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The Influence of Attitudes towards Cycling and Walking on Travel Intentions and Actual Behavior

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Abstract: The design and implementation of effective transport policies to reduce car use in urban areas requires a deep comprehension of the factors that influence travel behavior. In this context, psychological factors play an important role in explaining travel-related decisions. The purpose of this paper is to present a study on the effects of cognitive, affective and behavioral attitudes towards the use of walking and cycling on both intentions and real use of cars, public transport, bicycles, and walking. The data used was obtained from an on-line survey carried out in 2017. Analyses included reliability and validity of the questionnaire, exploratory and confirmatory factor analyses, and structural equation models. Results indicate that cycling and walking are evaluated differently in terms of feelings of freedom, pleasure, and relaxation. Positive evaluation of elements related to past walking behavior are negatively associated to both the intention to walk and actual walking. Transport policies to encourage cycling should be different from those with the aim of promoting walking. Positive attitudes towards walking are not enough to increase real walking.

Keywords: Travel behavior; attitudes; structural equation modelling

1. Introduction

The reduction of car use is a transportation policy objective in most of the urban areas around the world to tackle pollution, accidents, noise, and the pressure on public space (EU, 2011). It has been proved that hard measures (e.g., car use restrictions in city centers) are not causing long-lasting effects on travel behavior [1], and usually provoke public disapproval [2,3]. There is a need to complement those measures with actions toward changing travel habits, using the so-called soft transport measures [4], which typically include awareness campaigns, personalize travel plans, and persuasion strategies [5]. The design of effective soft transport measures requires a deep understanding of the factors that influence travel behavior. In this context, psychological factors play and important role to change how people behave in terms of everyday travel [6–9].

The purpose of this work is to contribute to the study of how two important psychological factors, namely attitudes towards the use of travel modes, and the intentions to use those travel modes, influence on the actual travel behavior. In particular, the interrelations among cognitive, affective and behavioral attitudes towards walking and cycling, the intentions to use cars, public transport, bicycles, and walking, and the actual use of those travel modes, are analyzed. This travel behavior study is significant because the three-component model [10–12], which differentiates cognitive, affective and behavioral attitudes, is adopted to study the influence on travel behavior of a particular type of psychological factor: attitudes towards non-motorized travel modes. To the best of our knowledge, this is the first study in the travel behavior field that adopts the three-component model of attitudes.

Besides, this work is novel because we explicitly consider the interrelations between the aforementioned three-component attitudes model, the intentions to use four different travel modes, and the actual travel behavior on relation to those four travel modes: car, public transport, cycling, and walking. This approach allows us to identify how each subtype of attitudes influence on both the intention and the actual use of complementary and competing travel modes. As far as we know, this is the first work in the travel behavior field that study the influence of attitudes on the intention and real use of four travel modes. And the first work in the travel behavior field that study how walking is affected by attitudes towards cycling and walking.

The main theoretical frameworks in relation to attitudes are considered below, and how they have been used in travel behavior studies so far. Then, the literature review continues on works related to attitudes, intentions, and travel behavior. This section ends with the conceptual framework and hypotheses adopted for this study. Section 2 describes procedure, participants, measures, and data analysis. Section 3 includes results from factor analyses and structural equation models. Finally, Section 4 presents a discussion and conclusions.

1.1. Attitudes and Travel Behavior

There are different ways of defining attitudes, as can be checked in the literature. A definition that is commonly accepted is the following: "Attitudes are global and relatively stable evaluations that people do about persons, things or ideas" [13]. Attitudes are related to positive or negative views that people have regarding any aspect of reality [14,15]. Authors of studies in the travel behavior field include a variety of psychological factors that can be considered as attitudes, although they are named differently. For example, this is the case of the instrumental and affective factors defined by Annabel and Gatersleben [16] to study work and leisure travel. Similarly, Chen and Chao [17] used perceived usefulness to study the switching intentions toward public transit. And Donald et al. [18] considered environmental concerns influencing car and public transport use. All of them can be considered attitudes towards travel modes.

There are four theoretical frameworks in relation to attitudes. First, according to the three-component model, attitudes express feelings, beliefs, and past behaviors regarding an attitude object [19]. In this model, affective, cognitive, and behavioral attitudes are distinguished. Second, the belief-based model suggests that attitudes are simply affective responses to an object that are influenced by beliefs alone [20,21]. Following Fishbein and Ajzen [22], the total attitude is equal to the subjective belief multiplied by the evaluation. Third, following the unidimensional perspective, a total index of attitudes is computed averaging responses across many different scales that are anchored by different bipolar adjective pairs (e.g., bad versus good; negative versus positive), using for example the Semantic Differential Scale [23]. Fourth, the bidimensional model proposes that attitudes subsume an evaluation that varies in negativity and an evaluation that varies in positivity [24]. Thus, to measure attitudes from this perspective, the positive and negative responses must be assessed separately.

In the Travel Behavior field, several studies have analyzed the interrelationships among attitudes towards travel modes, intention to use travel modes, and actual travel behavior. Considering the attitude's framework used, the beliefs-based perspective has been used to study the intention to use car, bus, or bicycle [25]. Forward [26] used behavioral beliefs to study people's willingness to bike. To study similarities and differences in commuting by bicycle in Davis and Delft, Heinen and Handy [27] used beliefs-based attitudes and their relative importance. Heinen et al. [28], and Lois et al. [29] also used behavioral beliefs to study the use of bicycle and the intention to use bicycle, respectively. Nordlun and Westin [30] studied how various environmental and travel mode-related beliefs influence on the intention to travel by a new railway line under construction. Tan Val et al. [31] used rated beliefs to study intention to use car, public transport and other travel modes. Muñoz et al. [32] analyzed bicycle commuting using attitudes toward bicycle that were measured using belief and importance questions. Frater et al. [33] used bipolar adjectives to evaluate attitudes toward cycling to study the intention to cycle.

