



Avances en Psicología Latinoamericana

ISSN: 1794-4724

ISSN: 2145-4515

apl@urosario.edu.co

Universidad del Rosario

Colombia

Caballero, Romina; Franco, Paul; Tosi, Jeremías David; Jakovcevic, Adriana  
Using the Theory of Planned Behavior to Explain Cycling Behavior  
Avances en Psicología Latinoamericana, vol. 37, no. 2, 2019, May-August, pp. 283-294  
Universidad del Rosario  
Colombia

DOI: <https://doi.org/10.12804/revistas.urosario.edu.co/apl/a.6972>

Available in: <http://www.redalyc.org/articulo.oa?id=79959509008>

- How to cite
- Complete issue
- More information about this article
- Journal's webpage in redalyc.org

UDEM  redalyc.org

Scientific Information System Redalyc  
Network of Scientific Journals from Latin America and the Caribbean, Spain and  
Portugal

Project academic non-profit, developed under the open access initiative

# Using the Theory of Planned Behavior to Explain Cycling Behavior

Aplicación de la Teoría del Comportamiento Planificado para explicar el uso de bicicleta

Uso da Teoria do Comportamento Planejado para explicar o uso da bicicleta

Romina Caballero<sup>\*,\*\*</sup>, Paul Franco<sup>\*</sup>, Jeremías David Tosi<sup>\*\*\*</sup>,  
Rubén Daniel Ledesma<sup>\*\*\*</sup> & Adriana Jakovcevic<sup>\*</sup>

Doi: <http://dx.doi.org/10.12804/revistas.urosario.edu.co/apl/a.6972>

## Abstract

Latin American cities are facing crucial changes to become cycling cities. To develop effective policies in this regard, it is essential to understand the factors influencing bicycle commuting. The Theory of Planned Behavior —TPB— (Ajzen 1991) has provided a useful model to explain travel mode choice. The present study tested the TPB within the domain of bicycle mode choice with 172 participants from Buenos Aires, Argentina. Data was modeled using path analysis. The TPB model displayed an excellent fit. Results showed that intention predicted 53% of the variance in cycling to university. In addition, TPB variables (attitude, subjective norm, and perceived behavioral control) predicted 59% of the intention to use the bicycle to commute to university. The study also discusses the theoretical and practical implications for promoting bicycle use.

**Keywords:** Theory of Planned Behavior, bicycling behavior, active transportation.

## Resumen

Las ciudades latinoamericanas están realizando cambios importantes para propiciar el uso de bicicleta. Para desarrollar políticas en este sentido es importante conocer los factores que motivan el uso de bicicleta. La Teoría del Comportamiento Planificado (TCP, Ajzen, 1991) proporciona un modelo útil para comprender posibles motivos relacionados con la elección del modo de transporte. En este trabajo se aplicó la TCP para explicar el uso de bicicleta en viajes a la Universidad. Se trabajó con una muestra de 172 participantes de la Ciudad Autónoma de Buenos Aires, Argentina. Los datos fueron modelados mediante análisis de senderos (path analysis). La TCP mostró un excelente ajuste a los datos. Los resultados

\* Centro de Altos Estudios en Ciencias Humanas y de la Salud (CAECIHS), Universidad Abierta Interamericana.

\*\* Instituto de Investigaciones, Facultad de Psicología, Universidad de Buenos Aires.

\*\*\* IPSIBAT, Universidad Nacional de Mar del Plata y Consejo Nacional de Investigaciones Científicas y Técnicas (Argentina).

Dirección correspondencia: Lic Jeremías David Tosi, [jeremiasnosi@gmail.com](mailto:jeremiasnosi@gmail.com)

How to cite this article: Caballero, R. Franco, P., Tosi, J. D., Ledesma, R. D., & Jakovcevic, A. (2019). Use of the Planned Behavior Theory to Explain Bicycle Use. *Avances en Psicología Latinoamericana*, 37(2), 283-294. Doi: <http://dx.doi.org/10.12804/revistas.urosario.edu.co/apl/a.6972>

sugieren que la intención conductual explica el 53% de la varianza de la conducta de uso de bicicleta para viajar a la universidad. A su vez, el resto de los componentes de la TCP (*actitud, norma subjetiva, y control conductual percibido*) explican el 59% de la varianza en la intención de viajar en bicicleta. Se discuten las implicancias teóricas y prácticas para la promoción del uso de bicicleta como modo de transporte.

*Palabras clave:* Teoría del Comportamiento Planificado, uso de bicicleta, transporte activo.

## Resumo

As cidades latino-americanas estão enfrentando importantes mudanças em infraestrutura para se converter em cidades para ciclistas. Para gerar políticas efetivas de desenvolvimento sustentável de mobilidade, é essencial entender os fatores que influenciam o deslocamento em bicicleta. A Teoria do Comportamento Planejado —TCP— (Ajzen, 1991) tem proporcionado um modelo útil para explicar a eleição do modo de viagem, mas poucos estudos aplicam a TCP para explicar isto no comportamento do ciclista. O presente estudo analisou a TCP respeito à eleição do modo de viagem de 172 participantes de Buenos Aires, Argentina. Os resultados sugerem que a intenção explica o 53% da variância do comportamento de andar de bicicleta para ir à universidade. Adicionalmente, variáveis do TCP (*atitude, norma subjetiva, percepção do controle comportamental*) explicam o 59% da variância da eleição de andar de bicicleta à universidade. Discutem-se as implicações teóricas e práticas de promover o uso da bicicleta.

