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How does environmental concern influence mode choice habits? A mediation analysis

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ABSTRACT

Starting from the intuition that people with high environmental concern have a better perception of public transport and therefore a better perception of the utility of public transport, we construct a theoretical model in which the effect of environmental concern on mode choice habits is mediated by the indirect utility of travel. Travel procures the direct utility of providing access to activities, but it also offers an indirect utility that is inherently personal and perceptual. We approach the indirect utility of public transport by measuring perceptions of time and feelings. The indirect utility of the car is approached by measuring affective and symbolic motives. Taking into account car use habits and habits of public transport use, the results show that people who have a high environmental concern perceive public transport use as easier, more useful and more pleasurable than people who do not have that environmental motivation. Such positive attitudes foster public transport use. Conversely, low environmental concern generates non-instrumental motives for car use, such as affective and symbolic motives. However, the relationship between affective and symbolic motives and car use habits is not robust. We can conclude that environmental concern influences mode choice habits and that the effect is partially mediated by perceptions and feelings towards public transport but not significantly by affective and symbolic motives for car use.

1. Introduction

In the European Union, the car continues to be the most popular mode of transport. In 2013, passenger cars accounted for 83.2% of inland passenger transport[1] (Eurostat, 2016) despite the negative external costs involved (air pollution, noise, space usage, and so on). In response to these issues, a growing awareness of the ecological challenges associated with car use is informing the public debate and promoting more sustainable mobility. Yet, the relationship between environmental concern and travel behavior is still a challenging question to which contradictory answers have been given. While a correlation between environmental concern and environmentally-friendly behavior is observed in other fields, such as waste management (Barr, 2007), energy efficiency (Ramos et al., 2016) or water conservation (Millock and Nauges, 2010), the link seems to be more nuanced in the field of transportation. In some studies, the relationship between environmental concern and public transport use, or intention to use, is positive and thus confirms intuition (e.g., OECD, 2014; Garvill, 1999; Nilsson and Küller, 2000). However, other studies do not find a significant relationship (e.g., Walton et al., 2004; De Groot and Steg, 2007), which suggests a potential inconsistency between attitudes towards the environment and mode choice behavior.

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[1] As measured by the number of passenger-kilometers traveled by each mode.

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An explanation for this cognitive dissonance (Festinger, 1954) is that pro-environmental motivation is not enough for most people to engage in behavior that replaces or reduces private car use to the benefit of sustainable travel modes. In other words, modal shift is not easy enough. This is supported by the theory of planned behavior (Ajzen, 1991), which, through the concept of Perceived Behavioral Control (PBC), states that people are more likely to perform a behavior when they perceive it as easy to perform. To better understand the link between environmental concern and travel behavior, attitudes to travel modes need to be explored as well as the extent to which their use is perceived as easy, pleasant and useful by passengers.

In the theory of planned behavior, the traveler's attitude towards a behavior is portrayed as a cognition process where the rational consumer evaluates pros (positive utility) and cons (disutility) associated with the behavior in question. According to Mokhtarian and Salomon (2001), the positive utility associated with traveling with a specific mode is gained from (1) accessing the activities conducted at destination; (2) activities that can be conducted while traveling, and (3) the activity of traveling itself. The second and third elements reflect an indirect utility arising from traveling, which may explain "excess travel" and unexpected choices of travel modes. An illustration is given by Morris (2015), who finds that travel time generally exhibits a positive relationship with life satisfaction. One of his explanations is that the act of travel itself is fulfilling.

To our knowledge, previous works concerned with the relationship between environmental concern and mode choice do not take into account the influence of the indirect utility of travel on mode choice. However, individuals with a higher environmental concern may be more sensitive to the indirect utility provided by public transport and less sensitive to the indirect utility provided by the car. Thus, indirect utility, as well as PBC, may act as a mediator between environmental concern and mode choice habits.

Moreover, previous works (e.g., Walton et al., 2004; Nilsson and Küller, 2000; De Groot and Steg, 2007) mainly focus on single measures (e.g., intention to use a single mode, one-off choice or mode choice for a single purpose), which depend on the journey characteristic indicators such as travel cost or travel time. However, environmental concern and attitudes towards travel modes are not specific to a particular journey. Furthermore, some people use diversified modes of transport and adapt their choice to the context of the trip. In their literature review on the definition and measurement of multimodality, Molin et al. (2016) emphasize the advantage of choosing a wide time window (a year) to capture the multimodal dimension of mobility. An individual may indeed travel by car for commuting purposes but regularly use train for leisure or business trips. The impact of environmental concern on travel behavior thus has to be approached with a general measure, such as mode choice habits, to take into account three dimensions of mode choice: repetitiveness, intensity of travel (excess travel) and trade-off between modes.

The aim of this article is thus to extend previous research by means of an integrative tool (Structural Equation Modeling; SEM). SEM makes it possible to explain a multiple output, car use and public transport habits, with a mediation structure between environmental concern, PBC and the indirect utility of traveling.

The rest of the article is arranged in five sections. Section 2 sets out the background and defines the theoretical model and concepts. Section 3 proposes a number of hypotheses and suggests a theoretical model to test them. The collected data and the estimation method by SEM are presented in Section 4. The results of the estimations are discussed in Section 5. Section 6 offers conclusions.

2. Literature review

A growing body of literature lies at the interface between environmental and behavioral economics (Croson and Treich, 2014) and is based on psychological concepts and theories that focus directly on environmental issues, including travel mode choice.

2.1. Environmental psychology

Two behavioral theories, the theory of planned behavior and value-belief-norm theory, are critical to explain pro-environmental behavior, including transportation behavior. They are based on the idea that behavior is driven by internal mental states rather than external conditions, with the assumption that behavior is the outcome of a deliberative conscious process (Savage et al., 2011).

The theory of planned behavior, an extension of the theory of reasoned action (Fishbein and Ajzen, 1975), assumes that individuals behave strategically, evaluating the information they have access to and the implications of those actions. Individuals thus choose alternatives with lowest costs against highest benefits. The theory of planned behavior involves attitudinal dimensions (the degree to which engagement in behavior is positively valued), subjective norms (social pressure from important others to engage in a particular behavior) and PBC, and relates them to the intended behavior that precedes actual behavior. The theory of planned behavior is generally successful in explaining mobility behavior (Heath and Gifford, 2002; Bamberg et al., 2003; De Groot and Steg, 2007).

Pro-environmental behavior is often associated with higher costs. Individuals are therefore more likely to act pro-environmentally when they subscribe to altruistic or biospheric values beyond their own immediate interests. These values are integrated in value-belief-norm theory developed by Stern et al. (1999) based on a major study on the psychological determinants of pro-environmental behaviors (Stern, 1992). Value-belief-norm theory is based on Schwartz's norm-activation-model (Schwartz, 1977), which stipulates that a behavior is performed by individuals who feel a moral obligation to do so. These personal norms depend on the extent to which individuals are aware of the problems caused by their behavior and feel responsible for the problems and solutions. Value-belief norm theory further proposes that problem awareness is rooted in an ecological worldview, itself determined by personal values.[2] Low-cost

[2] Social-altruistic value: the environment is valued for what it brings society. Egoistic value: the environment is valued for what it brings me. Biospheric value: the environment is valued for itself, independently of its value for humankind.

environmental behavior (occasional recycling, water and electricity savings) or intentions are well explained by the norm-activation models and value-belief-norm theories (Gärling et al., 2003; Steg, 2005). Yet, in the presence of high behavioral costs or strong constraints on behavior, such as public transport or bike use, the explanation power of these theories is low (Bamberg and Schmidt, 2003). In such contexts, the theory of planned behavior appears to be more powerful in explaining behavior, probably because it takes into account non-environmental motivations as well as PBC (Gifford et al., 2011).

In the theory of planned behavior, PBC takes account of the influence of contextual factors as they are perceived by the user. Objective contextual factors may also be integrated, as in attitude-behavior-context theory (Guagnano et al., 1995), which assumes that a particular behavior occurs when an individual's attitudes are positive and the external conditions are favorable. In attitude-behavior-context theory, contextual factors act as moderators on the attitude-behavior relationship. Using regression models, Collins and Chambers (2005) show that the effect of psychological factors (PBC, biospheric beliefs and so on) on behavior (the intention to use public transport for commuting trips) are indeed moderated by contextual variables.

