riders*. The literature has consistently identified two general classes of transit riders: "choice riders", who use transit even though they have a reasonable alternative (typically the car), and "captive riders", who are bound to transit because it is their only practical choice (Beimborn et al., 2003; Kroesen et al., 2017). The literature provides ample evidence that captive transit users tend to have lower socioeconomic indicators (Paulley et al., 2006), while the dataset used in this paper indicates that those who report that they do not engage in other activities while traveling also tend to have lower socioeconomic indicators relative to respondents who reported specific benefits and/or disadvantages of travel-based multitasking. Based on these findings, we speculate that (1) captive riders are more often using lower-quality (less satisfying) transit services that are less conducive to multitasking, while choice riders are more often using higher-quality services; and (2) captive riders are less likely to hold the white-collar jobs that lend themselves to productive travel multitasking, and may have lower access to/facility with the electronic tools often associated with productive travel multitasking. Additional investigation of the relationships among type of transit, type of traveler, engagement in travel multitasking, perceived benefits and disadvantages of such multitasking, and travel satisfaction is certainly of interest.

Overall, the findings of this study provide fertile grounds for further exploration, especially looking forward to an era of (shared and/or private) autonomous vehicles (AVs). For example, how will multitasking in autonomous vehicles compare to multitasking conditions on transit vehicles? How will multitasking in shared AVs compare to that in private AVs? Such considerations have already begun to generate discussion regarding exactly how *much* autonomous vehicles will be able to re-work the travel-based multitasking landscape (Le Vine et al., 2015; Singleton, 2019).

## 7. Conclusions

Within this paper, we used data from a revealed preference travel behavior survey of N ≈ 2500 Northern California commuters to identify and model the types of benefits and disadvantages experienced as a result of conducting other activities while traveling. Travel-based multitasking has been the subject of a rich and diverse body of literature; however, to our knowledge, detailed here is the first empirical investigation that: (1) develops a typology of travel-based multitasking benefits and disadvantages; and (2) models the effects of attitudes, behaviors, and other variables on the identified types of benefits and disadvantages. The identified constructs are: hedonic benefits, productive benefits, affective disadvantages, and cognitive disadvantages of travel-based multitasking.

Highlighted results include the increased propensity of those who use active modes of transport to experience hedonic and productive benefits, with drivers being less likely to experience either type of benefit. While shared-ride and transit passengers are both likely to experience productive benefits and cognitive disadvantages, shared-ride passengers are more likely to experience affective disadvantages of travel-based multitasking relative to transit users, possibly either a function of the companions with whom the ride is being shared or the type of vehicle (automobile) that shared-ride users are more likely to be using for travel. Overall, we see that commuter rail, other transit, and shared-ride modes have a greater proportion of users, relative to drivers, who obtain travel-based multitasking benefits, with fewer accrued cognitive disadvantages. Thus, we see that chosen mode, as well as the perceived comfort and conduciveness of these modes for travel-based multitasking, affects the resultant benefits and disadvantages obtained, which likely has implications for future decisions on mode choice as well as travel-based multitasking.

Also of note is the fact that family-oriented attitudes result in a reduced likelihood of obtaining travel-based multitasking benefits, relative to having work- and leisure-oriented attitudes. Additionally, those with greater technology affinities and tendencies to use ICT while commuting are seen to have increased likelihoods of cognitive disadvantages. These effects either supplement or add to the existing body of knowledge regarding travel-based multitasking. We refer the reader to Sections 5 and 6 for additional effects of interest and importance that emerged in this modeling effort.

Overall, we see that mode attributes and activities that increase the likelihood of travel-based multitasking benefits can simultaneously increase the likelihood of travel-based multitasking disadvantages, a finding that resonates with the general multitasking literature. This suggests that the utility obtained from travel-based multitasking is not always positive, and is likely strongly influenced by taste and condition heterogeneity. Accordingly, a limitation of this study is that it is unable to directly capture the heterogeneity that can arise between choice and captive mode users, an important distinction when it comes to differences in expectations/attitudes towards mode choice, travel-based multitasking desires, and overall travel satisfaction. Furthermore, to improve and extend upon the work done here, we recommend that future studies of travel-based multitasking acknowledge differences in the various types of benefits and disadvantages, while seeking to further understand and demarcate the line between utility and disutility of multitasking for different types of travelers.

As travel-based multitasking becomes increasingly diverse, with ICT-enabled activities in particular becoming more widespread (Keseru and Macharis, 2018), this work is valuable for helping us to understand how multitasking will help and/or hurt travelers now – and perhaps even more importantly, in a future that may include autonomous vehicles and/or increasing shares of travel undertaken as "hands-free" passengers rather than drivers.

