Pedestrians' Beliefs about Road Crossing in Bogotá: Questionnaire Development*

Puntos de Vista de peatones en un cruce de vías en Bogotá: desarrollo de cuestionario

Recibido octubre 13 de 2011 |Revisado mayo 20 de 2012 | Aceptado octubre 10 de 2012

Lope Hugo Barrero **
Leonardo A. Quintana ***
Alfonso Sánchez ****
Alejandro Forero *****
Julián Quiroga ******
Pontificia Universidad Javeriana, Bogotá
Sarah Felknor *******
University of Texas, Houston, Texas, United States

doi:10.11144/Javeriana.UPSY12-2.pbrc

Para citar este artículo: Barrero, L. H., Quintana, L. A., Sánchez, A., Forero, A., Quiroga, J. & Felknor, S. (2013). Pedestrians' Beliefs about Road Crossing in Bogotá: Questionnaire Development. *Universitas Psychologica, 12*(2), 433-444.

* Acknowledgements: This project was funded in part by a grant from the National Institute of Health Fogarty International Center, grant number 5 D43 TW007564. The authors thank Drs. George Delclos and Bahman Roudsari for the invaluable comments at the early stages of this study. The authors also wish to thank the School of Public Health and the Southwest Center for Occupational and Environmental Health of the University of Texas – Houston, for their support during all stages of this study.

** Pontificia Universidad Javeriana, Bogotá. ScD. Pontificia Universidad Javeriana, Departament of Industrial Engineering. Carrera 7 # 40-62, Bogotá. Phone Number (57) (1) 3208320 ext. 5287. E-mail: lopehugo@javeriana.edu.co

*** Pontificia Universidad Javeriana, Bogotá. PhD. Departament of Industrial Engineering.

**** Pontificia Universidad Javeriana, Bogotá. MSc. Departament of Psychology.

***** Pontificia Universidad Javeriana, Bogotá. MEng. Departament of Electronic Engineering.

****** Pontificia Universidad Javeriana, Bogotá. MEng. Departament of Electronic Engineering.

******* University of Texas. PhD. Faculty of Public Health.

Abstract

Understanding the pedestrian choices is essential for the design of safe road systems. This study develops methods for self-reported assessment of pedestrian behavior. A self-report instrument was developed to investigate the Theory of Planned Behavior (TPB) constructs in relation to pedestrians' road crossing using a convenient sample. Internal consistency and factor analysis were conducted to test the reliability and construct validity of the instrument. Self-reported intention to execute risky behavior was compared with observed behaviors. The developed questionnaire showed high internal consistency for most of the TPB constructs (Chronbach's alpha>0.7). Factor analyses confirmed that questions grouped in constructs, as hypothesized. Pedestrians' intention to execute risky behavior was related to pedestrians' perceived physical capability and to the simultaneous crossing of other pedestrians. However, this intention correlated moderately with observed risky behavior (R_s=0.35). The potential to understand the mechanisms of pedestrian choices using the developed instrument are considered exploratory, yet promising.

Key words authors
Behavior, Developing Nations, Pedestrian, Self-report Methods, Theory of Planned Behavior
Key words plus
Quantitative Research, Transit Psychology, Psychological Test.

Resumen

El poder entender las decisiones que toma un peatón es esencial para el diseño de sistemas viales seguros. Este estudio desarrolla métodos para la medición del comportamiento del peatón por medio de auto-reportes. Se desarrolló un instrumento de auto-reporte para investigar los constructos de la Teoría del Comportamiento Planeado (TPB, por sus siglas en inglés) en relación al cruce de las vías por parte de los peatones, usando una muestra conveniente. Se condujeron análisis de consistencia interna y de factores para probar la confiabilidad y validez de constructos del instrumento. La intención auto-reportada de ejecutar comportamientos riesgosos fue comparada con los comportamientos observados. El desarrollo del cuestionario mostró una alta consistencia interna para la mayoría de los constructos del TPB (alfa de Cronbach > 0.7). El análisis de factores confirmó que las preguntas se agrupaban en constructos, tal y como se hipotetizó; la intención de los peatones de ejecutar comportamientos riesgosos estuvo relacionada con

la posibilidad física percibida por los peatones y con el cruce simultáneo de otros peatones. Sin embargo, esta intención se correlacionó solo moderadamente con el comportamiento riesgoso observado ($R_s = 0.35$). En conclusión, el potencial para entender los mecanismos de las elecciones de los peatones, usando el instrumento desarrollado, se considera aún exploratorio, pero sin embargo prometedor.
Palabras clave autores
Comportamiento, métodos de auto-reporte, naciones en desarrollo, peatón, Teoría del Comportamiento Planeado.
Palabras clave descriptores
Investigación Cuantitativa, Psicología del transito, pruebas psicológicas.