Neither of these behavioral models includes the role of habits. A behavior driven by habits tends to occur subconsciously, without the person having to consciously think much before performing it. The stronger the habits, the less important the link between attitudes (and other explanatory variables) and behavior. Habits are accounted for by the theory of interpersonal behavior (Triandis, 1977). In this model, habits, intention and contextual factors are the three key factors explaining behavior.

2.2. Environmental concern

There is currently no stable and consensual definition of environmental concern (Le Borgne et al., 2015), which is a concept that carries a wide array of attitudes about environmental issues. These differences in definitions, and thus in measures, may explain the contradictory results on the relationship between environmental concern and travel behavior.

Two examples of definition for environmental concern are: (1) "an individual's insight that humans endanger the natural environment combined with the willingness to protect nature" (Franzen and Vogl, 2013, p. 2), and (2) an inclusive concept, "ranging from a specific attitude toward environmentally relevant behavior to a more encompassing value orientation" (Fransson and Gärling, 1999, p. 370). A complementary approach is to define environmental concern based on the three dimensions of an attitude: affective, cognitive and conative (Franzen and Vogl, 2013). A person with high environmental concern can therefore be defined as someone who has a good knowledge of (or belief in) the environmental challenges (cognitive dimension), who feels concerned by those challenges (affective dimension) and who has intentions to act to protect the environment (conative dimension).

There are over 700 scales for measuring environmental concern, but the scale most widely used is the New Ecological Paradigm (NEP) Scale (Schleyer-Lindenmann et al., 2014; Dunlap, 2008). This scale has its origins in the 1970s (Dunlap and Van Liere, 1978). In order to address the criticisms acknowledged by the authors themselves and reported in Anderson (2012) (lack of internal consistency, poor correlation between the scale and behavior, and the "dated" language of the items), Dunlap et al. (2000) updated the original scale. The NEP scale includes three facets: balance of nature, limits to growth, and anti-anthropocentrism (Dunlap, 2008). In value-belief-norm theory, the NEP is the scale used to measure beliefs about human-environment relations (ecological worldview).

Research has examined the individual determinants of environmental concern such as gender, age, education or income with mixed results (Marquart-Pyatt, 2012). Previous studies have proved the effect of age on environmental concern (see Buttel, 1979, for a discussion on the comparative effects of age and education; Liu et al., 2014, for a literature review). Jones and Dunlap (1992) demonstrated that, among 11 socio-demographic and socio-political factors, age was the best predictor of environmental concern, with younger people being more environmentally concerned relative to older people. Literature reviews on the relationship between gender and environmental concern conclude that women tend to have higher levels of environmental concern than men (Liu et al., 2014; Waygood and Avineri, 2016). Three interrelated theories may explain the gender gap (Liu et al., 2014): different expectations for females and males during parenthood and socialization processes; gender-based divisions in the labor market and home, and different value formation processes between women and men.

2.3. Indirect utility of car use: affective and symbolic motives

The car is generally perceived as a flexible and low-cost mode of transport that provides rapid access to activities. Such motives for car use, described as "instrumental", are those most widely studied in the literature. However, Steg (2005) argues that behavior models that focus on the instrumental motives for car use are not enough to explain the predominant choice of the car. She builds on the notion of indirect utility and shows that accounting for affective and symbolic motives for car use allows for a deeper understanding of mode choice.

Affective motives for car use account for the pleasure derived from a car, not by virtue of reaching a destination but by virtue of the object (e.g., the enjoyment of owning a fine car) and of using it (e.g., the sensation of speed and movement in Mokhtarian and Salomon (2001)).

Symbolic motives for car use focus on self-image. The mode choice depends, then, on social pressure, on how others see us and on our perception of how others see us. According to Steg (2005), the car can thus be seen as a symbol that reveals who one is (Schlenker, 1980), that allows a person to compare himself with other people (Festinger, 1954) and that allows a person to comply with the norms (Cialdini et al., 1991).

Lois and López-Sáez (2009) estimate a structural equation model to analyze the influence of symbolic, affective and instrumental motives for car use. Their results partially coincide with those of Steg (2005), despite differences in the measures of variables. According to their model, neither instrumental nor symbolic motives directly predict car use. Affective motives are the key factor in the prediction of car use and, in turn, they are accounted for by instrumental and symbolic motives.

2.4. Indirect utility of public transport use: perceptions of time use and feelings experienced during travel

As for the car, motives for using public transport are diverse. Besides instrumental motives determined by the objective level of service variables (travel cost, travel time, frequency and so on), there is a growing awareness that public transport demand is also driven by perceptual variables. Perceptions may even matter more than reality in travel decisions (Bhattacharya et al., 2014; Kaufmann, 2002). According to Steg (2003), people who usually do not drive think that the car is less safe, more costly, less comfortable and that it offers fewer varied experiences than travel by public transport.

These very notions of comfort and experience are at the heart of a strand of literature concerned with activities, perceived time, and feelings experienced during travel by public transport. In public transport modes, travel time can be used to read, work or rest, for instance (Lyons et al., 2013; Wardman and Lyons, 2016; Joly and Vincent-Geslin, 2016). The digital revolution further reinforces travel-based multitasking and an economically or socially productive use of travel time (see Berliner et al., 2015, Malokin et al., 2017, for an overview on multitasking).

Depending on the user, travel time is perceived as either wasted time or as productive time (Lyons et al., 2013). Public transport users seem to increasingly judge their travel time as worthwhile. In the UK, the proportion of train users considering their time wasted went down by nearly a third between 2004 and 2010 from 19% to 13% of all passengers (Lyons et al., 2013). Correspondingly, the proportion of people making very worthwhile use of their time went up by a quarter – from 24% to 30%. Business travelers are those most likely to judge that they made worthwhile use of their time. The increase in worthwhile use of rail travel time may be linked to improvements in service provision (comfort, delay) but also to improvements in terms of individuals' equipment (laptops, smart phones). Yet, in urban public transport, travel time remains an untapped potential. In Lyon (France), a third of urban transport users judge that their travel time is wasted or too short to do anything (Casals, 2012).

Feelings experienced during travel time also vary. Based on the American Time Use Survey's well-being module, Morris and Guerra (2015) observed five distinct emotions experienced during travel. They find that bus and train users experience the most negative emotions, though a small part of this can be attributed to the fact that public transport is disproportionately used for the unloved work trip. In France, the above-mentioned local survey (Casals, 2012) provides different results. The majority of urban public transport users experience positive feelings during their travel time. Seventy percent are always or often in a good mood; 60% feel a sense of freedom; 54% feel comfortable and at ease.

3. Hypotheses and theoretical model

Based on the literature review, seven hypotheses are formulated on the relationships between environmental concern, motives for car use, perceptions and feelings towards public transport, and mode choice habits. Hypotheses are also formulated on how socio-demographic variables influence the latent variables and how constraints, such as accessibility to public transport, shape mode choice habits.

A first set of hypotheses is built around car use habits. According to these hypotheses, car use habits are stronger when car use generates indirect utility in addition to direct utility. Affective and symbolic motives for car use are a source of indirect utility. Individuals with high environmental concern have lower affective and symbolic motives for car use, car use being mainly motivated by instrumental motives. High environmental concern results in car use to access activities and not for pleasure. Hence, it is expected that affective and symbolic motives for car use will mediate the relationship between environmental concern and car use habits.

- **H1**: **High environmental concern…**
  (H1 a) …reduces affective and symbolic motives for car use;
  (H1 b) …reduces car use habits;
- **H2**: A high influence of **affective and symbolic motives** on car use promotes car use habits.
- **H3**: Affective and symbolic motives for car use play a **partial mediating role** between environmental concern and car use habits.

Similarly, a second set of hypotheses is built around public transport habits. According to these hypotheses, public transport habits are stronger in people who perceive it as easy, productive and pleasant to travel by public transport modes. People with high environmental concern are aware of the advantage of choosing public transport over the car, and they therefore have an additional motive for adopting public transport modes and will do so less reluctantly. They will have more positive attitudes towards public transport modes, perceive it as easier to travel by public transport, be in a more positive state of mind, and thus perceive more favorably their indirect utility. In short, people with high environmental concern, will experience more positive feelings and judge their time as more productive while traveling by public transport modes. Hence, perceptions and feelings towards public transport modes are expected to mediate the relationship between environmental concern and public transport habits.