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## Appendix

See Table 7.

**Table 7**
Survey constructs with associated statements and loadings.[1]

| Constructs | Statements[†] | Loadings[‡] |
|---|---|---|
| **Multitasking Attitudes and Preferences** | | |
| *Preference for activity- oriented multitasking*[a] | I typically do two or more activities at the same time | 0.614 |
| | I am comfortable doing more than one activity at the same time | 0.545 |
| | I like to juggle two or more activities at the same time | 0.496 |
| | Doing two or more activities at the same time is the most efficient way to use my time | 0.403 |
| *Preference for background audio*[a] | I generally like to have something (music/radio/TV) playing in the background | 0.948 |
| | Background music/radio/TV is too distracting for me | −0.835 |
| *Monotasking preference (day-scale)*[a] | I would rather complete parts of several projects every day than complete an entire project | −0.916 |
| | I would rather complete an entire project every day than complete parts of several projects | 0.613 |
| *Multitasking is normative*[a] | I believe people do their best work when they have many tasks to complete | 0.800 |
| | I believe people should try to do many things at once | 0.504 |
| | I believe it is best for people to be given several tasks and assignments to perform | 0.433 |
| *Affect toward multitasking*[b] | When doing multiple activities at a time, I feel: “dissatisfied” to “satisfied” (5-point scale) | 0.589 |
| | When doing multiple activities at a time, I feel: “out of control” to “in control” (5-point scale) | 0.566 |
| | When doing multiple activities at a time, I feel: “underappreciated” to “important” (5-point scale) | 0.534 |
| | When doing multiple activities at a time, I feel: “the results are worse” to “the results are better” (5-point scale) | 0.527 |
| | When doing multiple activities at a time, I feel: “not true to myself” to “true to myself” (5-point scale) | 0.511 |
| | When doing multiple activities at a time, I feel: “less productive” to “more productive” (5-point scale) | 0.486 |
| | When doing multiple activities at a time, I feel: “overwhelmed” to “energized” (5-point scale) | 0.446 |
| *Preference for task- oriented monotasking*[a] | I believe it is best to complete one task before beginning another | 0.519 |
| | I prefer to do one thing at a time | 0.501 |
| | When I work by myself, I usually work on one project at a time | 0.498 |
| | I seldom like to work on more than a single task or assignment at the same time | 0.413 |
| **Commute Preferences and Expectations**[c] | | |
| *Feels expected or would like to work* | Work during your commute | 0.513 |
| | Do “nothing” during your commute | −0.339 |
| *Feels expected or would like to socialize/recreate* | Do recreational activities during your commute | 0.641 |
| | Socialize with other people while commuting | 0.382 |
| | Constantly be available to friends | 0.299 |
| **Time Use Patterns, Preferences and Expectations** | | |
| *Feels expected or would like to be constantly available*[c] | Constantly be available to friends | 0.678 |
| | Constantly be available to family | 0.669 |
| | Constantly be available to co-workers/clients | 0.568 |
| *Perceived time spent on traditional social and recreational activities*[d] | Doing hobbies | 0.427 |
| | Getting exercise | 0.379 |
| | With family | 0.369 |
| | With friends | 0.585 |
| | Volunteering/doing service | 0.320 |
| *Perceived time spent traveling*[d] | Traveling (long-distance) | 0.462 |
| | Traveling (to/from work) | 0.336 |
| | Traveling (other local) | 0.596 |
| *Perceived time spent working*[d] | Amount of time you spend working | 0.784 |
| | Amount of time you spend relaxing | −0.452 |
| | Amount of time you spend on the computer/phone/internet for work | 0.415 |

(*continued on next page*)