The unidimensional attitudes approach was followed by Bamberg et al. [34] to study public transport use before and after an intervention. Donald et al. [18] also used this framework to study the use of car and public transport. Lo et al. [35] used unidimensional attitudes to study car use. Similarly, Jing et al. [36] used this framework to explore the intention to use autonomous vehicles.

The bidimensional model is the attitude's framework used by Majumdar and Mitra [37] to identify factors influencing bicycle use. Fernández-Heredia et al. [38] also used this model to evaluate factors that promote and inhibit cycling. Sigurdardottir et al. [39] used the bidimensional model to study the influence of attitudes on intentions of adolescents to commute by car or bicycle as adults. In this case, positive and negative attitudes were evaluated separately.

To the best of our knowledge, the present study is the first that has adopted the three-component attitudes model in the travel behavior field. In this study, the affective component of an attitude towards cycling and walking contains feelings of freedom, pleasure, and relaxation. The cognitive component of an attitude towards cycling and walking contains the following elements: adaptation, fast, comfortable, cheap, and safe. And the behavioral component of an attitude towards cycling and walking contains elements related to aspects considered by people when choosing cycling or walking like pollution, possibility of sharing with others, the built environment, support cycling/walking, and the needs or influence of others.

1.2. Attitudes, Intentions to Travel and Actual Travel Behavior

Behavioral intentions were first introduced by Fishbein and Ajzen [22] in their Theory of Reasoned Action (TRA), which aims to measure behavioral intention as prediction of actual behavior. They described that intentions are "assumed to capture motivational factors that influence a behavior" and can also be a measure of how much effort someone is willing to exert when performing a behavior.

Some studies have limited to analyze the relationship between attitudes (and other psychological factors) and intention to travel. In general, the literature includes works that focused only on studying the intention to use one single travel mode, and considering only the attitude toward travelling by that mode. For example, Murtagh et al. [40] investigated children's active (walking) school travel intention using attitude toward walking. Chen and Chao [17] studied how the attitude toward public transit influence on the switching intentions toward public transit. Similarly, Zailani et al. [41] studied the intention to use public transport. Muñoz et al. [42], Forward [26], Lois et al. [29] and Frater et al. [33] focused on studying people's intention to bike using attitudes toward cycling. Nordlun and Westin [30] investigated the intention to travel by a new railway line under construction using attitudes towards travelling by car and by train. Zhang et al. [43] studied the electric vehicle sharing intention using attitudes toward this travel model. Jing et al. [36]) studied the intention to use autonomous vehicle and share autonomous vehicle using attitudes towards those travel options

There are a few works in which authors studied simultaneously attitudes and intentions to use more than one travel mode. Sigurdardottir et al. [39] studied the intentions of adolescents to commute by car or bicycle as adults using attitudes towards those two travel modes. Tan Van et al. [31] studied the intentions to use car, public transport, or other travel mode, using attitudes towards car and public transport. Erikson and Forward [25] and Pojani et al. [44] considered attitudes towards cars, buses, and bicycles to study the intention to use those three travel modes.

Some studies have researched the influence of attitudes towards travel modes (and other psychological factors) directly on the actual use of those travel modes. Abrahamse et al. [45] investigated self-reported car use using attitudes toward car. Heinen et al. [28], Muñoz et al. [32,42], Majumdar and Mitra [37], and Piatkowski and Marshall [46] examined the decision to cycle considering attitudes towards bicycle characteristics.

On the other hand, the interrelations among attitudes towards travel modes, intention to travel and actual travel behavior have been studied very frequently using the framework of the Theory of Planned Behavior [47,48]. Again, most of the works focus only on one single travel mode. Bamberg et al. [34] studied how attitudes and other psychological factors influence the intention to use public transport,

and how the intention effects on public transport use before and after change of place of residence. Murtagh et al. [40] investigated children's walking as a way to travel to school, including the intention to behave like that (in the same study, they separately analyzed the influence of attitudes toward walking on the intention to walk). Fernández-Heredia et al. [38] examined frequency of bike use, using the intention to bike and several attitudes toward cycling as explanatory variables. Lo et al. [35] investigated the use of car, including the intention to commute by car and attitudes towards commuting by car, public transport, and bicycling. Şimşekoğlu et al. [49], Fun and Jua [50] studied public transport use, using behavioral intention and attitudes towards public transport.

Only Donald et al. [18] studied interrelations among attitudes towards travel modes, intention to use travel modes and actual travel behavior for more than one mode of transport. They did that research for car and public transport.

To the best of our knowledge, the present study is the first in the travel behavior field that carry out an analysis including intentions and real use of four travel modes simultaneously: car, public transport, bicycling, and walking.

1.3. Conceptual Framework

This study posits an in-depth analysis of the influence of attitudes on intentions to use travel modes and actual travel behavior. The three-component attitudes model is adopted, and their influence on both the intentions and the real use of car, public transport, bicycle and walk is tested. Additionally, the influence of the intentions to use those travel modes on the real use of them is also studied.

1.4. Hypotheses

Cognitive, affective, and behavioral related attitudes towards cycling and walking are always found in the literature to be positively associated to both the intention to use and the actual use of those travel modes. Inversely, they have been found negatively associated to both the intention to use and the actual use of motorized travel modes. Therefore, it is assumed that non-motorized travel modes are evaluated similarly.

Hypothesis 1: *Cognitive, affective, and behavioral attitudes towards cycling and walking are positively associated to both the intentions to use and the actual use of bicycle and walk.*

Hypothesis 2: *Cognitive, affective, and behavioral attitudes towards cycling and walking are negatively associated to both the intentions to use and the actual use of car and public transport.*

On the other hand, intentions to use each travel mode are always found in the literature to be positively associated to the actual use of that travel mode. It is also hypothesized that intentions to use each travel mode are negatively associated to the actual use of the others travel modes.