- **H4**: **High environmental concern…**
  (H4 a) …has a positive influence on perceptions and feelings towards public transport;
  (H4 b) …promotes public transport habits.
- **H5**: Positive **perceptions and feelings towards public transport** make it more likely to be used.
- **H6**: Positive perceptions and feelings towards public transport play a **partial mediating role** between environmental concern and

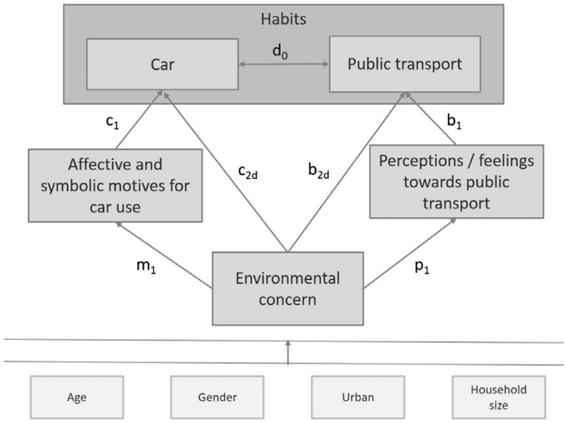

Fig. 1. Theoretical model.

public transport habits.
The last hypothesis makes the link between public transport and car use habits and reflects the trade-off dimension of mode choice habits.

- **H7**: **Public transport and car use habits** are negatively correlated.

With regard to the socio-demographic variables, the following hypotheses are made.[3] First, older people and men are expected to have lower environmental concern than younger people and women. Second, in terms of mode choice habits, hypotheses are based on the literature review by De Witte et al. (2013). People living in urban areas are expected to have a greater propensity to use public transport since it is more accessible. The size of the household is expected to be positively linked to car use habits. Mixed results are found concerning age and gender and no conclusion is drawn in the literature review.

A theoretical model to test the above-mentioned hypotheses is presented in Fig. 1. Consistent with the hypotheses, it incorporates a partial mediation relationship, so that there is a direct influence of environmental concern on mode choice habits, but also an indirect influence through the mediation of the two latent variables that reflect indirect utility.

4. Data and method

4.1. Survey

The data combines a stated preferences (SP) survey and a revealed preferences survey, specifically, a travel survey carried out in the Rhône-Alpes region. The respondents in the regional travel survey were sampled on the basis of stratified random sampling. In order to be sure that all areas in the Rhône-Alpes region were adequately represented, the sample is geographically stratified into 77 selected sample sectors. The regional travel survey was carried out in three phases by phone between 2012 and 2015. The respondents were then contacted to answer an online SP survey, which includes the measure of socio-demographic and socio-psychological variables. The sample includes 1061 people.

4.2. Measure of the socio-psychological variables

A three-stage process was used to choose and measure the socio-psychological variables: qualitative surveys (individual interviews and focus groups), a literature review and a quantitative survey. Based on the qualitative analysis and the literature review, a list of the relevant socio-psychological variables was compiled and included in a dedicated questionnaire answered by 277 persons. On that basis, the first analyses (exploratory factor analysis, measurement model and structural model) were conducted to select the most relevant variables and insert them into the final SP questionnaire.

Below, we record only the items retained in the final survey.[4] All these items are measured on the basis of 5-point Likert scales, which range from “completely agree” to “completely disagree”, except feelings experienced in public transport, which are measured on a 4-point scale ranging from “never” to “always”.

4.2.1. Environmental concern

The three dimensions of environmental concern (cognitive, affective and conative) are measured using items taken from the literature (Table 1). The cognitive dimension is measured with three items from the NEP, which are related to the concepts of

[3] Other variables and combinations of variables were initially considered (socio-economic and land use variables). The final choice was made according to significance tests and parsimony, with the constraint of having enough observations in the sample and of retaining uncorrelated explanatory variables.

[4] A list of all items used in the first questionnaire is available on request from the authors.

Table 1
Items measuring environmental concern.

Item	Definition	Dimension	Source
NEP1	The balance of nature is very delicate and easily upset	Cognitive	Dunlap et al. (2000)
NEP2	The so-called "ecological crisis" facing humankind has been greatly exaggerated		
NEP3	If things continue on their present course, we will soon experience a major ecological catastrophe		
Pbcar1	Is concerned by air pollution caused by cars	Affective	Steg (2003)
Pbcar2	Is concerned by space occupation caused by cars		
Pbcar3	Is concerned by traffic unsafety caused by cars		
Pbcar4	Is concerned by reduced quality of life caused by cars		
POL1	We need to build more parking lots downtown	Conative	Hurtubia et al. (2014)
POL2	We should increase the price of gasoline to reduce congestion and air pollution		Atasoy et al. (2011)
POL3	We need more public transport, even if it means higher taxes		
POL4	Everyone should be free to use their car whenever they want		Steg (2003)
POL5	The government has the right to reduce car use to safeguard environmental qualities and the urban quality of life		

Table 2
Items measuring motives for car use.

Item	Definition	Dimension	Source
AFF1	I like driving fast	Symbolic and affective motives for car use	Steg (2005)
AFF2	I am a bit in love with my car		
AFF3	You can know a person by looking at his or her car		
AFF4	The better your car is, the more successful you are in life		Lois and López-Sáez (2009)
INSTR1	I am safe in my car	Instrumental motives for car use	Steg (2005)
INSTR2	It does not matter to me which type of car I drive		
INSTR3	I am afraid of having an accident when I drive		

"ecological crisis" and "balance of nature" (Schleyer-Lindenmann et al., 2014). The affective dimension of environmental concern is measured using four items taken from Steg (2003). The respondents had to say to what extent they felt concerned by certain problems associated with using a car, such as air pollution, quality of life, traffic, odors, use of scant resources and space usage. The conative dimension of environmental concern was measured on the basis of two items involving the legitimacy ascribed to transport policies. Steg (2003) uses them to identify those people most likely to use public transport and how they may be persuaded to use it. We added three items selected from Atasoy et al. (2011) and Hurtubia et al. (2014).

4.2.2. Motives for car use

The measurement for the instrumental, affective and symbolic motives for car use (Table 2) comes principally from the work of Steg (2005) and Lois and López-Sáez (2009), themselves influenced notably by Steg et al. (2001) and Jensen (1999). One further item, "When I drive I am afraid of having an accident" was added to measure the instrumental motives for car use.[5] Indeed, the preliminary qualitative analysis emphasized that the risk of an accident comes into the motives for mode choice of some people.

4.2.3. Perceptions and feelings towards public transport

Perceptions and feelings towards public transport are measured by three dimensions: PBC, perceived time in public transport, and feelings experienced during journeys made by public transport (Table 3). The variables used to represent PBC were taken from Atasoy et al. (2011) and Morikawa et al. (1996). The more positively a person responds to these questions, the less control they feel they have in using public transport. The measurement for perception of time and feelings is based on a local study carried out on public transport in Lyon (Casals, 2012).

4.2.4. Mode choice habits

Mode choice is a decision repeated over time and strongly dependent on habits developed in the past (e.g. Verplanken et al., 1994; Cherchi et al., 2017). Measuring habits is necessarily difficult since behavior generated by habits results from limited awareness. Several scales have been suggested and used in the literature (Eriksson et al., 2008), specifically to appreciate the unintentional nature of behaviors generated by habits. We choose to measure habits by intensity of use, which is therefore restrictive compared with what other authors propose but better adapted to our objective, which is to explain actual behavior.

[5] Although the connection of this item to the instrumental motives may be challenged, the idea behind this categorization is that this item expresses the motive for traveling from point A to point B without being injured. Since accidentology is much higher during travel by car than by public transport modes, and as some people are well aware of that, the question of the accidents has only been addressed for the car.

Table 3
Items measuring perceptions and feelings towards public transport.