*Palavras-chave:* Teoria do Comportamento Planificado, comportamento do ciclista, transporte ativo.

## Using the Theory of Planned Behavior to Explain Cycling Behavior

With the goal of lessening the environmental impact of motorized vehicles, the promotion of the bicycle as an urban travel mode has been on the rise (Ríos Flores, Taddia, Pardo & Lleras,

2015). To achieve this modal shift, modifications to city infrastructure (e.g. public bicycles, bicycle lanes) must be accompanied by cultural changes. Consequently, it is imperative to be aware of the psychological variables associated with bicycle use for commuting. One of the most widely used models to understand travel mode choice is the Theory of Planned Behavior —TPB— (Ajzen, 1991); however, the application of this theory to bicycle use limits to just a few studies conducted mainly in European cities (e.g. de Bruijn, Kremers, Singh, van den Putte & van Mechelen, 2009; Milkovic & Stambuk, 2015). The objective of this study was to evaluate the predictive power of TPB regarding bicycle use as a means of urban transportation in a Latin American city (Buenos Aires, Argentina).

## Promotion of the bicycle as a travel mode

Recent decades have seen steady growth in the world's automobile fleet, as well as in the amount of traffic and road infrastructure (OICA, 2014). In Latin America, automobile use has increased by 43% from 2005 to 2014; in the specific case of Argentina, it increased by 48% (OICA, 2014). The ever more frequent use of the automobile, promoted for the advantages it offers (e.g., speed, comfort, privacy), has resulted in grave environmental and social problems, including traffic congestion and noise and air pollution (e.g., Dora, Hosking, Mudu & Fletcher, 2011; Tapia Granados, 1998).

To lessen these impacts, several cities around the world have made significant investments to prioritize non-motorized transportation modes (Ríos Flores, Taddia, Pardo & Lleras, 2015). In this respect, one of the best alternatives for urban mobility is the bicycle (Bacchieri, Barros, dos Santos & Gigante, 2010) because it not only has no negative environmental consequences, but it also has health benefits for the user (e.g. Andersen, Lawlor, Cooper, Froberg & Anderssen, 2009; de Geus, Joncheere & Meeusen, 2009; Hoevenaer-Blom, Wendel-Vos, Spijkerman, Kromhout

& Verschuren, 2011). Various urban centers around the world have implemented public policies to promote its use —e.g., the construction of bicycle lanes, public bicycle rental stations— (Pucher & Buehler, 2008). In the past decade, the number of cities with a bicycle-sharing system grew from 13 in 2004 to 855 in 2014 (Fishman, 2015). Nonetheless, changes in infrastructure are not enough to modify mobility behaviors (Moudon et al., 2005; Parkin, Wardman & Page, 2008). Changes in the beliefs and attitudes of citizens are also required. Baumann, Bojacá, Rambeau, and Wanner (2013) point out that although several Latin American cities have developed adequate infrastructure for bicycle use, the percentage of persons that actually take advantage of it remains low. The authors suggest this may be due to negative attitudes towards this transportation mode, associated with low socio-economic status and higher safety risk.

As Heinen, Maat and van Wee (2011) indicate, the individual decision to use an automobile over some other transportation modes is a potential starting point for interventions aimed at changing mobility behavior. When deciding among different transportation modes, subjects weigh their beliefs and attitudes towards each. For this reason and to achieve a cultural change in sustainable mobility, it is essential to know the psychological factors influencing bicycle commuting.

### **The Theory of Planned Behavior (TPB) in explaining bicycle use**

TPB (Ajzen, 1991) is one of the most widely used psychological models to study travel mode choice (for a review see Gardner & Abraham, 2008; Jakovcevic, Franco, Caballero & Ledesma, 2015). This theory maintains that people make reasoned choices and opt for those alternatives that guarantee the most benefits with the least costs (e.g., in terms of effort, money, safety and social acceptability). According to TPB, three principal factors guide human action: a favorable or unfavorable *attitude*

towards the behavior; a perceived social pressure to engage in the behavior or *subjective norm*, and the perception of control over it (*perceived behavioral control*). Collectively, these three considerations generate a *behavioral intention*, which is the immediate antecedent to the behavior object of the explanation (Ajzen, 2002). As a general rule, the more favorable the attitude, the stronger the subjective norm and the bigger the perceived behavioral control towards a behavior, the stronger it is the intention to behave in that manner (Ajzen, 2002). From this theoretical perspective, the intention to use a bicycle directly determines its use. To generate this intention, a person must have a positive attitude toward bicycle use, perceive that others also regard it as appropriate, and consider himself/herself capable of using a bicycle.