**Table 7** (*continued*)

| Constructs | Statements[†] | Loadings[‡] |
|---|---|---|
| *I do not mind waiting*[a] | I'm OK with waiting, even if I have nothing with me to fill the time | 0.735 |
| | I can pass the time just fine by daydreaming and looking around | 0.564 |
| | I often find myself stuck with nothing to do while waiting | −0.334 |
| | In general, waiting is unpleasant even if I have a way to use the time | 0.631 |
| | Waiting gives me a good chance to catch up on certain things | 0.588 |
| | If I know I am going to spend time waiting, I bring something to do while I wait | 0.071 |
| | Unexpected waiting generally makes me tense | −0.581 |
| | I don't mind waiting if I expect it ahead of time | 0.536 |
| | I plan ahead to minimize my waiting time | −0.206 |
| | Waiting is boring | −0.681 |
| | Having to wait can be a useful pause in a busy day | 0.678 |
| *I don't need to be equipped for a wait event*[a] | I'm OK with waiting, even if I have nothing with me to fill the time | 0.337 |
| | I can pass the time just fine by daydreaming and looking around | 0.201 |
| | I often find myself stuck with nothing to do while waiting | 0.592 |
| | In general, waiting is unpleasant even if I have a way to use the time | 0.199 |
| | Waiting gives me a good chance to catch up on certain things | −0.187 |
| | If I know I am going to spend time waiting, I bring something to do while I wait | −0.502 |
| *Waiting is okay if I expect it*[a] | Waiting gives me a good chance to catch up on certain things | 0.276 |
| | Unexpected waiting generally makes me tense | 0.174 |
| | I don't mind waiting if I expect it ahead of time | 0.351 |
| | I plan ahead to minimize my waiting time | 0.450 |
| | If I know I am going to spend time waiting, I bring something to do while I wait | 0.451 |
| **General Attitudes and Preferences** | | |
| *Feels expected or would like to multitask on the job*[c] | On the job: work on several tasks in the time span of one hour | 0.492 |
| | On the job: work on several tasks in the time span of one day | 1.022 |
| | On the job: work on several tasks in the time span of one week | 0.714 |
| *Pro-transit*[a] | I prefer to take transit rather than drive whenever possible | 0.739 |
| | I'd rather drive than travel by any other means | −0.588 |
| | I like the idea of driving as a means of travel for me | −0.536 |
| | I like the idea of transit as a means of travel for me | 0.510 |
| *Pro-technology*[a] | I like to be among the first to own new electronic products | 0.755 |
| | I like to track the development of technology | 0.747 |
| | I often introduce new trends to my friends | 0.577 |
| | The internet makes life more interesting | 0.343 |
| | Technology brings at least as many problems as solutions | −0.305 |
| *Pro-active modes*[a] | I like the idea of walking (or biking) as a means of transportation | 0.895 |
| | I prefer to walk or bike rather than drive whenever possible | 0.767 |
| | I like the idea of living in a neighborhood where I can walk to the grocery store | 0.420 |
| *Travel is wasted time*[a] | I generally enjoy the act of traveling itself | −0.774 |
| | The act of traveling is boring | 0.710 |
| | Time spent traveling is generally wasted time | 0.592 |
| | The only good thing about traveling is arriving at your destination | 0.567 |
| | I sometimes travel more than I have to, because I want to | −0.389 |
| | To me, a car is mostly just a way to get from place to place | 0.308 |
| *Commute benefits*[a] | My commute is generally pleasant | 0.773 |
| | My commute is stressful | −0.769 |
| | My commute serves as a welcome transition between home and work | 0.372 |
| *Real time pressure*[a] | I feel like I need to make the most of every single minute | 0.433 |
| | I'm often in a hurry to be somewhere else | 0.674 |
| | I'm too busy to do many things I'd like to do | 0.476 |

(*continued on next page*)

**Table 7** (*continued*)

| Constructs | Statements[†] | Loadings[‡] |
|---|---|---|
| *Preferred time pressure*[a] | I feel more productive when I am under pressure to complete work by a deadline | −0.709 |
| | I do my best work when I have more than enough time to complete it | 0.532 |
| *Satisfaction*[a] | I am generally satisfied with my job | 0.550 |
| | I am generally satisfied with my life | 0.806 |
| *Pro-density*[a] | I like the idea of living somewhere with large yards and lots of space between homes | −0.635 |
| | I prefer to live close to transit, even if it means I'll have a smaller home and more people living nearby | 0.625 |
| | Mixing different types of businesses (e.g., shops, restaurants, offices) with the homes in my neighborhood causes (or would cause) too much traffic or noise | −0.549 |
| **Personality Traits**[e] | | |
| *Extraverted* | Fun-oriented | 0.694 |
| | Spontaneous | 0.601 |
| | Variety-seeking | 0.537 |
| | Adventurous | 0.520 |
| | Like to meet new people | 0.439 |
| | Risk-taking | 0.308 |
| *Organized* | Organized | −0.811 |
| | Neat | −0.721 |
| | Tend to procrastinate | 0.467 |
| | Efficient | −0.446 |
| | Like a certain amount of chaos | 0.353 |
| | Often late | 0.303 |
| *Frustrated* | Tend to procrastinate | 0.330 |
| | Impatient | 0.495 |
| | Pessimistic | 0.480 |
| | Restless | 0.475 |
| | Perfectionistic | 0.371 |
| | Aggressive | 0.345 |
| *Loner* | Like being alone | 0.526 |
| | Like being independent | 0.525 |
| *Responsible* | Family-oriented | 0.607 |
| | Responsible | 0.567 |
| | Like to stick to a routine | 0.322 |
| *Risk-taker* | Risk-taking | −0.526 |
| | Aggressive | −0.523 |
| *Leader* | Efficient | −0.318 |
| | Ambitious | −0.698 |
| | Work-oriented | −0.513 |
| | Like being in charge | −0.373 |
| *Explorer* | Concerned about the environment | −0.751 |
| | Curious | −0.494 |
| | Like being outdoors | −0.396 |
| **Mode perceptions**[f] | | |
| *Perceived convenience of chosen mode* | Ability to run errands on the way to/from work | 0.687 |
| | Privacy | 0.487 |
| | Availability when needed/wanted | 0.789 |
| | Ability to carry things with me | 0.343 |
| | Door-to-door travel time | 0.595 |
| | Reliability | 0.648 |
| | Comfort | 0.333 |