Item	Definition	Dimension	Source
PBC1	I'm not comfortable when I travel with people I do not know well	Perceived behavioral control	Atasoy et al. (2011)
PBC2	Its hard to take public transport when I travel with my children		Morikawa et al. (1996)
PBC3	Its hard to take public transport when I travel with bags or luggage		
Time1	I like seeing people and having other people around me	Perceived time in public transport	Casals (2012)
Time2	It's time I put up with and I just wait for it to pass		
Time3	I use the time to rest and relax		
Time4	I use the time to do things I wouldn't necessarily do elsewhere		
Time5	I just want to be on my own and undisturbed		
Time6	Given my commutes, the time is too short: I don't have time to do anything		
Time7	It's wasted time		
Feel1	I feel a sense of freedom	Feelings in public transport	Casals (2012)
Feel2	It puts me in a good mood		
Feel3	I feel comfortable and at ease		
Feel4	I feel I could meet people and get into conversation with them		
Feel5	I feel I'm doing something, I feel useful		
Feel6	I find the people, noise and smells disagreeable		
Feel7	I feel stressed		
Feel8	I feel harassed		

Two discrete variables are introduced to measure the intensity of car use: (1) the frequency with which a car is used (see Table 6 for the scale of the measure) and (2) the number of cars available to the household (see Table 5). For public transport, intensity of use is also measured with two discrete variables: (1) the frequency with which urban public transport is used and (2) the frequency with which interurban trains and coaches are used (see Table 6). With respect to one-off choices, these measures have the advantage of translating both a level of use and an implicit trade-off between travel modes, as well as encompassing the repetitive dimension of mode choice.

4.3. Method

The theoretical model defines the relationships between latent variables and between latent and observable variables. SEM is an appropriate tool to estimate such a model since it can simultaneously handle numerous exogenous and endogenous variables, as well as latent variables specified as linear combinations of the observed variables (Hoyle, 2012). See Golob (2003) for a literature review on the use of structural equation modeling in transport and, for example, Ory and Mokhtarian (2009), Ye and Titheridge (2016) and Zailani et al. (2016) for more recent SEMs on the impact of attitudes on travel behavior.

In the presence of latent variables, an SEM is made up of a measurement model and a structural model (Hoyle, 2012; Esposito Vinzi and Trinchera, 2013). The measurement model relates each latent variable to its measuring items according to a reflexive linear relationship. The structural model describes the relationships between the latent variables and between the latent variables and the contextual variables. Note also that some items (e.g., POL1, POL4) are associated with a negative statement. Prior to estimation, the coding of those items was reversed. Moreover, the measurement errors of these reversed items are correlated with each other when they measure the same latent variable.

4.3.1. Exploratory factor analysis

As a first step, relevant items were selected using an exploratory factor analysis before inclusion in the SEM. The internal consistency of the latent variables was also tested by calculating Cronbach's alpha coefficient (α), for which a value greater than 0.7 indicates high internal consistency (Esposito Vinzi and Trinchera, 2013; West et al., 2012).

4.3.2. Mediation analysis

The indirect effect, which constitutes mediation in the strict sense, is calculated as the product of the effect of the independent variable on the mediator and of the effect of the mediator on the output (Hayes, 2013). The method described in Baron and Kenny (1986) is used to test the existence of a mediation effect and involves the estimation of three sub-models. The first step is to check whether the independent variable has an influence on the outcome (no mediation). The second step is to check that the independent variable affects the mediator and that the mediator influences the outcome (perfect mediation). The third step is to include all paths (partial mediation). If the indirect effect is significant and the direct effect is not, then the mediation is perfect. If both effects are significant, then the mediation is partial.

Since the indirect effects are obtained through the product of two random variables, their standard errors and related test statistics are calculated using the Delta method (Sobel, 1982). To check the robustness of the results, diagonally weighted least square estimations with bootstrapped standard errors (1000 sample draws) were also performed. Results are robust and available on request from the authors.

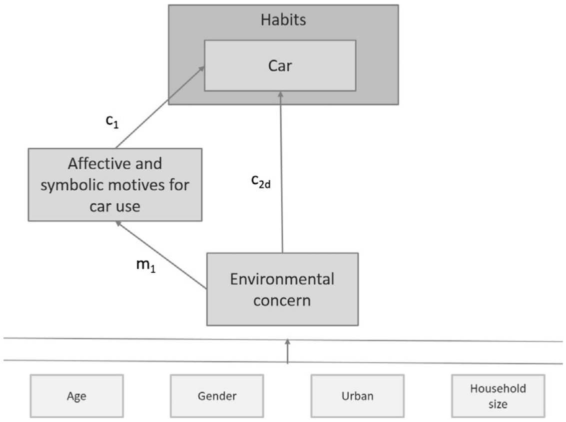

Fig. 2. Model M1.

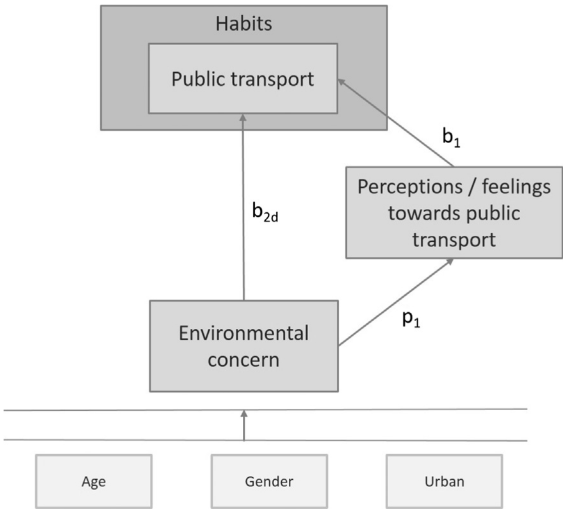

Fig. 3. Model M2.

4.3.3. Definition of the estimated models

First, public transport and car use habits are considered separately to gain insight into the partial mediation relationships of the theoretical model. Then, public transport and car use habits are considered together. This phased approach helps to progressively investigate the relationships stated in the theoretical model. The use of different models makes it possible to evaluate the effects of the latent variables on mode choice habits, both separately and together, and to check the robustness of the results.

The first model (M1, see Fig. 2) is built to explain car use habits (H1 to H3). The mediating variable, affective and symbolic motives for car use, allows for an analysis of (1) the direct effects of environmental concern on car use habits (c2d); (2) the indirect effect (c2i = m1 × c1) of environmental concern on car use habits through the mediation of affective and symbolic motives for car use, and (3) the total effect (c2t) of environmental concern on car use habits being the sum of the direct and indirect effects. Three sub-models are defined to investigate the partial mediation relationship (M1a: $m1 = c1 = 0$; M1b: $c2d = 0$; M1c: no constraint).

Similarly, the second model (M2, see Fig. 3) is built to explain public transport habits (H4 to H6). Three sub-models are defined to investigate the partial mediation relationship (M2a: $p1 = b1 = 0$; M2b: $b2d = 0$; M2c: no constraint).

The third model (M3, see Fig. 1) is the theoretical model, which takes account of both modes and their correlation (H7) together. Nine sub-models are estimated, corresponding to the 3 × 3 possible mediations for public transport and car use habits (no mediation, partial mediation or perfect mediation).

Table 4 provides a summary of all the estimated models according to the nature of the mediation.[6]

4.3.4. Estimation method

The observed items are ordinal variables with four or five levels. The maximum likelihood estimation is therefore not suitable

[6] Figures with the 15 estimated models are available on request from the authors.

Table 4
Estimated models.

Car use habits	Public transport habits	Model
No mediation	–	M1a
Perfect mediation	–	M1b
Partial mediation	–	M1c
–	No mediation	M2a
–	Perfect mediation	M2b
–	Partial mediation	M2c
No mediation	No mediation	M3a
No mediation	Perfect mediation	M3b
No mediation	Partial mediation	M3c
Perfect mediation	No mediation	M3d
Perfect mediation	Perfect mediation	M3e
Perfect mediation	Partial mediation	M3f
Partial mediation	No mediation	M3g
Partial mediation	Perfect mediation	M3h
Partial mediation	Partial mediation	M3i

because it leads to a biased estimate of the parameters and to inaccurate standard errors and test statistics (Rhemtulla et al., 2012). A commonly used alternative is to estimate a limited-information method. Each observed item is supposed to be the manifestation of a latent variable with a Gaussian distribution. A threshold model divides this continuous variable into categories to obtain the ordinal item as well as the matrix of polychoric correlation. The measurement model is then estimated on the basis of the matrix of polychoric correlation. Among the limited-information methods, the weighted least squares method is the most effective but it requires very large samples. We therefore use the diagonally Weighted Least Squares method with a Mean and Variance correction (WLSMV). Indeed, owing to the loss of efficiency, the standard errors need to be corrected (Muthén, 1993) and the test statistic adjusted by the average and variance (Muthén, 1993; Maydeu-Olivares, 2001).