Hypothesis 3: *Intentions to use each travel mode are positively associated to the actual use of that travel mode, and negatively associated to the use of the others travel modes.*

2. Methods

2.1. Procedure

The dataset used for this research is part of the MINERVA project. This project was funded by the Ministry of Economy and Competitiveness of Spain and one of its main goals focuses on the study of the interrelationships among psychological factors and travel behavior.

In order to gather information regarding the variables of the study, a web-based survey was developed and distributed online between May and October 2017. August was excluded because this month is a vacation period in Spain. Otherwise, the response rate would have negatively affected.

Several organizations contributed to the dissemination of the survey: universities, companies, regional government, etc. Sampling frame consisted of two parts: e-mail lists provided by different public institutions and private companies, and a customer research panel based on the sample. The main area of the study was Valencia (Spain), although different locations were also accepted.

The survey also collected information regarding activity-travel related behaviors, companions, personal values, perceptions, and attitudes towards different types of elements (such as environmental concerns or use of Information and Communications technologies), which are out of the scope of this study [51].

2.2. Participants

Sample size included 1641 responses after data cleaning and validation. A survey response was considered valid when respondents completed information regarding demographic and socioeconomic information, and attitudes data. The distribution of the sample according to gender and education level is reasonably balanced (Table 1). However, those over 50 years old are under-represented in the sample. Respondents are predominantly employed individuals and students, which contrasts with the fact that most of the people over 18 years old in the Valencia area are not students nor employed.

Table 1. Sample distribution.

		Sample	**Valencia Area**
Gender	Male	46% (754)	48%
	Female	54% (887)	52%
Age	<30	41% (679)	30%
	30–50	41% (671)	31%
	>50	18% (291)	39%
Occupation	Student	24% (390)	5%
	Employed	54% (893)	25%
	Others	22% (358)	70%
Education level	University	51% (833)	58%
	No university	49% (808)	42%

2.3. Measures

Information regarding intention and real use of each mode of transport were obtained using a one-hundred-point scale. This way, participants are asked to distribute 100 points between their intentions to travel with each mode (car, public transport, walking, and cycling). Similarly, the same question is proposed for stating their actual use of each travel mode. Thus, both the actual modal split and the intention are obtained and measured with percentages of each mode compared to the total amount of travel. In the cases where the total percentage did not sum 100 points, a correction was applied in order to standardize the responses and distribute the sum among one hundred percent. We acknowledge that this subjective self-information data regarding real use of transport modes could include small difference compared with observed data. Nevertheless, considering that the information was provided in percentage of use of each travel mode, only small differences could exist between observed and stated travel mode use.

To evaluate attitudes towards cycling and walking modes, the three-component attitudes model already described (affective, cognitive, and behavioral) are assessed through 5-point Likert scales. For each transport mode, 16 items are included in the survey.

The construct which measures affective attitudes is composed by 5 items, such as “I like it” or “It’s relaxing”. For cognitive attitudes 6 items were used, e.g., “It suits my needs” or “It’s comfortable”. Last, behavioral attitudes are measured with 5 items, in this case, as these types of attitudes have a behavioral component, the questions we framed in a specific area of study: urban mobility. For instance, the items

are formulated as follows "I choose this travel mode considering the urban structure and its convenience" or "For urban trips, I choose this travel mode considering other people's influence and needs".

For each of the items composing the constructs, several descriptive analyses were carried out. Tables 2 and 3 include the name of the variable, description of the items, median, mode, and Standard Deviation measures for attitudes toward cycling and attitudes toward walking respectively. Consequently, 3 latent variables are built based on Factor Analysis results, as it is shown in the next section.

2.4. Data Analysis

First, several descriptive statistics were obtained that indicated the presence of slight signs of non-normality, asymmetry and kurtosis in some of the items. In order to take this fact into consideration, robust estimators (MLR) are incorporated later in the model estimation step.

Internal consistency was measured using Cronbach's Alpha, which determines if a certain set of items are related as a group, and how close they are among them. The three measures obtained for attitudes towards cycling are acceptable (cognitive attitudes = 0.824, affective attitudes = 0.771, behavioral attitudes = 0.704). Similarly, Cronbach's Alpha indicator is calculated for the three latent constructs related to attitudes towards walking (cognitive attitudes = 0. 705, affective attitudes = 0.749, behavioral attitudes = 0.610). As it can be seen, the last index is slightly below the recommended value. Considering that the score did not show any improvement after removing any specific item, it was determined to carry out additional verifications to check the appropriateness of the dataset to use Factorial Analysis technique.

For this reason, Bartlett's test of sphericity was carried out and a null value was obtained. Additionally, the Kaiser–Meyer–Olkin Measure of Sampling Adequacy (KMO) was used to determine the proportion of variance in the variables that might be caused by the underlying factors. High values were obtained (>0.8), which indicate that the Factor Analysis technique may be appropriate.

Furthermore, Pearson's correlation matrix was obtained to observe the correlations between the three latent variables and among individual items for each transport mode. As expected, some correlations were detected, because the three latent variables measure different types of attitudes for the same transport mode. Consequently, these correlations are later included in the formulation of the model.

Next, two different exploratory factor analyses (EFA) were conducted based on the three theoretical constructs that represents attitudes towards each nonmotorized travel mode. EFA was used to examine all the pairwise relationships between individual variables. EFA seeks to extract latent factors from the measured variables. To facilitate the interpretation of the results, the clusters of items are rotated so that they are more closely aligned with the axis lines. To this end, Varimax rotation method was used, which produce factors that are uncorrelated. Considering the results from EFA analyses, confirmatory factor analyses (CFA) were conducted, specifying the posited relationships of the observed indicators to the latent variables. CFA determines whether the hypothesized structure provides a good fit to the data, or in other words, that a relationship between the observed variables and their underlying latent, or unobserved, constructs exist. The CFA models were estimated using a robust maximum likelihood method. Finally, two SEM models were fit in order to study the interrelationships among cognitive, affective and behavioral attitudes towards walking and cycling, intentions and current use of cars, public transport, bicycling, and walking.