Introduction

Pedestrians are one of the most vulnerable groups of road users around the world. The situation is more concerning in developing countries, where large increments in the number of victims are expected based on current trends (World Health Organization [WHO], 2009). In Colombia, approximately 6,000 and 40,000 persons die and are injured every year as a result of motor vehicle crashes; 31.5% and 27.1% of all those deaths and injuries respectively were pedestrians (Instituto Nacional de Medicina Legal y Ciencias Forenses [INMLCF], 2007). In Bogotá only, there were 35,800 crashes in year 2007 that resulted in about 527 deaths and 27,472 injuries (Fondo de Prevención Vial, 2007). Out of these deaths occurring in Bogotá, 56% were pedestrians. Thus, the investigation of the causes of these events in which pedestrians are involved should be guaranteed.

Pedestrian-vehicle crashes may result from an interaction of traffic-related variables, contextual variables (e.g., environmental conditions), infrastructure and characteristics of road users, (Peden et al., 2004). The assessment of the relative importance of such factors has been attempted mainly through retrospective assessment of crash circumstances (e.g., Lee & Abdel-Aty, 2005; Ryb, Dischinger, Kufera & Soderstrom, 2007) and the assessment of road user response under hypothetical scenarios (e.g., Factor, Mahalel & Fair, 2007; Parker, West, Stradling & Manstead, 1995). While the former approach allows the assessment of real conditions, it is limited by the information that can be collected retrospectively or the resources and time required by analyzing sufficient number of cases. On the other hand, the assessment of behavior under hypothetical circumstances allows a systematic assessment of road users' responses under a variety of stimuli; however, the responses under such conditions can differ from responses under factual conditions.

Another approach consists in studying determinants of road user's behaviors under real conditions. In the specific case of pedestrians, the studies using this approach observe pedestrians on the streets by using video-recordings in order to extract information such as age and gender of pedestrians, and whether pedestrians were accompanied with other people (e.g., Das, Manski & Manuszak, 2005; Rosenbloom, Nemrodov & Barkan, 2004; Tiwari, Bangdiwala, Saraswat & Gaurav, 2007).

Subsequently, they report differences in behaviors depending on those basic characteristics. The assessment of determinants of observed behaviors related to more detailed personal characteristics of pedestrians (e.g., demographics, attitudes, motivations and intentions when using the roads, beliefs about the road system), require that they are approached and interviewed after completing the behaviors of interest in order to acquire this type of information. This approach results appealing because it allows to study in more detail the reasoning of pedestrians' choices, and perhaps to build mechanistic hypothesis for those choices under real conditions. This approach has been attempted only by a few studies, which have obtained important results about the factors that determine the risks that pedestrians are willing to accept when crossing urban roads (Hamed 2001; Keegan & O'Mahony, 2003; Räsänen, Lajunen, Alticafarbay & Aydin 2007).

Hamed (2001) reported that the level of risk that is accepted by pedestrians increases, as measured by the waiting time to cross urban streets in Amman, Jordan, if pedestrians: are men, are younger, are in their way to work, do not have children in their households, do not drive a private car, cross the assessed road frequently or cross with other pedestrians. Räsänen et al. (2007) reported that a

higher frequency of visits to the geographical area of interest was significantly related to the choice of not using bridges in urban sites of Ankara, Turkey. In their study, they found that feeling safe was a minor predictor of the bridge use and was unimportant if the time required to cross the bridge was too large; and that gender or age were not related to the choice to use or not the bridge.

Keegan and O'Mahony (2003) assessed whether pedestrians in Dublin, Ireland were more likely to wait for the right time to cross after the installation of a countdown pedestrian light, increasing the pleasantness of a cross, as a response to the reduction in the uncertainty about the waiting time to cross. The study showed convincingly that a higher proportion of pedestrians crossed at the proper times after the installation of the lights. Also, the study reported that nearly 35% of those pedestrians who did not wait for the proper time to cross explained that they thought it was safe to cross; and another 30% explained that they were in a hurry, and that nearly 40% of pedestrians who did wait explained that they did it for "fear/danger".

These studies have contributed to the understanding of pedestrians' choices when using the road system. However, their results are likely more applicable to the specific road traffic conditions and characteristics of individuals. Furthermore, the number of potential personal predictors that were studied was relatively small, and the validity of the used questions is unknown. In the present study, we report the development of a self-report instrument to assess detailed pedestrian beliefs and intentions to execute risky behavior after having completed a road cross in two urban busy sites in Bogotá, Colombia. We studied the reliability of the developed instrument and attempted to compare their results to observed behaviors with a convenient sample.