Table 1 summarizes previous studies that applied the TPB to the understanding of cycling behavior (Forward, 2004; de Bruijn et al., 2009; Heinen et al., 2011; Milkovic & Stambuk, 2015; Frater, Kuijer, & Kingham, 2017; Acheampong, 2017). In general, the TPB model explains, to a large extent, the behavioral intention and the behavior (explained variance from 25% to 73%). Furthermore, when other psychological variables are included (e.g. habit, personal norm), there is no observable significant increase in explained variance (Frater et al., 2017; Milkovic & Stambuk, 2015; de Bruijn et al., 2009). In terms of the relative importance of the model's various components, the results varied. Only one study found significant effects for all of the model's components (Milkovic & Stambuk, 2015). In other studies, perceived behavioral control seemed to be the component most consistently associated with behavior (Acheampong, 2017; Heinen et al., 2011; de Bruijn et al., 2009; Forward, 2004). Three of the seven studies found attitudes to be associated, and one of these found them to be the most important (Milkovic & Stambuk, 2015). Lastly, regarding the subjective norm, two studies identified it as a predictor, and it emerged as the most important

in one about secondary school students (Frater et al., 2017). In any case, it is difficult to compare results across studies due to differences in methodology, the criteria being predicted (behavioral intention or the behavior itself) and the statistical focus used to evaluate the model (with all the variables placed at the same level or according to those levels proposed by the TPB).

Additionally, there have been studies to identify the promoting and inhibiting factors on the

use of the bicycle as a means of stimulating physical activity (see Caballero et al., 2014). These studies indicate that the main promoters include social facilitators (e.g., social support, modeling; de Geus et al., 2008; Titze et al., 2007, 2008), as well as the perceived feeling that one is trained to use a bicycle (Nkurunziza et al., 2012; Titze et al., 2007). These variables could be indicators of the subjective norm as well as the perceived behavioral control postulated by the TPB. Lastly,

Table 1  
*Previous studies using the TPB in explaining cycling behavior*

Authors/year	Country	Participants	Target behavior	Brief description
Forward (2004)	The Netherlands Spain Denmark Sweden	$n = 542$ adults (age, between 18 and 69 years; 53.1% men)	Commuting from the home to a destination 2.5 km away by bicycle.	The author used the TPB model and habit to predict different travel behaviors, cycling intention among them. The model explained 47-48% of intent. Habit and perceived behavioral control were the only significant predictors (except in the Netherlands, where the subjective norm and habit were significant).
de Bruijn et al. (2009)	The Netherlands	$n = 317$ (mean age, 42.09 years, 46.7% men)	Commuting to work by bicycle	Researchers tested two explanatory models that included TPB variables as well as other predictors to explain the selection of the bicycle to commute to work in an urban environment. On average, these models explained 25% of bicycle use and the main predictor was perceived behavioral control, followed by the intention to use a bicycle and attitudes. The subjective norm was an insignificant predictor. When habit strength was added, only intention made a significant contribution.
Heinen et al. (2011)	The Netherlands	$n = 6008$ (age, between 18 and 65 years)	Commuting to work by bicycle	Heinen et al. tested a model that included TPB variables together with attitudinal and habit variables. The authors sought to determine whether psychological variables that predict bicycle use as a travel mode (vs. non-use) varied according to the distance travelled. To this end they conducted repeated measures with sub-samples based on the distance typically travelled (up to 5 km, between 5 and 10 km and more than 10 km). Perceived behavioral control was consistently the main predictor, followed by the perceived immediate benefits of bicycle use (i.e., savings in terms of time and money) and, in third place, habit. However, we should note that the researchers did not include intention in their model and did not describe how bicycle commuting behavior was operationalized, thus making it difficult to replicate the results.
Milkovic and Stambuk (2015)	Croatia	$n = 712$ (mean age, 22.4 years, 76% female)	Commuting to university by bicycle	Researchers examined the TPB with the addition of the personal norm in explaining the intention to cycle to university. The model explained 55% of the variance in intention, while the personal norm increased the explained variance by a modest 2%. All the variables were significant predictors. Attitudes had greater weight, followed by behavioral control, subjective norm and personal norm.

Authors/year	Country	Participants	Target behavior	Brief description
Frater, Kuijer and Kingham (2017)	New Zealand	<i>n</i> = 331 (between 13 and 18 years, 63% male)	Commuting to school by bicycle	The authors used the TPB in combination with the prototype willingness model (PWM) to predict the intention to cycle to school on the part of adolescents. The TPB explained 44% of the variance, while the PWM only added 2%. The subjective norm (social pressure from friends and parents) was the strongest predictor; attitudes were also predictors but to a lesser degree. Perceived behavioral control did not have a significant association.
Acheampong (2017)	Ghana	<i>n</i> = 348 (mean age, 33 years, 49% male)	Commuting to work by bicycle	The author examined TPB together with other variables to predict the intention to cycle to work. The model explained 73% of the variance. Perceived behavioral control was the only significant predictor from the TPB model. Other important predictors included the perception of the traffic environment, bicycle ownership, frequency of use and gender.

there is other evidence indicating that attitudes towards the bicycle are related to its efficient use (Emond, & Handy, 2012; Hunecke et al., 2010; Rondinella et al., 2012).

Collectively, the reviewed antecedents suggest that TPB is a suitable theoretical approach to explain bicycle use behavior. However, the previous research was conducted mainly in European cities, where contextual barriers (distance, infrastructure, etc.) to bicycle use are assumed to be lower than in Latin American cities. Additionally, the results vary widely, suggesting that cultural and contextual variables might be relevant. The present study aims to evaluate TPB according to the guidelines proposed by Ajzen (2002) in explaining the selection of the bicycle as a means of commuting to university in an Argentine city (City of Buenos Aires). In particular, the study analyzes the contribution of the TPB and the relative weight of each of its components in predicting bicycle use to commute to university. Based on the findings of prior studies, we hypothesize that the model will predict not only behavioral intention but also the final behavior. We hope that this study will shed light on the usefulness of the TPB in attaining a greater understanding of bicycle use.