3. Results

3.1. Exploratory and Confirmatory Factorial Analyses Results.

3.1.1. Attitudes toward Cycling.

An EFA was executed employing Varimax rotation method. Considering the results obtained, a CFA was conducted, specifying the posited relationships of the observed indicators to the latent

variables. A factor loading of 0.40 in EFA was considered as the threshold to maintain items in the factor, as it is shown in Table 2. Thus, several items were removed from the original factors. Although, "AF_34" item ("*If I use this travel mode, I will have more freedom of movement*") was kept with a lower factor loading (0.398), taking into account that global fit indices are reasonable, and the inconveniences of removing an extra item from the construct.

Following the recommendation of Marsh, Balla, and Hau [52], and of Jaccard and Wan [53], in this study a range of goodness of fit indices from different classes are used, so that the limitations of each index can be overcome. The goodness of fit indices considered are: Standardized Root Mean Residual (SRMR) [54], the Comparative Fit Index (CFI) [55], the Tucker Lewis index (TLI) [55], and the Root Mean Square of Approximation (RMSEA) [56]. According to Hu and Bentler [55], and more recently by Newson [57], the suggested values for each index are the following: CFI < 0.95, TLI > 0.95, RMSE < 0.06, SRMR < 0.08. In this case, the values obtained for the goodness of fit indices support the validity of the constructed scales (RMSEA = 0.057; CFI = 0.975; TLI = 0.964; SRMR = 0.025). Most of the estimated coefficients exceed 0.6, indicating that all statements are strongly correlated with the latent variables defined. These analyses demonstrate the existence of the three theoretical constructs proposed: cognitive, affective, and behavioral attitudes towards cycling.

Table 2. Results of Exploratory and Confirmatory Factor Analyses. Attitudes toward cycling.

Variable [1]	Item [2]	Descriptive Measures			EFA	CFA
	Definition	Median	Mean	SD	Factor Loadings	Standardized Factor Loadings (S.E)
COG_4	It suits my needs	3.00	3.09	1.449	0.442	0.780 (0.013)
COG_9	It's fast	3.00	3.05	1.198	0.876	0.759 (0.013)
COG_14	It's comfortable	3.00	2.90	1.223	0.506	0.816 (0.012)
AF_34	If I use this travel mode, I will have more freedom of movement	4.00	3.78	1.179	0.398	0.624 (0.017)
AF_39	I like it	4.00	3.43	1.366	0.778	0.828 (0.011)
AF_49	It's relaxing	4.00	3.45	1.335	0.610	0.748 (0.014)
BEH_59	For urban trips, I choose this travel mode considering the pollution it might cause.	4.00	3.40	1.612	0.410	0.491 (0.022)
BEH_69	For urban trips, I choose this travel mode considering the urban structure and its convenience.	4.00	3.49	1.322	0.509	0.602 (0.019)
BEH_74	For urban trips I choose this travel mode in order to support it.	4.00	3.51	1.371	0.734	0.792 (0.015)
BEH_79	For urban trips, I choose this travel mode considering other people's influence and needs.	3.00	2.88	1.329	0.573	0.603 (0.019)

[1] The acronym of each item: COG stands for cognitive, AF stands for affective, BEH stands for behavior, EFA stands for exploratory factor analyses; CFA stands for confirmatory factor analyses. [2] Definition of each item, as they are presented to respondents.

3.1.2. Attitudes Towards Walking.

The same procedure was followed for the three types of attitudes towards walking. Although TLI is slightly lower than the cutoff value, overall the goodness of fit indices support the validity of the constructed scales (RMSEA = 0.062; CFI = 0.955; TLI = 0.932; SRMR = 0.035). Thus, it can be stated that the items are strongly correlated with the latent variables defined. The existence of the three theoretical constructs proposed: cognitive, affective, and behavioral attitudes towards walking is also confirmed.

3.2. SEM Results

Structural Equation Models were fitted using the maximum likelihood method with Huber–White covariance adjustment (MLR) for parameter estimation [58]. This is a robust estimator that uses White's sandwich-based method to deal with non-independence and non-normality [59].

3.2.1. Model 1. Attitudes towards Cycling, Intention and Use of Transport Modes

The first model includes the relationships between cognitive, affective and behavioral attitudes towards cycling with intention and the actual use of each travel modes (car, public transport, bicycling, and walking), and between these intentions with actual use of each travel mode. Following the hypotheses of this research, direct relations from attitudes to actual use are also included. Measures of goodness of fit were assessed which support the validity of this model (RMSEA = 0.043; CFI = 0.976; TLI = 0.967; SRMR = 0.031).

Table 3. Results of exploratory and confirmatory factor analyses. Attitudes toward walking.

Variable	Item	Descriptive Measures			EFA	CFA
	Definition	Median	Mean	SD	Factor Loadings	Standardized Factor Loadings (S.E)
COG_5	It suits my needs	4.00	3.91	1.159	0.467	0.699 (0.021)
COG_10	It's fast	2.00	2.50	1.204	0.719	0.471 (0.026)
COG_15	It's comfortable	3.00	3.25	1.245	0.655	0.661 (0.021)
AF_35	If I use this travel mode, I will have more freedom of movement	5.00	4.34	1.026	0.551	0.578 (0.019)
AF_40	I like it	4.00	4.15	1.043	0.703	0.841 (0.015)
AF_50	It's relaxing	5.00	4.25	1.002	0.686	0.672 (0.016)
AF_55	If I use this travel mode, I will be able to make to make other things during the trip (read, listen to music, think . . .)	5.00	4.12	1.157	0.495	0.643 (0.021)
BEH_65	I choose this travel mode considering the possibility of sharing the trip with other people	3.00	3.01	1.513	0.489	0.493 (0.025)
BEH_75	For urban trips I choose this travel mode in order to support it.	4.00	3.88	1.262	0.572	0.731 (0.023)
BEH_80	For urban trips, I choose this travel mode considering other people's influence and needs.	3.00	3.30	1.362	0.675	0.610 (0.023)

Figure 1 shows direct effects of model 1. Significant relationships were found between cognitive attitudes towards cycling and the intention to cycle and walk. As expected, these type of attitudes are found negatively associated with the intention to use motorized transport modes: public transport and car, and positively associated to the intention to cycling and walking. According to the values of the estimated coefficients, the sizes of the effects are similar in all cases except for the intention to cycling, which is almost double those of the other relationships. Affective attitudes toward cycling also provided a significant and positive relation with the intention to cycle, but surprisingly a negative association with the intention to walk. Behavioral attitude towards cycling is negatively related with both the intention and the real use of car.