4.3.5. Goodness-of-fit indices

There are dozens of indices for assessing the goodness-of-fit (GOF) of a theoretical model to the data. Two GOF indices commonly used in the literature[7] (West et al., 2012) are: the Comparative Fit Index (CFI) and the Root Mean Square Error of Approximation (RMSEA). The literature defines thresholds in order to assess the GOF of a model to the available data. Although thresholds vary according to the authors, a CFI of more than 0.90 indicates a good fit (West et al., 2012; Hair et al., 2006). The RMSEA should be less than 0.06 or 0.08 (West et al., 2012; Hair et al., 2006). As recommended by West et al. (2012), thresholds are reported as guidelines but not to select a specific model.

5. Results

The exploratory factor analysis was done in SAS. The estimation of the SEM uses the R package Lavaan (Rosseel, 2012).

5.1. Description of the sample

The sample consists of 1061 people, 542 of whom are men (51%, see Table 5). The respondents are between 18 and 91 years of age, with an average age of 52. The household consists of an average of 2.5 people with a maximum of 7 in the household. Forty-eight percent of the respondents live in an urban area.

If we focus on the variables used to measure the dependent variables, we can see that, on average, the households have access to 1.7 cars, with a minimum of 0 and a maximum of 5 cars per household (see Table 5). In terms of travel modes used (see Table 6), the car is the predominant mode, since 64% of respondents use it every day or nearly every day, whereas that is only the case for 8% of the respondents for bicycles, 7% for urban public transport (bus, tram and underground), 5% for the train or coach and 2% for car-sharing. The frequency of car use is lower for people living in urban areas (see Table 7) than for people living in rural areas, the difference between urban and non-urban areas being higher for men than for women, since 75.3% of the men living in a rural area use a car every day or nearly every day (60.6% for men living in an urban area; p-value = 0.01) whereas that is the case for 67.4% of the women living in a rural area (64.9% for women living in a rural area; p-value = 0.75). A corollary is that the frequency of people using public transport modes twice a month or more is higher in urban areas than in rural areas, and that is true for both men (8.2% *versus* 25.4%; p-value < 0.01) and women (8.4% *versus* 24.8%; p-value < 0.01). With regard to the use of train and coach, among the people living in urban areas the proportion of people using these modes twice a month or more is only slightly higher (15.8%

[7] The χ^2 test has not been computed because of its limitations. One major problem with this test is indeed that, as the size of the sample increases, its power to detect even trivial differences between the sample covariance matrix of the observed variables and the covariance matrix as predicted by the model specification approaches 1.0 (see West et al., 2012, p. 211). Moreover, it is based on the assumption that the observed variables have a multivariate normal distribution (ibid), which is not the case for the items used in the models.

Table 5
Descriptive statistics.

Definition	Label	Mean	S.d.	Min	Max
Age (in years)	Age	52.27	13.56	18.00	91.00
Gender (1 for men, 0 for women)	Gender	0.51	0.50	0.00	1.00
Live an urban area (1 for yes, 0 for no)	Urban	0.84	0.37	0.00	1.00
Size of the household	Househ.	2.53	1.23	1.00	7.00
Number of cars in the household	Nb_cars	1.74	0.70	0.00	5.00

Table 6
Frequency of use of transport modes (in %).

	Car	Bicycle	Urban public transport	Train/coach	Car-sharing
Never	0.4	58.8	59.9	51.8	61.6
Occasionally	5.2	20.4	17.7	32.9	22.2
At least twice a month	6.7	5.8	8.0	6.7	8.4
At least twice a week	23.7	7.4	7.9	3.9	5.8
Every day or nearly every day	64.1	7.6	6.5	4.7	2.1

Table 7
Frequency of use of transport modes (in %) with a distinction between people living in an urban area and people living in a rural area.

	Car		Bicycle		Urban public transport		Train/coach		Car-sharing	
	Woman	Man	Woman	Man	Woman	Man	Woman	Man	Woman	Man
Urban area (N = 893)										
Never	0.69	0.00	65.83	51.86	57.57	54.27	50.92	50.98	61.24	65.86
Occasionally	5.04	6.34	17.43	22.32	17.66	20.35	35.32	31.29	21.56	22.10
At least twice a month	8.03	6.56	5.96	5.25	8.72	9.19	6.65	7.00	8.94	6.13
At least twice a week	21.33	26.48	5.96	8.53	8.94	9.19	2.75	5.47	6.42	4.16
Every day or nearly every day	64.91	60.61	4.82	12.04	7.11	7.00	4.36	5.25	1.83	1.75
Rural area (N = 163)										
Never	1.20	0.00	63.86	55.29	83.13	78.82	49.40	63.53	37.35	64.71
Occasionally	2.41	2.35	16.87	28.24	8.43	12.94	34.94	27.06	27.71	20.00
At least twice a month	4.82	2.35	8.43	5.88	2.41	3.53	7.23	4.71	20.48	5.88
At least twice a week	24.10	20.00	7.23	8.24	2.41	1.18	4.82	0.00	9.64	7.06
Every day or nearly every day	67.47	75.29	3.61	2.35	3.61	3.53	3.61	4.71	4.82	2.35

overall, 13.8% for women and 17.7% for men) than the proportion using these modes in rural areas (12.5%, 15.7% for women and 9.4% for men) and the difference is not statistically significant (p-value = 0.33).

Most of the items measuring the socio-psychological variables are asymmetrically distributed with marked kurtosis (see Fig. 4). The use of the WLSMV estimation method is thus fully justified.

5.2. Exploratory factor analysis

An exploratory factor analysis with promax rotation identifies the factors that best distinguish the sample and the observed variables with the greatest loadings. Previously, some coding was reversed so that each observed variable expressed the same idea in the same way.

Four factors have a value higher than one but three are enough to explain 80% of the variance in the data. As the fourth factor explains less than 10%, it was omitted. Also, the interpretability of the first three factors is good and consistent with the theoretical models (see Table 8). Only the items with a loading greater than 0.35 were retained in the SEM. Some items are therefore not included in any factor (Instr2, Instr3, Time5 and Time6).

The first factor ($\alpha = 0.83$) refers to environmental concern and involves the three dimensions previously established, the New Ecological Paradigm (NEP), the degree of agreement with policies promoting public transport, and awareness of environmental problems.

The second factor refers to the affective and symbolic motives for car use and includes five items. Unlike Steg (2005), the item "I feel safe in my car" is not associated with instrumental motives but shows evidence of affective motives ascribed to the car. The relatively low Cronbach's alpha ($\alpha = 0.66 < 0.7$) suggests caution regarding the interpretation of parameters associated with motives for car use.