(*continued on next page*)

**Table 7** (*continued*)

| Constructs | Statements[†] | Loadings[‡] |
|---|---|---|
| *Perceived benefit of chosen mode* | Effect on the environment | 0.801 |
| | Cost | 0.591 |
| | Avoiding congestion | 0.625 |
| | Amount of physical activity involved | 0.578 |
| *Perceived comfort of chosen mode* | Safety | −0.592 |
| | Traveling in poor weather conditions | −0.559 |
| | Comfort | −0.412 |
| | Reliability | −0.333 |
| *Perceived multitaskability of chosen mode* | Ability to run errands on the way to/from work | 0.304 |
| | Privacy | 0.478 |
| | Ability to carry things with me | 0.493 |
| | Ability to do things I need/want while traveling | 0.490 |

[1] **Note.** Except where otherwise indicated, the numbers in this table are pattern matrix loadings from a series of factor analyses performed on respective blocks of variables from the survey, with oblique rotation of factors. Details of the factor analyses are documented in a series of internal working memos, available from the authors.

[†] A statement can load on more than one construct. Constructs that do not appear in this table, but that appear in the results, are "standalone" variables, i.e., they are not latent constructs, but rather direct measurements from the survey responses.

[‡] Represents the degree of association between the statement and the construct. Only loadings greater than 0.3 are reported, except for the waiting constructs (reported under time use patterns). The waiting constructs are the results of a bi-factor analysis; further information on these constructs can be accessed at Mishra et al. (2015).

[a] Items measured on a 5-point Likert-type scale ranging from "Strongly disagree" to "Strongly agree".

[b] Items were in response to a statement, " When doing multiple activities at a time, I feel:", followed by a 5-point scale that measured a variety of feelings/self-assessments (detailed above) towards multitasking.

[c] Items measured on a 3-point ordinal scale ranging from "Generally no" to "Generally yes".

[d] Items measured on a 5-point ordinal scale ranging from "Way too little" to "Way too much".

[e] Items measured on a 5-point ordinal scale for "how well each of the following words or phrases describes you", ranging from "Hardly at all" to "Almost completely".

[f] Items measured on a 5-point ordinal scale ranging from "Very bad" to "Very good". Identical blocks of items were presented to respondents for four different modes: drive alone, shared ride, local transit (including light rail and metro rail), and either commuter (intercity) train (for all paper survey respondents, and online respondents with commutes of 10 miles or more) or bicycle/walk (for online respondents with commutes less than 10 miles). To reduce respondent burden, the perceptions for the "shared ride" mode did not distinguish being the driver for the shared ride from being a passenger – the result being that the extent to which each of those possible roles influenced the reported shared ride perceptions is unknown. This raised the issue, for the models of Tables 4 and 5, of which set of perceptions to attribute to the "chosen mode", when the primary commute mode was shared-ride driver. Given that (1) many shared-ride drivers drive alone for some portion of the commute (before picking up the first passenger and after dropping off the last one); (2) the drive-alone perceptions came first in the survey (and thus shared-ride drivers may well have responded to those items from the perspective of a shared-ride driver as much as or more than from that of a solo driver); (3) perceptions of many of the items shown in the table could be expected to be similar for solo and shared-ride drivers; and (4) the drive-alone perceptions are the only ones that unambiguously pertain to the driving role, we took the drive-alone responses to best represent the chosen-mode perceptions for shared-ride drivers.

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