Results also confirm the existence of several direct relationships between attitudes toward cycling and current use of each travel mode, although this is only observed for cognitive attitudes. Cognitive attitudes toward cycling are positively associated with the real use of cycling and walking, and negatively associated to the real use of the car. The size of the effect is very small on walking, and larger on cycling.

As expected, results indicate that the intentions to use each travel mode is positively associated with the real use of the same mode. The size of these effects are much larger than the relationships

between attitudes and real use. Only the intention to walk is found to be significantly and negatively associated with real bike use, with a very small size effect.

It is also interesting to highlight that important correlations were found in the measurement part of the model. These correlations were expected due to the fact that the three latent variables measure different types of attitudes regarding the same transport mode.

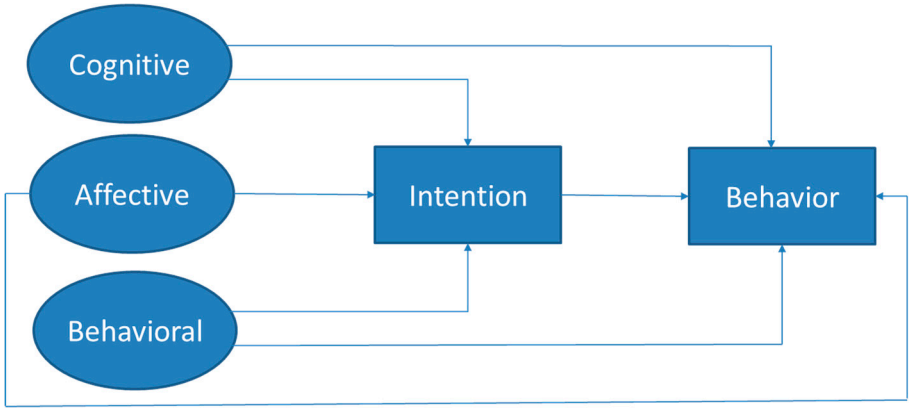

Figure 1. Conceptual framework.

Several hypothesized direct associations were not found in the model. For this reason, the next step consisted of evaluating the existence of indirect relationship between attitudes and current use, following the assumption that intentions are mediators of this relation.

For this purpose, indirect associations were obtained as well. Even though the model estimated was the same as Model 1 (Figure 2), separate diagrams are presented below in order to make easier the interpretation of results.

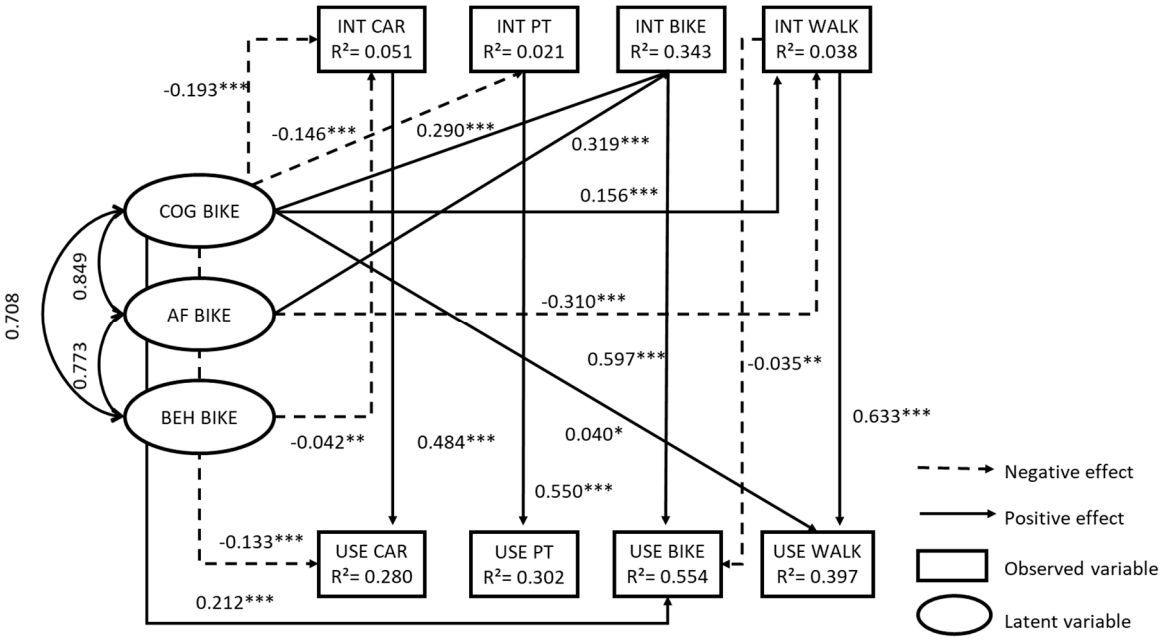

Figure 2. Model 1. SEM results. Attitudes toward cycling, intention and use of transport modes. Direct effects. COG/AF/BEH BIKE: Cognitive/affective/behavioral attitudes toward cycling. INT CAR/PT/BIKE/WALK: Intention to use car/public transport/bicycle/walk. USE CAR/PT/BIKE/WALK: Real use of car/public transport/bicycle/walking. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Figure 3 shows the significant indirect effects found between attitudes toward cycling and the actual use of bicycles. There is a positive relationship between cognitive attitudes towards cycling and real bike use mediated through the intention to cycle. However, a negative relationship was found when the mediator is the intention to walk. Regarding affective attitudes towards cycling and bike use, both mediators (intention to cycle and intention to walk) were found to be positive. The size of the effect of attitudes toward cycling on the real use of bike mediated by the intention to walk is much lower than the other indirect effects.