## Method

### Participants

The sample comprised was of 172 participants (69% women) from the Psychology Department of the University of Buenos Aires (UBA). The average age was 25.85 years (*SD* = 8.7). In terms of their roles in the university, 92% were undergraduate students and 8% employees. The preponderance of female participants matches the population values reported in the last university census for this department (UBA, 2011). Regarding the transportation mode used to commute to the university, 60% indicated using public transportation, 27% a bicycle, 7% a private motorized vehicle (automobile or motorcycle), and 6% walked to the university. The vast majority (97%) of participants indicated they knew how to ride a bicycle, 58% reported having access to one sometime or always, while 42% indicated never having access. Among them, 55.2% said they had access to a car sometime or always, and 46.5% had a driver's license. We should note that Buenos Aires city has a free public bicycle system; thus any citizen can have access to a bicycle. As an inclusion criterion, subjects were required to be city residents to control distance as a factor



that could affect the selection of the bicycle for the trip to the university. The commuting distances to the university ranged from 1.6 km to 25.9 km and averaged 6.34 km (SD = 3.86).

### Procedure

An instrument was developed based on the TPB. We evaluated the initial version with a sample of 10 participants, who responded to and discussed it in an interview. Based on these interviews, we made changes and improvements to instructions and the items. The corrected version of the instrument was administered to the total sample, using a casual non-probabilistic sampling. Participants were contacted at the university as well as via an email sent to a group of students. These individuals were invited to participate in a study on attitudes towards different travel modes. Prior to responding, we asked them for their informed consent and guaranteed confidentiality, anonymity and the right to stop participating whenever they wished to. Of the total number of subjects in the sample 18% ( $n=31$ ) responded to the survey online and 82% ( $n = 141$ ) did so in person. We did not find any significant differences between these groups (online vs. in person) in their TPB measures.

### Variables and Measures

#### *Attitudes Towards Bicycle Use (ATT)*

These were evaluated using a semantic differential scale developed by Caballero et al. (2015) and based on research by de Bruijn et al. (2009) and Mann and Abraham (2012). Participants indicated to what extent (from 1 to 7) they felt commuting to university by bicycle was: good/bad, uncomfortable/comfortable, prejudicial/beneficial, unpleasant/pleasant ( $M = 5.55$ ;  $SD = 1.68$ ;  $\alpha = .90$ ).

#### *Subjective Norm and Perceived Behavioral Control (PBC)*

These were evaluated using items pertaining to bicycle use adapted from Mann and Abraham (2012) and TPB, based on the guidelines established by Ajzen (2002). The subjective norm was evaluated based on the degree of agreement with three items (e.g. “*My friends feel that I should use a bicycle for most of my trips to the university next week*”) while PBC was examined based on the degree of agreement with four items (e.g., “*I feel I am capable of using a bicycle for most of my trips to the university next week*”). In both instances, a 7-point scale was used from 1 (disagree) to 7 (agree). Both subjective norm ( $M = 3.40$ ;  $SD = 1.58$ ) and PBC ( $M = 4.66$ ;  $SD = 1.95$ ) displayed good internal consistency ( $\alpha = .86$  y  $\alpha = .83$ , respectively).

#### *Behavioral Intention*

This factor was evaluated based on the degree of agreement with four items (e.g., “*I intend to use a bicycle for most of my trips to the university next week*”) that were constructed based on suggestions by de Bruijn et al. (2009) and Gardner (2009). Participants responded using a scale from 1 (disagree) to 7 (agree;  $M = 3.52$ ;  $SD = 2.36$ ;  $\alpha = .96$ ).

#### *Bicycle use Behavior*

The transportation mode used to commute to the university was evaluated based on two questions: (a) the number of trips to the university made during the week prior to being administered the survey and (b) transportation mode used for each of those trips. Based on these responses, the percentage of trips made by bicycle was calculated taking the number of them made using this travel mode divided by their total to the university made during the previous week.

Given that this measure evaluates past bicycle use behavior, it was re-evaluated with a sub-sample of participants ( $n = 39$ ) a week after we administered the complete survey. This sub-sample (average age: 23.5 years,  $SD = 7.23$ ; 74 % women) did not show significant differences in terms of sex and age with the overall sample ( $p > .05$ ). We will refer to the behavior evaluated in the first step as *Past behavior* and to the one in the second step as *Present behavior*. According to Bamberg, Ajzen and Schmidt (2003), a strong correlation between past behavior and present behavior would indicate stability in mobility behavior over time.

### Data analysis

An exploratory analysis of the data was conducted to evaluate missing values and detect extreme cases. None of the items had more than 5% missing data, and we randomly distributed them. As a result, we decided to impute missing values via the expectation-maximization method. We analyzed the existence of univariate atypical cases via standard score calculations; those with  $z$  scores greater than  $\pm 3.29$  were considered atypical (Tabachnick & Fidell, 2001). From a final examined sample of 171 cases, only a single case showed univariate atypicality. We also discarded the presence of multivariate atypical cases via a Mahalanobis distance test ( $p < .001$ ).