Methods

Subjects

The base population of this study includes adult (18 to 60 years old) men and women pedestrians who crossed roads at noontime in two busy urban pedestrian crossing sites in Bogotá, Colombia during a non-rainy weekday. The participants were recruited through fliers that were handed out on the streets. Pedestrians were offered a gift certificate as a compensation to participate. All procedures were approved by the IRB of the School of Public Health of the University of Texas in Houston and the Pontificia Universidad Javeriana.

Data collection

This was an observational study consisting of two consecutive data collection moments at two locations of pedestrian road crossing. The data collection at both locations was planned to recruit pedestrians immediately after crossing the street, video-tape the cross from an adjacent building, and interview pedestrians about their behavior. The locations considered for this study included those with high frequency of pedestrian crossing; and those that allowed for video-camera recording from above street level (Figure 1). For the first location, pedestrians were asked to contact our research group for an appointment at our school laboratory. During the appointment, the participating pedestrians were asked to identify themselves in the videos of the day that fliers were distributed, based on the approximate crossing times. For the second location, pedestrians had the option to respond to the interview on the street right after receiving the flier or to make an appointment for a later interview at our laboratory. At the second location, the identification of pedestrians was conducted by our team based on information about the approximate crossing time, and recorded the information about clothing of participating pedestrians.

Self-report instrument development: A goal was set to develop an instrument to measure constructs of the Theory of Plan Behavior (TPB) (i.e., pedestrians' attitudes, perceived control and subjective norms) (Ajzen, 1991). Questions were formulated to assess pedestrians' behavior within the context of a hypothetical scenario that was developed to closely match the real-life street-crossing

Figure 1. Sites of field methods testing
Source: own work

situation in the present study. The instrument also aimed to assess general beliefs about Bogotá's traffic system, risk-taking attitude of respondents under other daily life activities, and circumstances of the observed cross.

The instrument development was conducted in three stages: 1) generation of initial pool of items; 2) item reduction; and 3) internal consistency and construct validity testing. Sources for items included questions reported in previous studies (Ajzen, 2006; Evans & Norman, 2003; Moyano 1997). The items were reviewed for grammar and were tested with a convenient sample of faculty members, administrative staff, cleaning staff and students using cognitive interviews (Tourengeau, Rips & Rasinski, 2000).

The item reduction was conducted after the first moment of data collection. Item selection was conducted considering total item correlation of questions within the same construct; and a comparison was conducted of the total item correlation of each question with other questions in the same sub-construct, and with other questions in the same construct. Internal consistency and construct validity was conducted after the second moment of data collection with the items that remained in the questionnaire after the first moment of data collection. Chronbach's alpha coefficients were estimated for each construct and sub-construct in the questionnaire. Lastly, a factor analysis was conducted to confirm whether questions tended to group together in the hypothesized constructs.

Analysis of determinants of risky behavior and intention to execute risky behavior

An exploratory analysis with a convenient sample was conducted to assess the association of pedestrians' self-reported beliefs with the pedestrians' self-reported intentions to execute risk behavior, and with pedestrians' observed behavior. Linear regression models were created to test the model presented in Figure 2. Independent variables of interest include demographic variables, and constructs and sub-constructs of the TPB as investigated in this study (questions measuring the same construct were averaged to estimate the tested variable). Unadjusted and adjusted models were tested systematically using step-wise forward procedures.

The intention to execute risky behavior was measured with a question asking whether the person would cross the street under a hypothetical scenario and a 100 mm VAS response: "You are in the sidewalk of a road of the city of Bogotá. You are going to some place such as the bank, your job or your home to run personal or business errands. To do this, you have to get to the opposite site of the sidewalk in which you are. The road you need to cross is relatively busy, it has two lanes in the same direction for buses, trucks, taxis and automobiles. Although cars are passing by, you decide to cross right there." This scenario was adapted from scenarios described in previous studies (Holland & Hill, 2007; Moyano, 1997), and was similar to the

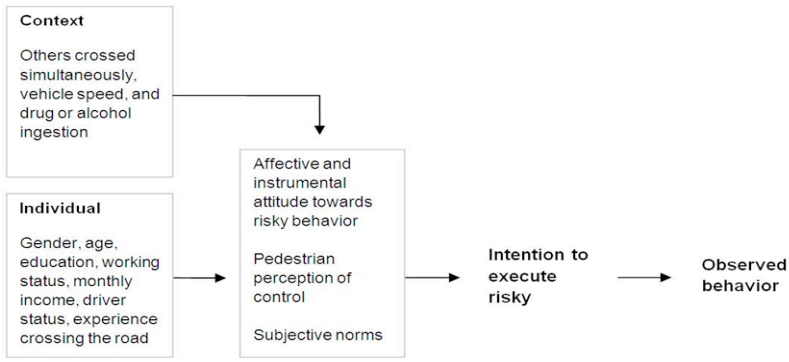

Figure 2. Conceptual causal model based on Theory of Planned Behavior (TPB).
Source: own work

real scenario that pedestrians had faced when crossing the road at the locations of the present study.