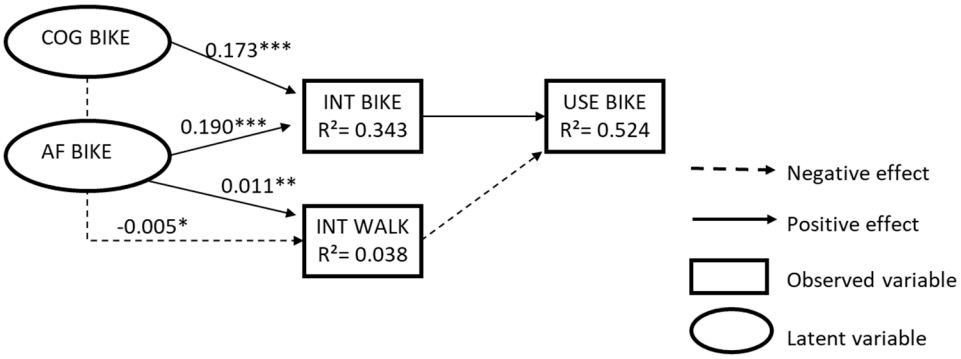

Figure 3. Model 1. SEM results. Attitudes toward cycling, intentions and use of cycling mode. Indirect effects. COG/AF BIKE: Cognitive/affective attitudes toward cycling. INT BIKE/WALK: intention to use bicycle/walk. USE BIKE: Real use of bicycle. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Additionally, cognitive and behavioral attitudes toward cycling are indirectly associated to the real use of car through the intention to use car as a negative mediator (Figure 4). Both effects are found to be small, in particular the one caused by behavioral attitudes toward cycling.

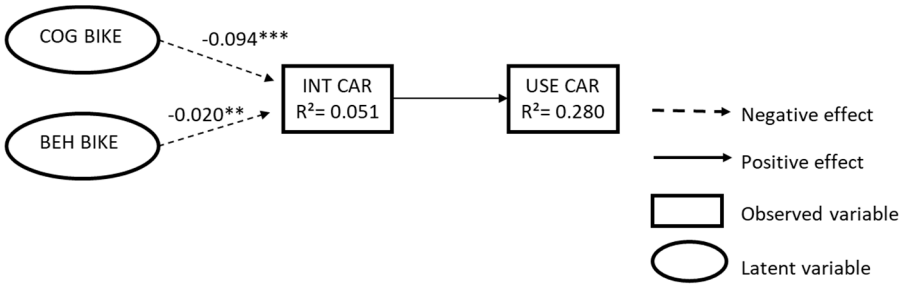

Figure 4. SEM model results. Attitudes towards cycling, intentions and use of car. Indirect effects. COG/BEH BIKE: cognitive/behavioral attitudes toward cycling. INT CAR: intention to use car. USE CAR: real use of car. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Figure 5 shows the significant indirect effects found between attitudes toward cycling and the actual walking. In this case, the intention to walk mediates cognitive attitudes toward cycling positively through actual walking. In contrast, intention to walk mediates affective attitudes toward cycling negatively through actual walking. The latter effect is only somewhat higher.

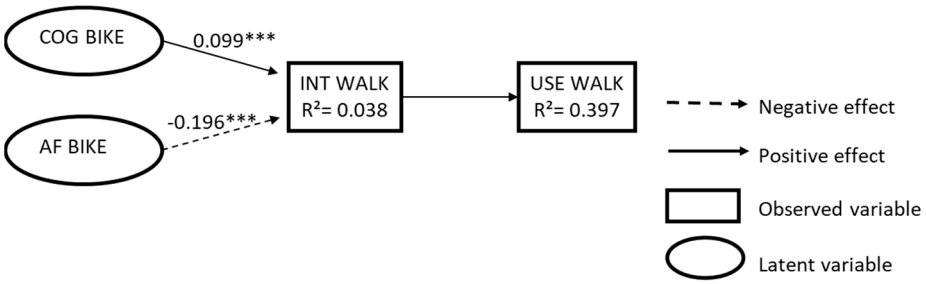

Figure 5. SEM model results. Attitudes toward cycling, intentions and walking. Indirect effects. COG/AF BIKE: Cognitive/affective attitudes toward cycling. INT WALK: Intention to walk. USE WALK: Real walking. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

A similar effect was found with cognitive attitudes toward cycling and the use of public transport, which is negatively mediated with the intention to use public transport (Figure 6). According to the estimated value of the coefficient, the size of this effect is low.

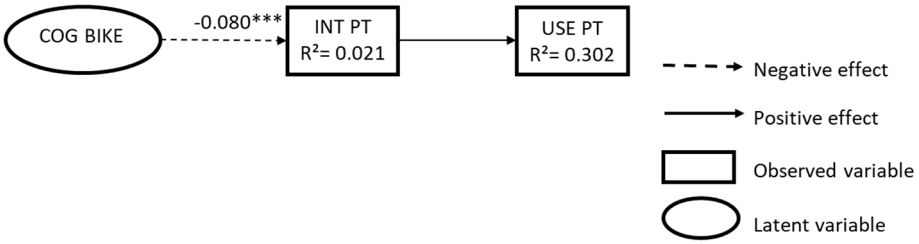

Figure 6. SEM model results. Attitudes toward cycling, intentions and use of public transport (PT). Indirect effects. COG BIKE: Cognitive attitudes toward cycling. INT PT: Intention to use public transport. USE PT: Real use of public transport. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

3.2.2. Model 2. Attitudes toward Walking, Intention, and Actual Use of Transport Modes

The second model includes the relationships between cognitive, affective, and behavioral attitudes toward walking with the intention to use and real use of cars, public transport, bicycling and walking, and between those intentions with actual use of each travel mode. Although TLI is slightly lower than the cutoff value, overall the measures of goodness of fit are also appropriated and support the validity of this model (RMSEA= 0.050; CFI = 0.956; TLI = 0.941; SRMR = 0.038).