The third factor ($\alpha = 0.86$) refers to the perceptions and feelings towards public transport and is made up of three dimensions:

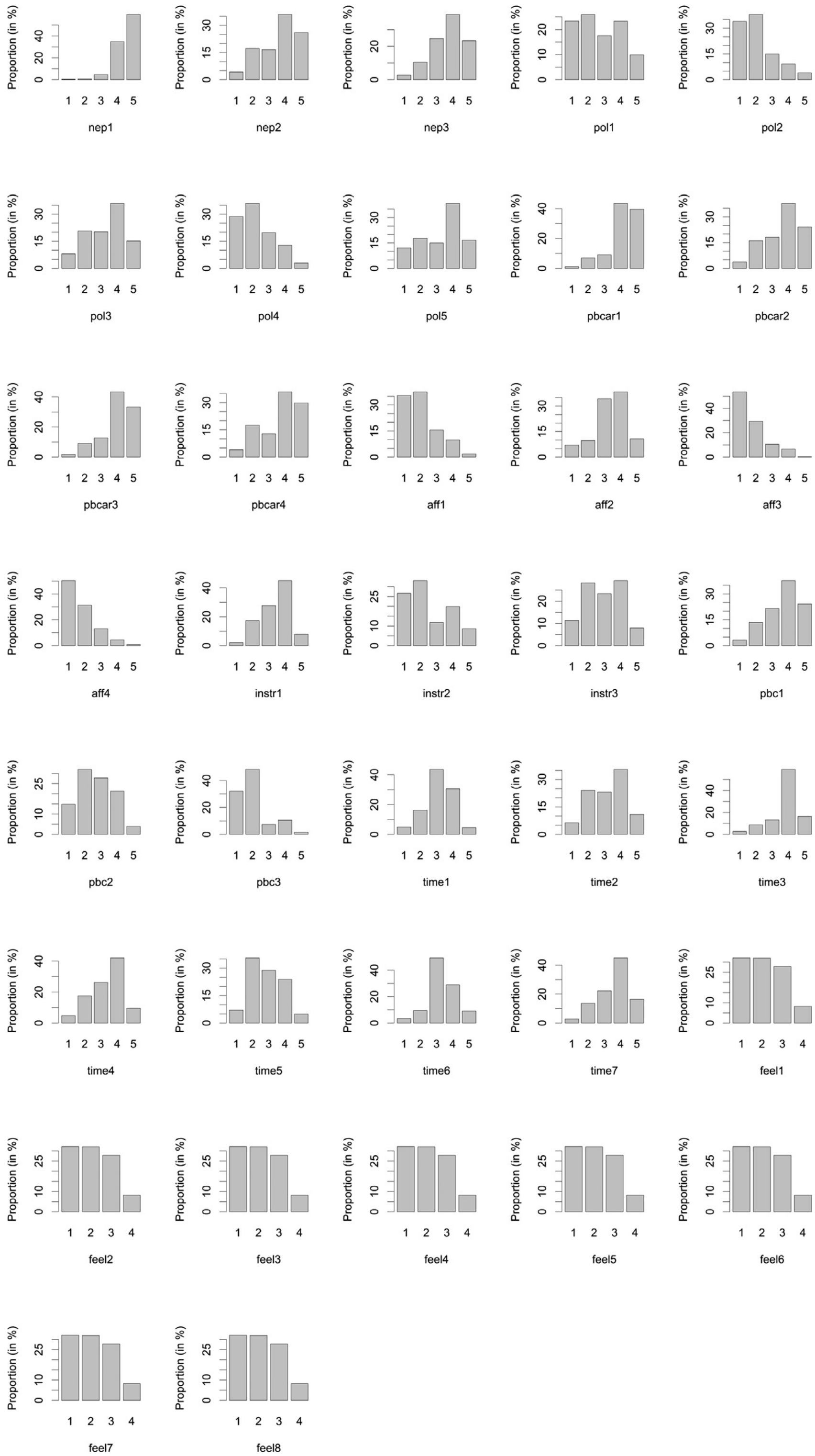

Fig. 4. Distribution of answers on items.

Table 8
Exploratory factor analysis loadings.

	Factor 1 Environmental concern	Factor 2 Affective and symbolic motives for car use	Factor 3 Perceptions and feelings towards public transport
NEP1	48*	−21	16
NEP2(i)	63*	−15	13
NEP3	59*	−15	16
POL1(i)	41*	−12	26
POL2	49*	−4	27
POL3	47*	−10	26
POL4(i)	52*	−10	24
POL5	61*	−7	35
Pbcar1	65*	−17	21
Pbcar2	61*	−20	21
Pbcar3	39*	−19	7
Pbcar4	59*	−18	20
AFF1	−16	43*	−10
AFF2	−30	47*	−16
AFF3	−7	66*	−10
AFF4	−14	70*	−9
INSTR1	−33	42*	−11
INSTR2(i + a)	−10	33	−7
INSTR3(a)	21	−25	−5
PBC1(i)	30	−26	51*
PBC2(i)	29	−11	39*
PBC3(i)	28	−9	36*
Time1	22	−8	57*
Time2(i)	25	−12	59*
Time3	21	−8	52*
Time4	20	−6	40*
Time5(i + a)	3	−12	29
Time6(i + a)	16	−9	17
Time7(i)	19	−16	50*
Feel1	23	−9	67*
Feel2	16	−7	66*
Feel3	20	−8	68*
Feel4	20	−13	54*
Feel5	22	−8	51*
Feel6(i)	14	−5	55*
Feel7(i)	14	4	53*
Feel8(i)	19	4	53*
Cronbach's α	0.83	0.67	0.86

Notes:

*Loading greater than 0.35.

(i) Variable for which the coding has been reversed.

(a) Variable not included in any factor because of too small a loading.

PBC, how time spent on public transport is viewed, and people's feelings during journeys made on public transport.

5.3. Structural equation modeling

Consistent with our methodology, mediation is first evaluated in two separate models for each mode and then evaluated in a joint model. Fifteen models are tested: three sub-models for M1, three sub-models for M2 and nine sub-model for M3. For the sake of simplicity, Table 11 shows only the results relevant for the discussion on the hypotheses.[8] Tables 9 and 10 show the relevant results for the mediation analysis in the separate models M1 and M2.

Table 11 also shows robust GOF indices and degrees of freedom for the sub-models whose results are discussed in Sections 5.3.1 and 5.3.2. All the models show a reasonable goodness of fit. Apart from M3i, the CFI of all sub-models is above the threshold value of 0.9. The RMSEA is below the threshold value 0.06 for all sub-models.

The part of the variance of public transport habits explained by sub-models M2c, M3c and M3i is 15%. It is higher for car use

[8] Extensive results for the 15 models are available on request from the authors.

Table 9
Test of mediation: Model M1.

Dependent variable	Explanatory variable	Label	M1a no mediation	M1b perfect mediation	M1c partial mediation
Motives (car)	Env. concern	m1		−0.483 (0.065)***	−0.443 (0.062)***
Car use habits	Motives	c1		0.471 (0.08)***	0.114 (0.069)*
	Env. concern (dir.)	c2d	−0.678 (0.094)***		−0.585 (0.094)***
	Env. concern (ind.)	c2i		−0.227 (0.041)***	−0.051 (0.031)
	Env. concern (tot.)	c2t			−0.636 (0.09)***

Notes:

(***) Significant at the 1% threshold; (**) significant at the 5% threshold; (*) significant at the 10% threshold.

Abbreviation: Env. concern: environmental concern; Motives (car): affective and symbolic motives for car use; dir.: direct effect; ind.: indirect effect; tot.: total effect.

Table 10
Test of mediation: Model M2.

Dependent variable	Explanatory variable	Label	M2a no mediation	M2b perfect mediation	M2c partial mediation
Percep. (PT)	Env. concern	p1		0.662 (0.065)***	0.645 (0.064)***
PT habits	Percep.	b1		0.467 (0.078)***	0.241 (0.083)***
	Env. concern (dir.)	b2d	0.778 (0.127)***		0.39 (0.109)***
	Env. concern (ind.)	b2i		0.31 (0.055)***	0.156 (0.054)***
	Env. concern (tot.)	b2t			0.546 (0.095)***

Notes:

(***) Significant at the 1% threshold; (**) significant at the 5% threshold; (*) significant at the 10% threshold.

Abbreviation: Env. concern: environmental concern; Percep. (PT): perceptions and feelings towards public transport; PT habits: public transport habits; dir.: direct effect; ind.: indirect effect; tot.: total effect.

habits with 33–37% of variance explained by models M1c, M3c and M3i.

5.3.1. Impact of latent variables on mode choice habits

We first look at the analysis of car use habits in model M1. According to sub-models M1a, M1b and M1c, affective and symbolic motives for car use do not mediate the relationship between environmental concern and car use habits.

In sub-models M1a (no mediation) and M1c (partial mediation), a high environmental concern significantly lowers motives for car use (respectively, $m1 = -0.483$, $p.value < 0.01$ and $m1 = -0.443$, $p.value < 0.01$) and car use habits (respectively $c2d = -0.678$, $p.value < 0.01$ and $c2d = -0.585$, $p.value < 0.01$). According to sub-model M1c, affective and symbolic motives for car use do not mediate the relationship between environmental concern and car use habits. Indeed, the parameter associated with the indirect effect of environmental concern on car use habits is significantly different from zero in sub-model M1b (perfect mediation) ($c2i = -0.227$, $p.value < 0.01$) but becomes non-significant in sub-model M1c ($c2i = -0.051$, $p.value > 0.1$).