The actual behavior was evaluated based on the video of the participant pedestrian. In the videos, an experienced analyst watched for specific pedestrian behaviors that may be considered hazardous or that may measure the possibility of vehicle-pedestrian conflict (Barrero, 2013): Pedestrian crossed running, crossed through non-designated places (i.e., out of the marked zebra) or crossed at less than 2 meters from a moving vehicle. Because sometimes the participant pedestrian could not be identified in the videos, the sample size for this analysis was reduced to 20 participants.

Results

Self-report instrument: An instrument to investigate TPB constructs was developed and refined from an initial set of 141 items (Figure 3). After the first moment of data collection, a questionnaire of 81 questions (applied between 15 and 20 minutes) was proposed and tested in the second moment of data collection. Using the pooled responses at the two moments, a factor analysis was conducted to confirm the hypothesized construct grouping of the questions. A final questionnaire with 71 questions was proposed after excluding questions that did not seem to measure the constructs of interest. To avoid social desirability and deviation bias, (Streiner & Norman, 2003), we emphasized in the anonymity nature of the responses and we trained the interviewers to not show emotions to participants' responses. Also, to reduce cognitive demands on respondents, we used a limited number of end-anchors of the response scales. However, to avoid acquiescence bias (Streiner & Norman, 2003), not always marking at the right side of the scale meant a proper behavior. Lastly, to prevent that answers were given based on previous responses, we placed one question per page and spaced out questions within the same sub-construct throughout the questionnaire.

Generally, Chronbach's alpha coefficients for sub-constructs were above 70. However, internal consistency of the full construct was not high for the affective attitude towards a risky behavior (31.2) and for the subjective norms constructs (41.6), which was somewhat expected, considering the variety of aspects included in those constructs.

Pedestrian attitudes, perceived control, and subjective norms and their relation to intention to execute a risky behavior:

A description of the sample for this analysis is presented in Table 1. Individuals were generally young and mostly educated. Most people in the sample (64%) reported to execute the observed cross at least once a week.

Regarding the self-report about the more important individuals in one's life, 25 out of 40 persons included mothers as the most important person. In contrast, sons/daughters were not a frequent refer-

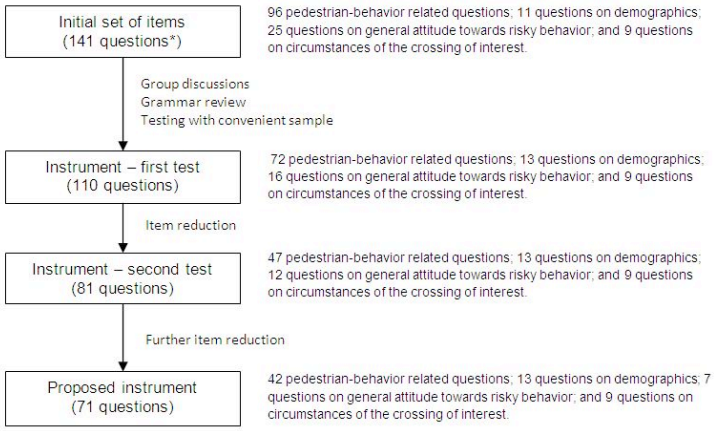

Figure 3. Development of self-report-based instrument
Source: own work

ent, even among those who were the head of their families. Similarly, husband/wife and friends or members of the community were not an important behavioral referent.

Pedestrians reported to have only moderate intention to cross in a risky way as described in the scenario ($M = 48.1$, $SD=33.8$) (Table 2). The individuals reported to have a bad attitude towards the proposed road-crossing scenario (low scores in the range from 0 to 100). Also interviewed pedestrians would not feel good by crossing as depicted and recognized that it could result in grave injuries. Similarly, on average pedestrians reported that crossing as described does not necessarily save time or energy, or if it does, they reported that this consequence was unimportant. In contrast, individuals reported moderate levels of capability to cross as described in the scenario, and agreed moderately with the statement that crossing as described is easier when other people cross simultaneously. Lastly, participants reported that the authority could help preventing risky crossings (Table 2).

The unadjusted association analyses indicated that all the TPB constructs were related to the intention to execute a risky behavior. Demographic variables generally showed strong, although no significant associations (Table 3, unadjusted). Men, in particular, reported being more willing to cross as described in the scenario. The adjusted analyses revealed that among all TPB constructs, only the perceived capability of individuals and the belief that it is safer to cross when other individuals cross, were positively related to the intention to cross in a risky way (Table 3, partially adjusted). Lastly, only BMI was related to such intention above the effect of the two significant TPB constructs (Table 3).