Secondly, we conducted a bivariate correlation analysis for validating past bicycle use behavior as a criterion variable, analyzing the association between it and present behavior. Lastly, we performed a path analysis to evaluate the TPB's fit statistic to the empirical data (Kline, 2011; Wolffe, 2003). For the analysis of symmetry and kurtosis, we considered the values between +1.00 and -1.00 as excellent, while those inferior to 1.60 as adequate (George & Mallery, 2001). For the

multivariate normality analysis, Bollen's (1989) criterion was used, which holds that whenever the value of  $p(p+2)$ , where  $p$  is the number of observed variables, is greater than Mardia's coefficient, then this assumption can be considered met. Additionally, as Rodríguez Ayán and Ruiz (2008) indicate, Mardia's multivariate index values inferior to 70 show that the departure from multivariate normality is not a critical problem for the analysis. In terms of multicollinearity, Pearson's  $r$  correlations were analyzed, with the criterion that values equal to or greater than .85 indicate multivariate collinearity (Kline, 2011). Lastly, the model's parameters were estimated using the ML method (Maximum Likelihood). Several indices were calculated to evaluate the model fit: chi square/degree of freedom ratio (CMIN/DF); comparative fit index (CFI); Goodness-of-fit index (GFI); Adjusted goodness-of-fit index (AGFI); normed fit index (NFI); root-mean-square residual (RMSR), and root-mean-square error of approximation (RMSEA) (Hu & Bentler, 1995). Acceptable values for the fit indexes were: CMIN/DF below 5; CFI, GFI, AGFI, and NFI above .90; RMSEA below .06, and RMSR below .08 (Hu & Bentler, 1999). We used the EQS 6.1 software (Bentler, 1985).

## Results

### Descriptive statistics

Table 1 presents the means, standard deviations, skewness, kurtosis, and bivariate correlations for each variable. In general, we observed that asymmetry and kurtosis indexes were adequate (George, & Mallery, 2001), supporting the existence of univariate normality. Further, Mardia's coefficient was -.94, which, according to Bollen (1989), indicates the presence of multivariate normality, as it is inferior to  $p(p+2) = 14$ .



Table 2  
Descriptive statistics of variables of TPB model regarding bicycle use behavior to commute to the university.

Variables	1	2	3	4	5
1. Intention	-				
2. Subjective norm	.60**	-			
3. Perceived behavioral control	.62**	.42**	-		
4. Attitude	.64**	.55**	.44**	-	
5. Behavior	.73**	.45**	.45**	.42**	-
Mean	3.52	3.41	4.67	5.56	0.24
SD	2.37	1.59	1.96	1.68	0.40
Skewness	0.33	0.17	-0.51	-1.12	1.21
Kurtosis	-1.53	-0.74	-0.96	0.29	-0.42

Note:

\*  $p < .05$ .

\*\*  $p < .01$ .

The analyses of correlations between TPB variables do not indicate the presence of multivariate collinearity, given that the values of the first were inferior to .85 (Kline, 2011). Table 1 shows moderate, positive and significant correlations between TPB variables and bicycle use behavior, and indicates that the strongest correlation exists with behavioral intention. Additionally, we observed positive, significant and moderate correlations between the remaining variables.

### Path analysis

Figure 1 shows the TPB model and the estimated parameters. The model displayed an excellent fit (GFI = 0.997; AGFI = 0.984; CFI = 1.000; NFI = 0.997; CMIN/DF = 0.478; RMSEA = 0.001; RMSR = 0.011). The intention to use a bicycle explained 53% of bicycle use behavior and the variables subjective norm, perceived behavioral control and attitude explained 59% of intention variance. The variables subjective norm ( $\beta = .27$ ;  $p < .001$ ), attitude ( $\beta = .34$ ;  $p < .001$ ) and perceived behavioral control ( $\beta = .35$ ;  $p < .001$ ) have a direct positive and significant effect on intention. In turn, intention directly predicts, in a positive and significant way, the use of a bicycle to commute to the university ( $\beta = .73$ ;  $p < .001$ ).

trol ( $\beta = .35$ ;  $p < .001$ ) have a direct positive and significant effect on intention. In turn, intention directly predicts, in a positive and significant way, the use of a bicycle to commute to the university ( $\beta = .73$ ;  $p < .001$ ).

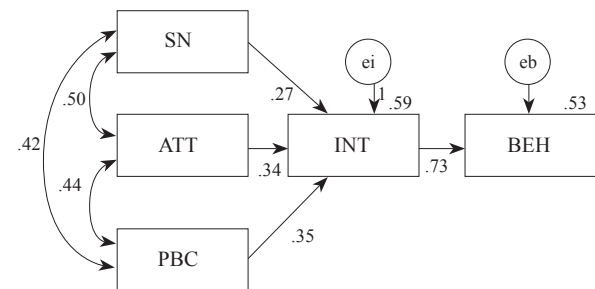


Figure 1. Path diagram for TPB model: bicycle use behavior to commute to the university showing standardized path coefficients and correlation ratios ( $N=171$ ).

Note: subjective norm; ATT: attitudes towards bicycle use; PBC = perceived behavioral control; INT= behavioral intention; BEH: bicycle use behavior.  $\chi^2$  (df) = 1.33 (3),  $p > .05$ , GFI = 0.997; AGFI = 0.984; CFI = 1.000; NFI = 0.997; CMIN/DF = 0.478; RMSEA = 0.000; RMSR = 0.011.