Only the direct effect of environmental concern on car use habits (H1b) seems to be supported by the data. Hypothesis H3, which states that affective and symbolic motives for car use play a mediating role between environmental concern and car use habits, is rejected with our data. However, environmental concern seems to influence affective and symbolic motives for car use (H1a).

An explanation for the absence of an indirect effect is that the relationship between affective and symbolic motives for car use and car use habits (H2) is not robust, since the associated parameter is significant only at the 10% level in sub-model M1c ($c1 = 0.114$, $p.value < 0.1$). The direct effect of environmental concern on car use habits seems to overcome both the indirect effect and the affective and symbolic motives effect on car use habits.

The three sub-models related to public transport habits (M2a M2b, M2c) indicate that perceptions and feelings towards public transport play a partial mediation role.

In M2c, environmental concern has a positive influence on perceptions and feelings towards public transport ($p1 = 0.645$, $p.value < 0.01$), which, in turn, increase public transport habits ($b1 = 0.241$, $p.value < 0.01$).

Environmental concern promotes public transport habits ($b2t = 0.546$, $p.value < 0.01$), both directly and indirectly. Indeed, the direct and indirect effects of environmental concern on public transport habits are significantly different from zero ($b2d = 0.39$, $p.value < 0.01$; $b2i = 0.156$, $p.value < 0.01$), which supports the hypothesis of a partial mediation.

All hypotheses related to model M2 are thus supported by the data. A high environmental concern has a positive influence on perceptions and feelings towards public transport (H4a) and promotes public transport habits (H4b). Positive perceptions and feelings towards public transport make it more likely to be used (H5), and perceptions and feelings towards public transport play a partial mediating role between environmental concern and public transport habits (H6).

In model M3, both mode choice habits are considered together. The model tests whether the results which hold with separate habits are still relevant jointly. The nine sub-models provide consistent results, which support previous conclusions.

Table 11
Estimation results.

Dependent variable	Explanatory variable	Label	M1c partial mediation	M2c partial mediation	M3c no mediation/partial mediation	M3i partial/partial mediation
Env. concern	Age	e3	0.02 (0.006)***	0.025 (0.008)***	0.024 (0.008)***	0.024 (0.008)***
	Age^2	e4	-2×10^{-4} (0)***	-2×10^{-4} (0)***	-2×10^{-4} (0)***	-2×10^{-4} (0)***
	Gender	e5	−0.051 (0.027)*	−0.057 (0.033)*	−0.06 (0.033)*	−0.061 (0.033)*
Motives (car)	Env. concern	m1	−0.443 (0.062)***			−0.376 (0.051)***
	Age	m3	−0.015 (0.006)**			−0.015 (0.006)**
	Age^2	m4	9×10^{-5} (0)			9×10^{-5} (0)
	Gender	m5	0.105 (0.029)***			0.105 (0.03)***
Percep. (PT)	Env. concern	p1		0.645 (0.064)***	0.651 (0.064)***	0.698 (0.065)***
	Age	p3		−0.007 (0.008)	−0.006 (0.008)	−0.007 (0.008)
	Age^2	p4		1×10^{-4} (0)*	1×10^{-4} (0)	1×10^{-4} (0)*
	Gender	p5		0.072 (0.038)*	0.077 (0.038)**	0.08 (0.04)**
PT habits	Percep. (PT)	b1		0.241 (0.083)***	0.233 (0.086)***	0.221 (0.085)***
	Env. concern (dir.)	b2d		0.39 (0.109)***	0.438 (0.113)***	0.445 (0.117)***
	Env. concern (ind.)	b2i		0.156 (0.054)***	0.152 (0.057)***	0.154 (0.06)***
	Env. concern (tot.)	b2t		0.546 (0.095)***	0.59 (0.096)***	0.599 (0.097)***
	Age	b3		−0.081 (0.015)***	−0.082 (0.015)***	−0.082 (0.015)***
	Age^2	b4		0.001 (0)***	0.001 (0)***	0.001 (0)***
	Gender	b5		0.053 (0.066)	0.073 (0.069)	0.074 (0.07)
	Urban	b6		0.346 (0.116)***	0.385 (0.123)***	0.385 (0.123)***
Car use habits	Motives (car)	c1	0.114 (0.069)*			0.091 (0.07)
	Env. concern (dir.)	c2d	−0.585 (0.094)***		−0.563 (0.073)***	−0.521 (0.077)***
	Env. concern (indir.)	c2i	−0.051 (0.031)			−0.034 (0.027)
	Env. concern (total)	c2t	−0.636 (0.09)***			−0.556 (0.072)***
	Age	c3	0.053 (0.011)***		0.057 (0.011)***	0.057 (0.011)***
	Age^2	c4	−0.001 (0)***		−0.001 (0)***	−0.001 (0)***
	Gender	c5	0.047 (0.052)		0.057 (0.055)	0.048 (0.055)
	Urban	c6	−0.236 (0.075)***		−0.254 (0.081)***	−0.249 (0.079)***
	Househ.	c7	0.168 (0.025)***		0.155 (0.025)***	0.16 (0.025)***
Covariance (PT habits/car use habits)						
		d0			−0.233 (0.03)***	−0.229 (0.03)***
Goodness-of-fit indicators						
		χ^2	1042	1551	1734	2370
		Df	229	500	592	777
		Cfi	0.917	0.907	0.906	0.886
		Rmsea	0.058	0.045	0.043	0.044

Notes:

(***) Significant at the 1% threshold; (**) significant at the 5% threshold; (*) significant at the 10% threshold.

Abbreviation: Env. concern: environmental concern; Motives (car): affective and symbolic motives for car use; Percep. (PT): perceptions and feelings towards public transport; PT habits: public transport habits; dir.: direct effect; ind.: indirect effect; tot.: total effect.

Table 11 shows the estimation results of the theoretical model (M3i) with partial mediation for both mode choice habits. It also displays the results for the model M3c, which is a model with partial mediation for public transport habits and no mediation for car use habits, with better GOF.

M3i confirms that affective and symbolic motives for car use play no mediating role ($c2i = -0.034$, p-value > 0.1). The relationship between affective and symbolic motives for car use and car use habits is no longer valid once the influence of environmental concern is taken into account ($c1 = 0.091$, p.value > 0.1). As in model M1, including environmental concern, both as a determinant of affective and symbolic motives and as a determinant of mode choice habits, reveals its dominant role over affective and symbolic motives for car use. Those affective and symbolic motives for car use are significantly determined by environmental concern in a negative way ($m1 = -0.376$, p-value < 0.01).

Finally, the more parsimonious model M3c (no mediation/partial mediation) provides a better fit and leads to the following results. Environmental concern influences both mode choice habits. More precisely, people with high environmental concern are more prone to use public transport modes ($b2t = 0.59$, p-value < 0.01) and more reluctant to use the car ($c2d = -0.563$, p-value < 0.01). The coefficients regarding the effects of environmental concern on car use habits are similar in magnitude to those obtained for public transport habits. However, for public transport habits, the total effect is composed of both an indirect effect ($b2i = 0.152$, p-value < 0.01) and a direct effect ($b2d = 0.438$, p-value < 0.01). Since both parameters are significant, model M3c confirms that environmental concern is partially mediated by perceptions and feelings towards public transport. Moreover, people with a higher environmental concern assign a higher indirect utility to public transport ($p1 = 0.651$, p-value < 0.01).

Results are thus robust to the shift from separate to joint models. Taking into account the trade-off between public transport and car use habits does not alter the results even if, as expected, this trade-off is significantly different from zero ($d0 = -0.233$, p-

Table 12
Summary of hypotheses and results.