Video-based pedestrian behavior and its relation to intention to execute risky behavior:

About the exploratory association between intended and observed behavior, we could study only one of the measures of risky behavior (i.e., pedestrians crossing through designated places vs. crossing through non-designated places), as there was too little variability in the other measures. Self-reported intention to execute risk behavior was positively but only moderately associated with the observed crossing through non-designated locations (Spearman's rank correlation=0.35, p=0.13).

Discussion

This study aimed to develop self-report methods for pedestrian behavior research in urban settings. The ultimate goal was to design a detailed instrument that could help to investigate how pedestrians make decisions when using roads. The developed instrument showed high internal consistency and

Table 1
Characteristics of individuals by moments of data collection

	First moment		Second moment		Total	
	N	*M (SD) or %*	*N*	*M (SD) or %*	*N*	*M (SD) or %*
Age range	11		29		40	
% of persons 18 to 20 years old		0		17.3		12.5
% of persons 21 to 30 years old		45.5		55.2		52.5
% of persons 31 to 40 years old		18.2		6.9		10
% of persons 41 to 50 years old		0		6.9		5
% of persons 51 to 60 years old		27.3		6.9		12.5
% of persons > 60 years old		9.1		6.9		7.5
Mass (Kg)	11	59.2 (10.5)	28*	65.9 (11.1)	39*	64 (11.3)
BMI (Kg / m^2)	11	21.6 (3.3)	28*	23.3 (4.1)	39*	22.8 (3.9)
Gender	11		29		40	
% of women		36.4		55.2		50
Years of education	11		29		40	
% of persons with 0-11 years		9.1		20.7		17.5
% of persons with >11 - 16 years		18.2		75.9		60
% of persons with >16 years		72.7		3.5		22.5
Work status	11		30		41	
% who have a job		81.9		55.3		62.6
Crossing circumstances	10		25		35	
% coming from running errands		40		37.9		38.5
% going to run errands		30		44.8		41
Time pressure	-	-	24		24	
% who were in a hurry	-	-		10		10
How representative the observed crossing is	10		23		33	81.8
% crossing always as observed		70		87		81.8
Experience doing the crossing	10		25		35	
% doing the cross everyday		50		31		35.9
% doing the cross at least one day/weekday		40		24		28.1
% doing the cross once a month		10		24.1		20.5
% doing the cross for the first time		0		3.5		2.6
Risk perception of crossing	10		24		34	
% saying the crossing was no dangerous at all		30		41.7		38.2
% saying the crossing was not very dangerous		50		16.7		26.5
% saying the crossing was moderately dangerous		10		37.5		29.4
% saying the crossing was very dangerous		10		4.2		5.9
Head of the family						
% persons who are head of the family	11	36.4	29	34.5	40	35

Source: own work

construct validity to measure the constructs of the Theory of Plan Behavior. Lastly, the self-reported intention to execute risky behavior showed moderate strength in the association with pedestrian

Table 2
Attitudes, perceived control, subjective norms and intention to execute risky behavior

Construct	Sub-construct	First moment M (SD) N=11	Second moment M (SD) N=29	Total M (SD) N=40
Intention to execute risky behavior		52.2 (37.5)	46.5 (32.8)	48.1 (33.8)
Affective attitude	Feeling good	23.8 (23.7)	20 (15.5)	21 (17.9)
	Not being injured	3.5 (7)	1.4 (2.8)	2 (4.4)
	Being able to cross calmly	8.5 (6.4)	23 (29.8)	19 (26.3)
	Avoiding robbery	51.4 (31.9)	31.4 (26.8)	36.9 (29.3)
Instrumental attitude	Saving time /energy	31.1 (30.5)	20.7 (23.2)	23.6 (26.5)
Perceived control	Physical capability	44.6 (29.7)	37 (27.)	39.1 (28.2)
	Existence of infrastructure	21.7 (15.6)	24.6 (24.9)	23.8 (22.6)
	Other people crossing	47.1 (36.1)	43.1 (28.2)	44.4 (30.2)
	Authority	6.8 (9.3)	13.6(14.2)	11.8 (13.3)
Subjective norms	Other pedestrians	13.7 (18)	23.6 (27.1)	20.9 (25.1)
	Drivers	2.5 (4.8)	12.3 (23.8)	9.6 (20.8)
	Important persons in one's life	0.4 (0.5)	1.3 (3.1)	1.1 (2.7)
General attitude towards risk		19.4 (10.2)	34.4 (20.7)	30.3 (19.5)

All means are standardized to have a range from 0 to 100. Higher means can be interpreted as representing a more accepting attitude towards risky behavior, a higher perceived control to execute risky behavior and a less important subjective norm referent when crossing an urban road.
Source: own work

hazardous behavior, namely the cross through non-designated areas.