### Discussion

The goal of this study was to evaluate the value of TBP to explain bicycle use as a travel mode to commute to the university. In summary, the results indicate that it is an appropriate model to explain this behavior. In fact, 53% of the variance in bicycle use behavior was explained solely by behavioral intention. Further, 59% of behavioral intention was explained by its predictors: attitude towards the bicycle; subjective norm, and perceived behavioral control. The results are very much in line with previous studies that indicate the usefulness of the TPB in explaining bicycle use (Forward, 2004; de Bruijn et al., 2009; Heinen et al., 2011; Milkovic & Stambuk, 2015; Frater, Kuijer, & Kingham, 2017; Acheampong, 2017). Our results coincide especially with those of Milkovic and Stambuk (2015), who found that the model's three components explained behavioral intention with attitudes and perceived behavioral control being stronger

predictors than the subjective norm. We understand that the similarity between our study and theirs is due to the same behavior criteria (commuting to university), while others were conducted in different settings and involved other trip destinations. In a more general sense, our findings are also in line with studies that indicate the usefulness of the TPB in predicting travel and mode choice behavior for conveyance means other than the bicycle, such as the automobile (Abrahamse et al., 2009; Bamberg & Schmidt, 2003; Gardner & Abraham, 2010; Kaiser & Gutsche, 2003; Klöckner & Blöbaum, 2010) and public transportation (Thøgersen, 2006).

We should note that, as far as the authors are aware, this is the first study that uses a non-European sample. As indicated in a review of the literature on the influence of psychological factors on bicycle use (Caballero et al., 2014), the vast majority of studies in this area have taken place in Europe, where bicycle use is more common and infrastructure conditions are more favorable. Conversely, in Latin America, policies promoting bicycle use are relatively recent, and personal factors play an essential role in the selection of this transportation mode.

The present study had some limitations worth mentioning. First, given that we used an incidental sample comprised mainly of university students, the results cannot be extrapolated to the general population. Complementary studies on other populational groups are needed. Second, bicycle use behavior was evaluated using a self-reporting instrument, which implies the possibility of response bias (Nunnally & Bernstein, 1995). However, unlike previous studies (de Bruijn et al., 2009), the stability of mobility behavior was examined at two different moments in time. This shows that the model predicts not only past but also future behavior, just like Ajzen (1991) suggested.

It is the belief of the authors that the results of this study reinforce TPB's applicability in the exploration of transportation mode choice and offers some guidance for promoting bicycle use. First,

the evaluations of bicycle use (attitudes) showed their link to the intention of use. It is essential, therefore, to reinforce these attitudes through, for example, communication campaigns that associate bicycle use with enjoyment, freedom and time savings. In addition to that, it is crucial to develop the perception among individuals that this is an activity they are capable of doing. In this respect, actions to increase or reinforce perceived behavioral control are imperative. Possible interventions include raising awareness of bicycle use as an accessible activity and offering training programs or coaching to teach people to ride a bicycle in an urban environment. Lastly, beliefs of what others think (subjective norm) about bicycle use also play a central role. These beliefs can change via the promotion of social bicycle use activities, such as group rides or massive bicycling events that consolidate bicycle use as a social activity. It would be interesting for future research to take steps to evaluate the effectiveness of some of these measures.

## References

- Abrahamse, W., Steg, L., Gifford, R., & Vlek, C. (2009). Factors influencing car use for commuting and the intention to reduce it: A question of self-interest or morality? *Transportation Research Part F: Traffic Psychology and Behaviour*, 12, 317-324. Doi: 10.1016/j.trf.2009.04.004
- Acheampong, R. A. (2017). Towards sustainable urban transportation in Ghana: Exploring adults' intention to adopt cycling to work using theory of planned behaviour and structural equation modeling. *Transportation in Developing Economies*, 3(2), 18.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50, 179-211. Doi: 10.1016/0749-5978(91)90020-T