Hypothesis	Related parameter	Model(s)	Supported by data?
H1: High environmental concern			
(H1 a) reduces affective and symbolic motives for car use habits;	m1	M1/M3	Yes
(H1 b) reduces car use habits.	c2d/c2t	M1/M3	Yes
H2: A high influence of affective and symbolic motives on car use promotes car use habits	c1	M1/M3	No at the 5% level
H3: Affective and symbolic motives for car use play a **partial mediating role** between environmental concern and car use habits.	c2i	M1	No
H4: High environmental concern			
(H4 a) has a positive influence on perceptions of public transport;	p1	M2/M3	Yes
(H4 b) promotes public transport habits;	b2d/b2t	M2/M3	Yes
H5: Positive perceptions of public transport make it more likely to be used.	b1	M2/M3	Yes
H6: Perceptions of public transport play a **partial mediating role** between environmental concern and public transport habits.	b2i	M2/M3	Yes
H7: Public transport and car use habits are negatively correlated.	d0	M3	Yes

value < 0.01).

Table 12 summarizes whether the hypotheses are consistent with our data.

5.3.2. Socio-demographic variables as determinants of latent variables and mode choice habits

Surprisingly, environmental concern increases with age ($e3 = 0.024$, p.value < 0.01), with a concave relationship ($e4 = -2 \times 10^{-4}$, p.value < 0.01). A similar negative relationship between age and environmental concern was found by Liu et al. (2014) in American national public surveys conducted in 2007 and 2013. They explain this effect with possible generational changes and declining trends of youth attitudes to environmental issues and rely on three theoretical reasons: the rising importance of extrinsic values (such as money); a lack of connection to nature due to more time spent indoors, and a technological worldview that suggests that technology can and will solve all problems, including environmental problems. Women are found to be more concerned by environmental issues ($e5 = -0.06$, p.value < 0.01), which is consistent with previous research.

Age reduces public transport habits ($b3 = -0.082$, p.value < 0.01) to the advantage of the car ($c3 = 0.057$, p.value < 0.01). Conversely, those effects are reduced as age increases, since age^2 has a positive coefficient for public transport ($b4 = 0.001$, p.value < 0.01) and a positive value for the car ($c4 = -0.001$, p.value < 0.01). Contextual constraints such as access to public transport also explain behavior, since living in an urban area significantly increases public transport habits ($b6 = 0.385$, p.value < 0.01) and reduces car use habits ($c6 = -0.254$, p.value < 0.01). The household size has an inverse effect: the larger the household, the more mode choice habits involve car use ($c7 = 0.155$, p.value < 0.01). With our data, gender is not a determinant of mode choice habits ($b4 = 0.073$, p.value > 0.1; $c4 = 0.057$, p.value > 0.1).

6. Discussion and conclusion

The SEM analysis shows that the relationship between environmental concern and mode choice habits takes different forms: a partial mediation form for public transport habits and a non-mediated form for car habits. By comparison with previous work, the combined effect of public transport perceptions and environmental concern on public transport habits and the existence of a partial mediation relationship enrich the understanding of how pro-environmental behavior is determined by environmental concern. An intuitive interpretation is that people with higher environmental concern are more motivated to use public transport and thus derive more indirect utility from using it. Conversely, motives for car use and car use habits are explained by environmental concern. However, affective and symbolic motives for car use do not mediate this last relationship. These results seem to be robust in the sense that they appear in the separate analyses for each mode use habit and in the joint analysis. The intuitive negative correlation between public transport and car use habits thus provides a more realistic model for people using multiple modes without altering the understanding of the process underlying each mode choice habit.

Our approach and our results are consistent with two recent meta-analyses concerned with environmental psychology theories to explain mode choice (Lanzini and Khan, 2017; Hoffmann et al., 2017). Indeed, the variables investigated in this paper include three of the four psychological variables most related to car use, which are habits and intentions, as well as constructs of the theory of planned behavior, in particular attitudes toward travel modes and perceived behavioral control. However, according to Lanzini and Khan (2017), environmental variables only play a marginal role in the prediction of actual behavior. Whereas previous studies are mostly concerned with the relationship between environmental concern and a one-off choice, one added-value of our paper is to show that environmental concern is related to a more general measure, mode choice habits, with the additional originality of analyzing the structure of this relationship in part with some constructs of the theory of planned behavior.

One limitation of our work concerns the direction of some relationships. The estimated models assume that attitudes influence behavior, which is fully consistent with most leading psychological theories. This direction of causality is nonetheless challenged by a recently published paper by Kroesen et al. (2017), who show that the reversed direction of causality from behavior toward attitudes is stronger. Indeed, cognitive dissonance predicts that people whose attitudes are not consistent with their behavior are more likely to change their attitudes than their behavior. In the same way, the finding that living in an urban area significantly increases public transport habits and reduces car use habits, may also be explained by self-selection, since people who wish to travel by public transport are more likely to choose a residence in an urban area. Although both relationships may be true, the direction of causality cannot be demonstrated with the available data, since panel data would be necessary.

Despite those limitations, our results show that even where "objective" constraints, such as residential location or the household size, have an impact, the socio-psychological determinants of mode choice habits also have to be considered. Their inclusion helps to better understand the behavioral process underlying mode choice habits, and can be seen as an opportunity to identify alternative solutions to traditional economic instruments that only work imperfectly (Croson and Treich, 2014). A challenge is thus to design robust policies based on contextual dependent socio-psychological factors. Although the transferability of our results to other urban and cultural contexts needs to be further investigated, we suggest three interrelated directions in terms of infrastructures, communication strategies and nudges.

First, we show a significant influence exerted on mode choice habits by the quality of travel time and by people's feelings while traveling on public transport. This result, also supported by previous research, provides evidence of the importance of designing infrastructures that make time spent on public transport as pleasant and as efficient as possible. Infrastructures and public policies that improve public transport users' emotional experience may be a key determinant to promote the use of public transport and induce modal shift.

Second, if mode choice habits are partly dictated by environmental concern, affective and symbolic motives and perceptions and feelings, then those dimensions need to be managed, by, for example, publicizing the environmental impact of the car or by promoting the image of public transport. The media are quick to emphasize negative events, such as strikes or delays; so it is crucial to offset those negative images with suitable communication strategies. However, since negative events are more pregnant in memories than positive events (Baumeister et al., 2001), it might be difficult to counterbalance the negative events associated with public transport modes.

Third, a better knowledge of the framing of mode choice habits provides an opportunity to research the way in which users could be incited to use public transport modes. To form new habits and induce a modal shift from car to public transport, several tools may be used. Gärling and Schuitema (2007) show that non-coercive measures alone are not efficient and that coercive measures, such as increasing cost, are subject to public opposition. However, combined with non-coercive measures providing attractive public transport and communicating the benefits of car-use reduction to the public, coercive measures are likely to become more effective and socially acceptable. To provide attractive public transport, the results of the structural equation models show that public policies must not only rely on the reduction of travel time or travel cost, but also offer a comfortable environment to allow for positive experiences and a polychronic use of time. Another way to enhance the social acceptability of pricing policies is to use reward schemes, since reward seems to be at least as effective as punishment in terms of its effectiveness in influencing behavior (Balliet et al., 2011; Khademi and Timmermans, 2014). Such a scheme has been implemented in the Netherlands (Ben-Elia and Ettema, 2009; Tillema et al., 2013) to avoid peak hour driving. The results show that this policy has long-term effects to encourage off-peak driving, but also teleworking or changing route options (Khademi and Timmermans, 2014). A comparable reward scheme could encourage people to avoid using their car in general, or, more specifically, in the case of a peak pollution event. To accompany such a measure, information on the health consequences of pollution could be effective. According to the structural equation models estimated in this paper, if people were more aware of the consequences of pollution, they would be more aware of the utility of choosing public transport and be more inclined to use it. The reward system would act as a trigger to change habits.

Future research could extend our results and investigate their robustness. First, results may be dependent on how the latent variables are measured. It would be interesting to investigate whether the relationships still hold with different items, in particular for environmental concern since its measurement varies according to the studies, and for affective and symbolic motives for car use since our measure may be improved. Second, an interesting avenue of research would be to test whether the results remain true in different urban and cultural contexts, with different public transport infrastructures. Third, other transport modes, such as cycling or walking, also provide indirect utility, such as health benefits or the pleasure of being outside. An extended version of our model could thus study whether our results still hold with these active transport modes.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.trd.2018.01.007.

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