Assessment of pedestrian's beliefs, behaviors and their relation is essential to develop effective human-based solutions for the roads (Factor Mahalel & Fair, 2007; Parker, Manstead, Stradling & Reason, 1995). In Colombia, two studies have attempted to describe the road users' behaviors (Moncada 2008);Fondo de Prevención Vial, 2006). These studies found that pedestrians know traffic norms and perceive the risk associated with using roads. However, they frequently do not use those norms as referent for behavior. These results represent a progress in the understanding of road users' behaviors. However, little detailed information was presented and no information was reported on the psychometric characteristics of the employed instruments.

In the present study we developed and validated a methodology to assess, simultaneously, the pedestrians' attitudes, the perceived control and subjective norms as well as the actual behavior when crossing urban roads. The instrument incorporated a heterogeneous group of sub-constructs in order to explain road users' behaviors (Conner et al. 2007; Evans & Norman,2003; Holland & Hill, 2007; Moyano, 1997; Parker, Manstead, Stradling & Reason 1992). Although the instrument can be administered in about 15 minutes, it may still be considered long. Nevertheless, to our knowledge this may be one of the few instruments in Spanish for the *in-depth* assessment of pedestrian behavior fitted to urban conditions in the developing world, for which psychometric properties are known.

We were able to use video-based information and self-reported information to document beliefs of road users in Bogotá about the traffic system, and identify the potential determinants of intention to execute a risky behavior with a non-probabilistic sample. The perceived physical capability to cross in a risky way and the simultaneous crossing of other pedestrians was related to the intention to execute a risky behavior. This may be explained by previously proposed mechanisms about pedestrians' decision-making process. First, pedestrians seem to incorporate a function of vehicle speed-distance (te

Table 3
Relation of individual characteristics and TPB constructs with intention

Construct/ Sub-construct		Un-adjusted†	Partially adjusted‡	Fully adjusted¶
		β* (95% CI) (N=40)	β (95% CI) (N=40)	β (95% CI)
Range of age				
>50		-22.7 (-49.1 – 3.7)		-
30-50		6.1 (-21.6 – 33.9)	NA	-
<30		0		-
Gender				
Women		-24.6 (-44.3 – -4.9)	NA	-
Men		0		-
Education (years)		-0.41 (-3.4 – 2.6)	NA	-
BMI (Kg / m2) (n=39)		-0.3 (-3.1 – 2.4)	NA	1.6 (0.4 – 2.9)
Being head of the family				
Yes		-15.8 (-37.5 – 5.8)	NA	-
No		0		
Experience crossing the road (n=34)		-3.3 (-12.1 – 5.4)	NA	-
A few days a month or less frequently		-11.8 (-40.1 – 16.4)	NA	-
At least one day per week		5.3 (-21.4 – 31.9)	NA	-
Every day or almost every day		0	NA	-
Time pressure (n=24)				
Was not in a rush		-2.8 (-38.9 – 33.4)	NA	-
Was in a rush		0		
Work status				
Does have a job		-10.9 (-32.5 – 10.8)	NA	-
Does not have a job		0		
General attitude towards risk		0.7 (0.1 – 1.2)	NA	
Affective attitude	Feeling good	1.4 (1.1 – 1.8)	0.1(-0.5 – 0.7)	NA
	Not being injured	1.6 (-0.8 – 4)	0.1 (-1.4 – 1.5)	NA
	Being able to cross calmly	0.3 (-0.1 – 0.7)	-0.2 (-0.4 – 0.1)	NA
	Avoiding robbery	0 (-0.3 – 0.4)	-0.1 (-0.3 – 0.1)	NA
Instrumental attitude	Saving time /energy	0.9 (0.5 – 1.2)	-0.2 (-0.6 – 0.2)	NA
Perceived control	Physical capability	1 (0.8 – 1.2)	0.9 (0.5 – 1.4)	0.9 (0.7 – 1.1)
	Existence of infrastructure	0.8 (0.4 – 1.2)	0.3 (-0.1 – 0.7)	NA
	Other people crossing	0.8 (0.5 – 1)	0.3 (-0 – 0.5)	0.3 (0.1 – 0.5)
	Authority	1.1 (0.4 – 1.8)	0.3 (-0.2 – 0.9)	NA
Subjective norms	Other pedestrians	0.6 (0.2 – 1)	-0.3 (-0.6 – 0.1)	NA
	Drivers	0 (-0.5 – 0.6)	0.2 (-0.1 – 0.4)	NA
	Important persons	2.5 (-1.5 – 6.4)	1.2 (-1.1 – 3.5)	NA