- Ajzen, I. (2002). Constructing a TPB questionnaire: Conceptual and methodological considerations. Retrieved from <http://people.umass.edu/ajzen/pdf/tpb.measurement.pdf>
- Andersen, L. B., Lawlor, D. A., Cooper, A. R., Froberg, K., & Anderssen, S. A. (2009). Physical fitness in relation to transport to school in adolescents: the Danish youth and sports study. *Scandinavian Journal of Medicine & Science in Sports*, 19(3), 406-411. Doi: 10.1111/j.1600-0838.2008.00803.x
- Bacchieri, G., Barros, A.J., dos Santos, J. V. & Gigante, D. P. (2010). Cycling to work in Brazil: users profile, risk behaviors, and traffic accident occurrence. *Accident Analysis & Prevention*, 42, 1025-1030. Doi: 10.1016/j.aap.2009.12.009
- Heinen, E., Maat, K., & van Wee, B. (2011). The role of attitudes toward characteristics of bicycle commuting on the choice to cycle to work over various distances. *Transportation Research Part D: Transport and Environment*, 16, 102-109. Doi: 10.1016/j.trd.2010.08.010
- Bamberg, S., & Schmidt, P. (2003). Incentives, morality, or habit? Predicting students' car use for university routes with the models of Ajzen, Schwartz, and Triandis. *Environment and Behavior*, 35, 264-285. Doi: 10.1177/0013916502250134
- Baumann, C., Bojacá, M., Rambeau, M., & Wanner, Z. (2013). Biciudades: un estudio regional acerca del uso de la bicicleta como medio de transporte en América Latina y el Caribe (BID informe 2013). Retrieved from <http://dl.dropboxusercontent.com/u/97075176/SPA%20REPORT%209-10-13.pdf>
- Bentler, P. M. (1985). *Theory and implementation of EQS: A structural equations program*. BMDP Statistical Software.
- Bollen, K. A. (1989). *Structural equations with latent variables*. New York, NY: John Wiley & Sons.
- Caballero, R., Franco, P., Mustaca, A., & Jakovcevic, A. (2014). Uso de la bicicleta como medio de transporte: influencia de los factores psicológicos. Una revisión de la literatura. *Revista Psico*, 45, 316-324. Doi: 10.15448/1980-8623.2014.3.17286
- de Bruijn, G.J., Kremers, S.P.J., Singh, A., van den Putte, B., & van Mechelen, W. (2009). Adult active transportation adding habit strength to the theory of planned behavior. *American Journal of Preventive Medicine*, 36, 189-194. Doi: 10.1016/j.amepre.2008.10.019
- de Geus, B., Bourdeaudhuij, I., Jannes, C., & Meeusen, R. (2008). Psychosocial and environmental factors associated with cycling for transport among a working population. *Health Education Research*, 23, 697-708. Doi: 10.1093/her/cym055
- de Geus, B., Joncheere, J., & Meeusen, R. (2009). Commuter cycling: Effect on physical performance in untrained men and women in Flanders. Minimum dose to improve indexes of fitness. *Scandinavian Journal of Medicine & Science*, 19, 179-87. Doi: 10.1111/j.1600-0838.2008.00776.x
- Dora, C., Hosking, J., Mudu, P. & Fletcher, E. R. (2011). *Urban transport and health in sustainable transport. A sourcebook for policy makers in developing cities*. Eschborn, Alemania: Deutsche Gesellschaft für Internationale Zusammenarbeit.
- Emond, C.R., & Handy, S.L. (2012). Factors associated with bicycling to high school: Insights from Davis, C. A. *Journal of Transport Geography*, 20, 71-79. Doi: 10.1016/j.jtrangeo.2011.07.008
- Fishman, E. (2015). Bikeshare: A review of recent literature. *Transport Reviews*, 36(1), 92-113. Doi: <http://dx.doi.org/10.1080/01441647.2015.1033036>
- Forward, S. (2004). The prediction of travel behaviour using the theory of planned behaviour. In T. Rothengatter and R. D. E. Huguenin (Eds.) *Traffic and Transport Psychology: Theory and Application* (pp. 481-490). Oxford: UK, Elsevier.
- Frater, J., Kuijer, R., & Kingham, S. (2017). Why adolescents don't bicycle to school: Does the

- prototype/willingness model augment the theory of planned behaviour to explain intentions? *Transportation Research Part F: Traffic Psychology and Behaviour*, 46, 250-259.
- Gardner, B. (2009). Modeling motivation and habit in stable travel mode contexts. *Transportation Research Part F: Traffic Psychology and Behaviour*, 12, 68-76. Doi: 10.1016/j.trf.2008.08.001
- Gardner, B., & Abraham, C. (2008). Psychological correlates of car use: A meta-analysis. *Transportation Research Part F: Traffic Psychology and Behaviour*, 11, 300-311. Doi: 10.1016/j.trf.2008.01.004
- Gardner, B., & Abraham, C. (2010). Going Green? Modeling the impact of environmental concerns and perceptions of transportation alternatives on decisions to drive. *Journal of Applied Social Psychology*, 40, 831-849. Doi: 10.1111/j.1559-1816.2010.00600
- George, D., & Mallery, P. (2001). *SPSS for Windows step by step: A simple guide and reference 10.0 update*. Boston: Allyn and Bacon.
- Heinen, E., Maat, K., & van Wee, B. (2011). The role of attitudes toward characteristics of bicycle commuting on the choice to cycle to work over various distances. *Transportation Research Part D: Transport and Environment*, 16, 102-109. Doi: 10.1016/j.trd.2010.08.010
- Hoevenaars-Blom, M. P., Wendel-Vos, G. W., Spijkerman, A. M., Kromhout, D., & Verschuren, W. M. (2011). Cycling and sports, but not walking, are associated with 10-year cardiovascular disease incidence: the MORGEN Study. *European Journal of Cardiovascular Prevention & Rehabilitation*, 18(1), 41-47.
- Hu, L. T., & Bentler, P. (1995). Evaluating model fit. In R. H. Hoyle (Ed.), *Structural Equation Modeling. Concepts, Issues, and Applications* (pp. 76-99). London: Sage.
- Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: a Multidisciplinary Journal*, 6(1), 1-55.
- Hunecke, M., Haustein, S., Bohler, S., & Grischkat, S. (2010). Attitude based target groups to reduce the ecological impact of daily mobility behavior. *Environment & Behavior*, 42, 3-43. Doi: 10.1177/0013916508319587
- Jakovcovic, A., Franco, P., Caballero, R., & Ledesma, R. (2015). Determinantes psicológicos de las conductas de movilidad: Un estudio de revisión. *Revista Argentina de Ciencias del Comportamiento*, 7(2), 59-76.
- Kaiser, F., & Gutsche, H. (2003). The proposition of a general version of the theory of planned behavior: predicting ecological behavior. *Journal of Applied Social Psychology*, 33, 586-603. Doi: 10.1111/j.1559-1816.2003.tb01914.x
- Kline, R. B. (2011). *Principles and practice of structural equation modeling*. (3rd. Ed.). New York: Guilford Press.
- Klößner, C. A., & Blöbaum, A. (2010). A comprehensive action determination model: Toward a broader understanding of ecological behaviour using the example of travel mode choice. *Journal of Environmental Psychology*, 30, 574-586. Doi: 10.1016/j.jenvp.2010.03.001
- Mann, E., & Abraham, C. (2012). Identifying beliefs and cognitions underpinning commuters' travel mode choices. *Journal of Applied Social Psychology*, 42, 2730-2757. Doi: 10.1111/j.1559-1816.2012.00959.x
- Milkovic, M., & Stambuk, M. (2015). To bike or not to bike? Application of the theory of planned behavior in predicting bicycle commuting among students in Zagreb. *Psihologijske teme*, 24(2), 187-205.
- Moudon, A. V., Lee, C., Cheadle, A. D., Collier, C. W., Johnson, D., Schmid, T. L., & Weather, R. D. (2005). Cycling and the built environment, a US perspective. *Transportation Research Part D: Transport and Environment*, 10, 245-261. Doi: 10.1016/j.trd.2005.04.001