Figure 7 represents the results of the model. As it is shown, cognitive attitudes toward walking are positively associated with the intentions to use active transport (bike and walk). As expected, the association is negative between cognitive attitudes toward walking and the intention to use cars. Similarly, affective attitudes toward walking are positively associated with the intention to walk, and negatively associated with the intention to use car. On the other hand, behavioral attitudes toward walking are found to be positively associated to the intention to cycle, but unexpectedly negatively associated to the intention to walk. In general, the sizes of the effects are small, with the lowest values associated to the intentions to active transport.

Again, this model shows several direct associations between attitudes toward walking and actual use of travel modes. Thereby, cognitive attitudes toward walking are positively associated with current walking and negatively related with the use of car. The size of the effect is only a bit higher on the current walking. The model did not provide any significant association between affective attitudes toward walking and the use of travel modes, but behavioral attitudes toward walking are positively associated with the use of bike, and negatively related to the use of car. According to the estimated value of the coefficient, both effects are quite small.

Logically, intentions and actual travel behavior are associated in a similar way than in the previous model. The intention to use each travel mode is positively associated to the actual use of the same

travel mode. The size of these effects are much larger than the relationships between attitudes and real use.

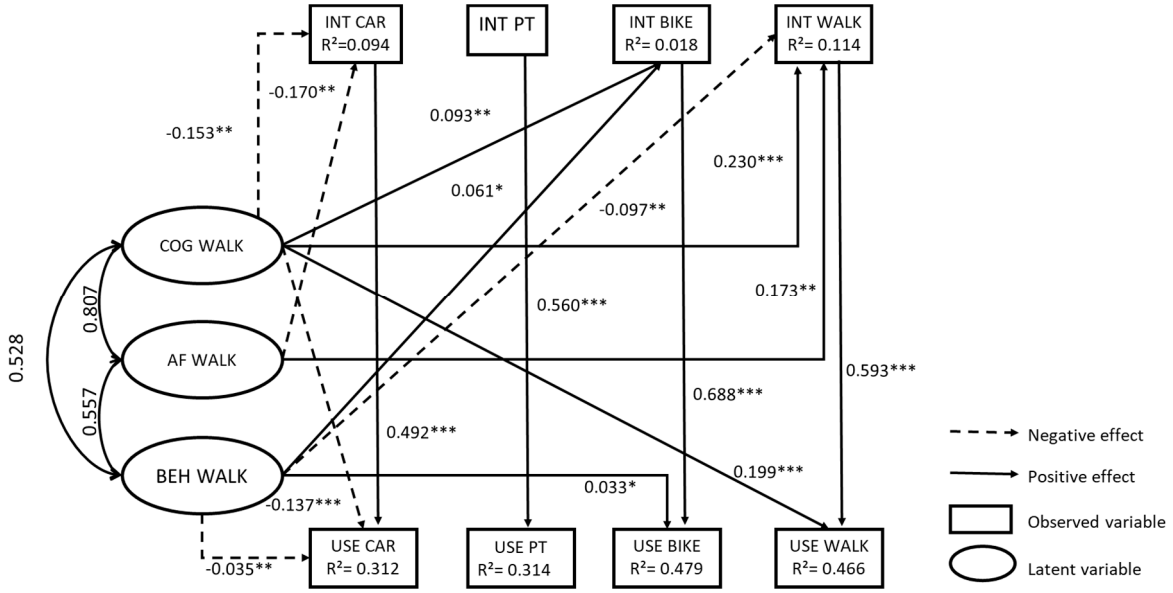

Figure 7. SEM model results. Attitudes toward walking, intention and use of transport modes. Direct effects. COG/AF/BEH WALK: Cognitive/affective/behavioral attitudes toward walking. INT CAR/PT/BIKE/WALK: Intention to use car/public transport/bicycle/walk. USE CAR/PT/BIKE/WALK: Real use of car/public transport/bicycle/walking. * p <0.1; ** p < 0.05; *** p < 0.01.

Figure 8 shows the significant indirect effects found between attitudes toward walking and the actual walk. The intention to walk was found to positively mediate between cognitive and affective attitudes toward walking and actual walking, but negatively mediates between behavioral attitude toward walking and actual walking. The latter effect is much lower than those related to cognitive and affective attitudes toward walking.

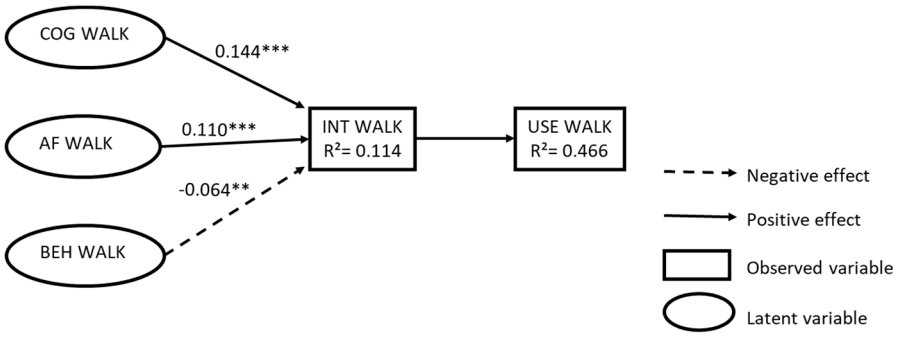

Figure 8. SEM model results. Attitudes toward walking, intentions and use of public transport. Indirect effects. COG/AF/BEH WALK: Cognitive/affective/behavioral attitudes toward walking. INT WALK: Intention to walk. USE WALK: Real use of walking: * p < 0.1; ** p < 0.05; *** p < 0.01.