Significant results at the 0.05 significance level in bold letters; * Lineal regression coefficients; NA: Variable not considered in the analysis
† Each one of the variables is related separately to intention to execute risky behavior
‡ All TPB constructs are included in the model simultaneously
¶ Significant TPB construct is adjusted for relevant demographic variables
Source: own work

Velde, van der Kamp, Barela & Salvesbergh, 2005). Pedestrians compare expected time to vehicle arrival with the expected time that they would take to cross (Hamed, 2001). Therefore, it is reasonable to think that a construct measuring pedestrian perceived physical capability to cross a road, would also reflect on their final intention to cross. Second, it has been shown that drivers are more likely to stop when more pedestrians cross the road simultaneously (Katz, Zaidel & Elgrishi, 1975). This may have been learned by pedestrians, which may affect their intention to cross in a risky situation.

Other factors such as the recognition that potential injuries could occur when crossing in a risky manner and the positive influence that can be exerted by important persons in the participants' lives were not related significantly with the participants' intention to execute a risky behavior. This was unexpected and should be further investigated with a representative sample. The results suggest that recent campaigns such as those using black stars painted on the roads where road users have died, or asking road users to think of their families to prompt responsible use of the road may not be effective to change the intention to execute a risky behavior. Instead, campaigns that are oriented to teach pedestrians over their senses and their perceived capabilities and how they can be misleading, may have a stronger impact on their intention to execute a risky behavior.

We also examined the association between the intended and actual behavior. We found that the intention did not explain an actual behavior as measured by the act of crossing through non-designated areas. Although this analysis was limited by the sample size and the number of pedestrians crossing in a risky way, we observed a moderate association between the intention and actual behavior. We believe this moderate association is likely due to the lack of complete correspondence between the scenario used to measure intention and our measure of risky behavior, than to the presence of bias on the self-reported intentions. This explanation is supported by the fact that 80% of the individuals reported that the cross they did was not dangerous, which does not correspond with the presented scenario; and also considering the methodological precautions we took to reduce social desirability bias. Future studies, where pedestrians are faced to more hazardous crossings, would allow confirming whether the moderate association between intended and actual behavior is due to the absence of correspondence between our measures of intended and actual behavior.

The sample of pedestrians in our study cannot be considered representative. Pedestrians participated on voluntary basis and were required to spend on average 20 minutes from their busy lives. Therefore, it can be argued that the internal consistency and construct validity that was achieved in this study cannot be generalized to other adult populations that cross similar urban streets in a city like Bogotá. The same can be said about the results that we obtained about the factors that more strongly determine the intention to execute a risky behavior. Nevertheless, our sample can be considered heterogeneous. Various groups of pedestrians in terms of age groups, gender, level of education, employment status, among others were represented. Indeed, 8% of the recruited individuals reported to be in a rush. This is important because those who were in a rush may be more prompted to execute a risky behavior (Räsänen et al., 2007). It is also reassuring that the resulting associations were strong and significant, in spite of the small sample size; and that associations were in the expected direction. Altogether, we recommend the use of our questionnaire making efforts to achieve and document participation rates that assure representative results.

Conclusions

Reliable methods for in-depth and valid analysis of self-reported pedestrian behavior are needed. In this study, we developed a self-report-based instrument, which showed good internal consistency and construct validity with a convenient sample of pedestrians in the city of Bogotá; and moderate agreement with observed behaviors in the same convenient sample. The potential to understand mechanisms of pedestrian choices with the developed instrument are promising. However, at

this stage these results are considered exploratory. Further improvements may be required to reduce the length of the instrument.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211.

Ajzen, I. (2006). Constructing a TpB questionnaire: Conceptual and methodological considerations. *Time 2002* (June 5), 1-3. Retrieved March 13, 2009, from http://people.umass.edu/aizen/tpb.html

Barrero, L.H. Sánchez A., Forero, A., Quiroga, J.A., Romero, N.S., Calderón, F.C. et al., (2013). "Video-based pedestrian behavior assessment in Colombia: Development and testing of methods." Submitted to *Revista de Salud Pública*.

Conner, M., Lawton, R., Parker, D., Chorlton, K., Manstead, A. S. R. & Stradling, S. (2007). Application of the theory of planned behavior to the prediction of objectively assessed breaking of posted limits. *British Journal of Psychology, 98*(3), 429-453.

Das, S., Manski, C. F. & Manuszak, M. D. (2005). Walk or wait? An empirical analysis of street crossing decisions. *Journal of Applied Econometrics, 20*(4), 529-548.