- Nkurunziza, A., Zuidgeest, M. H. P., Brussel, M. J. G., & van Maarseveen, M. F. A. M. (2012). Examining the potential for modal change: motivators and barriers for bicycle commuting in Dares-Salaam. *Transport Policy*, 24, 249-259. Doi: 10.1016/j.tranpol.2012.09.002
- Nunnally, J., & Bernstein, I. (1995). *Teoría Psicométrica*. México: Mc Graw Hill.
- OICA (2014). World vehicles in use - all vehicles. Retrieved from <http://www.oica.net/wp-content/uploads//total-inuse-2014.pdf>
- Parkin, J., Wardman, M., & Page, M. (2008). Estimation of the determinants of bicycle mode share for the journey to work using census data. *Transportation*, 35, 93-109. Doi: 10.1007/s11116-007-9137-5
- Pucher, J., & Buehler, R. (2008). Making Cycling Irresistible: Lessons from The Netherlands, Denmark and Germany. *Transport Reviews*, 28, 495-528. Doi: 10.1080/01221640701806612
- Ríos Flores, R. A., Taddia, A. P., Pardo, C., & Lleras, N. (2015). Ciclo-inclusión en América Latina y el Caribe: Guía para impulsar el uso de la bicicleta. Banco Interamericano de Desarrollo (BID). Retrieved from <http://publications.iadb.org/handle/11319/6808>
- Rodríguez Ayán, M. N., & Ruiz, M. A. (2008). Ate- nuación de la asimetría y de la curtosis de las puntuaciones observadas mediante transfor- maciones de variables: Incidencia sobre la es- tructura factorial. *Psicológica*, 29, 205-227.
- Rondinella, G., Fernandez-Heredia, A., & Monzón, A. (2012). *Analysis of perceptions of utilitarian cycling by level of user experience*. Paper pre- sented at Transportation Research Board 91st Annual Meeting, Washington, DC.
- Tabachnick, B. G., & Fidell, L. S. (2001). *Using Mul- tivariate Statistics*. Boston: Allyn and Bacon.
- Tapia Granados, J. A. (1998). La reducción del trá- fico de automóviles: una política urgente de promoción de la salud. *Revista Panamericana de Salud Pública*, 3, 137-151.
- Thogersen, J. (2006). Understanding repetitive travel mode choices in a stable context: A panel study approach. *Transportation Research Part A: Po- licy and Practice*, 40, 621-638. Doi: 10.1016/j. tra.2005.11.004
- Titze, S., Stronegger, W.J., Janschitz, S., & Oja, P. (2007). Environmental, social, and personal correlates of cycling for transportation in a student population. *Journal of Physical Activity and Health*, 4, 66-79.
- Titze, S., Stronegger, W.J., Janschitz, S., & Oja, P. (2008). Association of built-environment, so- cial-environment and personal factors with bicycling as a mode of transportation among Austrian city dwellers. *Preventive Medicine*, 47, 252-259. Doi: 10.1016/j.ypmed.2008.02.019
- Universidad de Buenos Aires (2011). Censo de es- tudiantes 2011. Retrieved from <http://www. uba.ar/institucional/censos/Estudiantes2011/ estudiantes2011.pdf>
- Wolfe, L. M. (2003). The introduction of path analy- sis to the social sciences, and some emergent themes: An annotated bibliography. *Structural Equation Modeling*, 10, 1-34. Doi: [http://dx.doi. org/10.1207/S15328007SEM1001\\_1](http://dx.doi. org/10.1207/S15328007SEM1001_1)

**Date of receipt: August 1<sup>st</sup>, 2018**

**Approved date: January 1<sup>st</sup>, 2019**