Figure 9 shows the significant indirect effects found between attitudes toward walking and the actual use of car. The intention to use car was found to negatively mediate between cognitive and affective attitudes toward walking and the actual use of car. According to the estimated value of the coefficients, both effects are quite low.

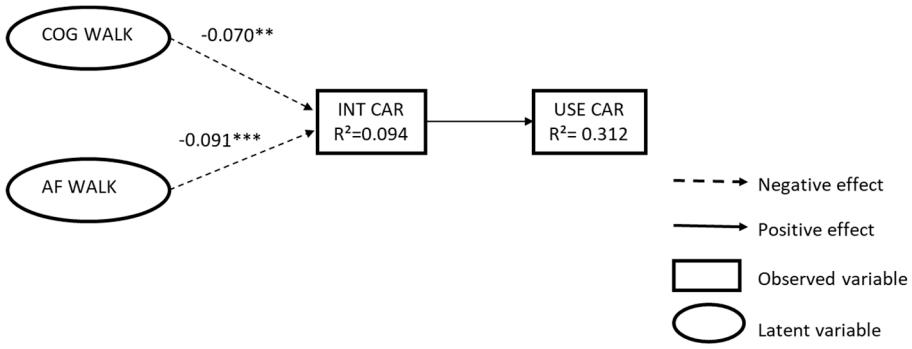

Figure 9. SEM model results. Attitudes toward walking, intention and use of car. Indirect effects. COG/AF/ WALK: Cognitive/affective attitudes toward walking. INT CAR: Intention to use car. USE CAR: Real use of car. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Finally, Figure 10 shows the significant indirect effects found between attitudes toward walking and the actual use of bicycle. The intention to use bicycle was found to positively mediate between cognitive and behavioral attitudes toward walking and the actual use of bicycle. Again, according to the estimated value of the coefficients, both effects are quite low.

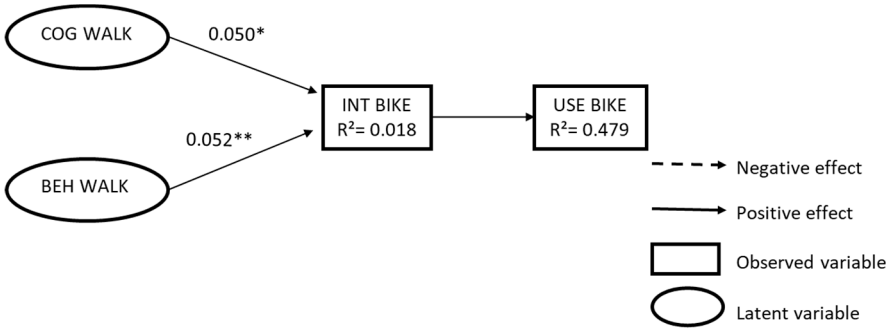

Figure 10. Attitudes toward walk, intention and use bike. Note: Indirect effects. COG/BEH WALK: Cognitive//behavioral attitudes toward walking. INT BIKE: Intention to use bicycle. USE BIKE: Real use of bicycle * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

4. Discussion and Conclusions

This paper presents a study of the influence of attitudes towards travel modes on the intention to use them and the real travel behavior. The effects of intentions on real use is also analyzed. The main contributions of this study are twofold. First, the study adopts the three-component model of attitudes, by differentiating cognitive, affective, and behavioral attitudes towards cycling and walking. Second, the study includes simultaneously the interrelationships among intentions and real use of four different travel modes: car, public transport, bicycling, and walking.

The intentions are the most influential factors on the actual use of each travel mode, as have been found elsewhere [18,34,38,40,49,50]. Cognitive, affective and behavioral attitudes towards cycling and walking affects to a similar extent both the intention and the actual use of the travel modes. The intentions to use car, public transport, bicycling, and walking, have a significant role as mediators between attitudes towards cycling and walking and the actual use of the travel modes considered.

The results confirm most of the expected influences of all attitudes on intentions and use of car, public transport, bicycling, and walking, with two important exceptions. The affective attitude toward cycling is negatively associated with the intention to walk. Besides, the intention to walk is a negative mediator between the affective attitude toward cycling and actual walking. However, as hypothesized, cognitive attitudes toward cycling are positively associated to the intentions to both cycling and walking. This result indicates that cycling and walking are valued differently in terms of feelings of freedom, pleasure and relax.

On the other hand, behavioral attitudes toward walking is negatively associated to the intention to walk. Besides, the intention to walk is a negative mediator between the behavioral attitudes toward walking and actual walking. This result may be explained by the fact that people usually positively value general statements about walking behavior. However, other factors can impede people from walking. These factors are frequently associated with distance or time pressure [60,61].

Travel behavior studies should consider active travel modes, i.e., cycling and walking, separately, to facilitate the adequate characterization of both travel modes. Although both are considered active travel modes, they are seen differently by people, and can be considered competing transport modes. Transport policies to encourage cycling should be different from those with the aim of promoting walking.

Regarding walking, safe and comfortable pedestrian paths are not enough to encourage walking. There is a need that future urban developments are undertaken to facilitate people in carrying out any type of travel activity.

We acknowledge that the information regarding real use of travel modes was estimated from subjective self-informed data. Real uses of travel modes were assessed from stated information given by respondents. Nevertheless, considering that the information was provided in percentages of use of each travel mode, only small differences could exist between observed and stated travel mode use.

This work will be expand including the analysis of the influence of affective, cognitive, and behavioral attitudes towards using car and public transport on both the intentions and the real use of car, public transport, bicycling and walking. The effects of attitudes towards different types of elements (such as environmental concerns or use of Information and Communications technologies) on intentions and travel behavior will be studied as well.

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