Evans, D. & Norman, P. (2003). Predicting adolescent pedestrians' road-crossing intentions: an application and extension of the Theory of Planned Behavior. *Health Education Research, 18*(3), 267-277.

Factor, R., Mahalel, D. & Fair, G. (2007). The social accident: A theoretical model and research agenda for studying the influence of social and cultural characteristics on motor vehicle accidents. *Accident Analysis & Prevention, 39*(5), 914-921.

Fondo de Prevención Vial. (2006). *Diagnóstico de la movilidad y la cultura ciudadana en ciudades con SITM.* Bogotá: Author.

Fondo de Prevención Vial. (2007). *Accidentalidad vial en Colombia 2007.* Bogotá: Author.

Hamed, M. M. (2001). Analysis of pedestrian's behavior at pedestrian crossings. *Safety Science, 38*(1), 63-82.

Holland, C. & Hill, R. (2007). The effect of age, gender and driver status on pedestrian's intention to cross the road in risky situation. *Accident Analysis & Prevention, 39*(2), 224-237.

Instituto Nacional de Medicina Legal y Ciencias Forenses. (2007). *Forensis 2006. Datos para la vida.* Bogotá: Montes S.A.

Katz, A., Zaidel, D. & Elgrishi, A. (1975). An experimental study of driver and pedestrian interaction during the crossing conflict. *Human Factors, 17*(5), 514-527.

Keegan, O. & O'Mahony, M. (2003). Modifying pedestrian behavior. *Transportation Research Part A: Policy and Practice, 37*(10), 889-901.

Lee, C. & Abdel-Aty, M. (2005). Comprehensive analysis of vehicle-pedestrian crashes at intersections in Florida. *Accident Analysis & Prevention, 37*(4), 775-786.

Moncada, C. A. (2008). *Análisis de la vulnerabilidad y la percepción de riesgo de los actores involucrados en la vía para las ciudades de Bogotá, Medellín, Cali, Barranquilla, Cúcuta, Pasto, Manizales e Ibagué.* Bogotá: Fondo de Prevención Vial.

Moyano, E. (1997). Teoría del Comportamiento Planificado e intención de infringir normas de tránsito en peatones. *Estudios de Psicología, 2*(2), 335-348.

Parker, D., Manstead, A. S. R., Stradling, S. G. & Reason, J. T. (1992). Intention to commit driving violations: An application of the Theory of Planned Behavior. *Journal of Applied Psychology, 77*(1), 94-101.

Parker, D., West, R., Stradling, S. & Manstead, A. S. R. (1995). Behavioral characteristics and involvement in different types of traffic accident. *Accident Analysis & Prevention, 27*(4), 571-581.

Räsänen, M., Lajunen, T., Alticafarbay, F. & Aydin, C. (2007). Pedestrian self-reports of factors influencing the use of pedestrian bridges. *Accident Analysis & Prevention, 39*(5), 969-973.

Rosenbloom, T., Nemrodov, D. & Barkan, H. (2004). For heaven's sake follow the rules: pedestrians' behavior in an ultra-orthodox and a non-orthodox city. *Transportation Research Part F: Traffic Psychology and Behaviour, 7*(6), 395-404.

Ryb, G. E., Dischinger, P. C., Kufera, J. A. & Soderstrom, C. A. (2007). Social, behavioral and driving characteristics of injured pedestrians: A comparison

with other unintentional trauma patients. *Accident Analysis & Prevention, 39*(2), 313-318.

Streiner, D. L. & Norman, G. R. (2003). Biases in responding. En D. L. Streiner & G. R. Norman (Eds.), *Health measurement scales: A practical guide to their development and use* (3 th. ed., pp. 80-98). Oxford: Oxford University Press.

te Velde, A. F., van der Kamp, J., Barela, J. A. & Salvesbergh, G. J. P. (2005). Visual timing and adaptative behavior in a road-crossing simulation study. *Accident Analysis & Prevention, 37*(3), 399-406.

Tiwari, G., Bangdiwala, S., Saraswat A. & Gaurav, S. (2007). Survival analysis: Pedestrian risk exposure at signalized intersections. *Transportation Research Part F: Traffic Psychology and Behaviour, 10*(2), 77-89.

Tourengeau, R., Rips, L. G. & Rasinski, K. (2000). *The psychology of survey response.* Cambridge: Cambridge University Press.

Peden, M., Scurfield, R., Sleet, D., Mohan, D., Hyder, A. A., Jarawan, E., et al. (Eds.). (2004). *World report on road traffic injury prevention.* Geneva: World Health Organization.

World Health Organization. (2009). *Global status report on road safety.* Geneva: Author.