Journal of Safety Research 66 (2018) 187–194

Contents lists available at ScienceDirect

Journal of Safety Research

journal homepage: www.elsevier.com/locate/jsr

Predicting road safety behavior with implicit attitudes and the Theory of Planned Behavior

Rubén D. Ledesma, [a,b,*] Jeremías D. Tosi, [a,b] Carlos M. Díaz-Lázaro, [c] Fernando M. Poó [a,b]

[a] IPSIBAT, Universidad Nacional de Mar del Plata, Argentina
[b] Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina
[c] Walden University, United States of America

ARTICLE INFO

Article history:
Received 8 May 2018
Received in revised form 3 July 2018
Accepted 12 July 2018
Available online 17 July 2018

Keywords:
Road safety
Attitudes
Theory-of-planned-behavior
Implicit attitudes
Seat-belt

ABSTRACT

Introduction The Theory of Planned Behavior (TPB) is one of the most widely used psychological models when it comes to explaining road safety behaviors. Recently, studies have also been conducted from the perspective of dual-process models. However, the present is the first study on road safety behaviors that integrates both perspectives. The study evaluates the roles of both implicit attitudes and TPB constructs in the prediction of seatbelt use. *Method* A sample of 100 drivers completed: (1) a self-reporting instrument on seatbelt use, (2) a questionnaire addressing TPB constructs, (3) an indirect measure of attitudes (Implicit Association Test), and (4) a social desirability scale. *Results* Results suggest that both types of attitudes make a significant and quite similar contribution to the explanation of seatbelt use. Interestingly, implicit attitudes were a better predictor than explicit attitudes among participants reporting inconsistent seatbelt use. In addition, path analysis models suggested that implicit attitudes appear to be relatively independent of TPB constructs and have a direct effect on seatbelt use. *Conclusion* The findings advance the idea of adding implicit attitudes to variables from the TPB model in order to increase the explanatory power of models used to predict road safety behaviors. *Practical applications* Potential use of implicit attitude measures in the education and training of drivers are discussed.

1. Introduction

The relationship between attitudes and risk behaviors continues to be a relevant topic of research in various health areas (Sheeran et al., 2015). A significant part of the research in this domain has been grounded in classic social psychology models (Wiers et al., 2010); in this respect, the theories of reasoned action (TRA) and planned behavior (TPB) have predominated (Fishbein & Ajzen, 2010). In recent years the field has been revitalized thanks to theoretical developments on implicit attitudes (Blair, Dasgupta, & Glaser, 2015; Sheeran et al., 2016). New questions, models, and methods have emerged from these developments. This article analyzes the role of implicit and explicit attitudes in road safety behaviors and is the first study in this field to integrate the contributions of both the more recent perspective on implicit attitudes and the classic TPB approach.

1.1. Implicit and explicit attitudes

Current research suggests that attitudes can exist at two mutually interacting levels that influence our behavior (Blair et al., 2015). On the one hand, attitudes take place at an *explicit* level, which is consciously accessible to the subject and thus assumed controllable. These attitudes can be evaluated through self-reporting methods such as surveys and Likert scales. On the other hand, there are also attitudes at an *implicit* level, which are more automatic, less consciously accessible, and thus not necessarily controllable. The evaluation of implicit attitudes requires indirect assessment measures capable of "activating" our attitudes toward a given object (Gawronski & Bodenhausen, 2011). The Implicit Association Test (IAT, Greenwald, McGhee, & Schwartz, 1998) is one such indirect method. Based on its success, the IAT has generated one of the foremost research programs on implicit attitudes.

The IAT is a computer-based measure that evaluates the strength of automatic association between pairs of concepts (Greenwald et al., 1998). When measuring attitudes, the first pair of concepts refers to the attitude object (e.g. "seat-belt use" and "non-seat-belt use"), while the second pair corresponds to the attitudinal valence (e.g. "good" and

* Corresponding author at: Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) and Universidad Nacional de Mar del Plata, Funes 3350, Mar del Plata 7600, Argentina.
E-mail address: rdledesma@conicet.gob.ar (R.D. Ledesma).

https://doi.org/10.1016/j.jsr.2018.07.006
0022-4375/

"bad" or "pleasant" and "unpleasant"). The task consists of quickly classifying stimuli corresponding to the four concepts under two basic conditions: (1) a compatible block (e.g. with the same response-key used to classify stimuli from the categories "seat-belt" and "good," and another response key to categorize stimuli representing "non-seat-belt use" and "bad"); and (2) an incompatible block (pairings are inverted). The final score is the difference in reaction times between these two conditions (i.e., compatible and incompatible). The IAT rests on the assumption that the categorization task should be easier, and thus quicker, when the two concepts paired with the same response key are "implicitly" associated for the participant. This simple procedure has been used in a variety of fields and has been the subject of numerous validity studies (Bar-Anan & Nosek, 2014; Greenwald, Poehlman, Uhlmann, & Banaji, 2009).

A relevant finding is that the IAT is more robust than self-reporting measures in dealing with response biases (e.g., social desirability; Gawronski & De Houwer, 2014). These biases could be particularly relevant when evaluating attitudes toward behaviors that are sensitive to the participant and/or when involving norm violations. A previous study on helmet use, for example, showed an explicit attitude measure – but not an implicit one (IAT scores) – to be correlated with a social desirability measure (Ledesma, Tosi, Poo, Montes, & López, 2015). This supports the idea that implicit measures can be more robust when exploring socially unacceptable behaviors (Greenwald et al., 2009). In the case of road behavior, this finding is particularly relevant considering that risky behaviors generally involve violations of traffic rules.

Even if implicit and explicit attitudes originate from qualitatively different processes, these are assumed to be associated in a different way, with the strength of the relationship changing according to the attitude object (Bar-Anan & Nosek, 2014; Greenwald et al., 2009; Hofmann, Gschwendner, Nosek, & Schmitt, 2005; Nosek, 2005). In the case of road safety behaviors, results vary considerably from study to study. Fernandes, Hatfield, and Job (2006) analyzed the relationship between implicit attitudes and constructs from the *Health Belief Model*, and considered various behaviors (speeding, drunk driving, driving while fatigued, and not wearing a seatbelt). Non-significant associations were found in most of these cases. In two other studies weak to moderate correlations were found between implicit and explicit attitudes toward speeding (Hatfield, Fernandes, Faunce, & Job, 2008; Rusu, Sârbescu, Moza, & Stancu, 2017). Lastly, a study on helmet use (Ledesma et al., 2015) found moderate correlations between implicit attitudes and the emotional component of explicit attitudes. These inconsistent results could be explained by the presence of factors acting as moderators on the implicit–explicit relationship (Blair et al., 2015; Hofmann et al., 2005; Nosek, 2007). Such moderators could be methodological (e.g. type of stimuli used) or conceptual (e.g. attitude dimensionality; Greenwald et al., 2009).

Another key research topic has been the predictive ability of measures such as the IAT. Particularly, there has been great interest in its incremental predictive validity with respect to explicit measures (Greenwald et al., 2009). Previous research suggests that when evaluating sensitive research topics (e.g. racial prejudice) implicit attitudes have a greater predictive power than their explicit counterparts. In addition, in these cases there is a tendency to find low correlations between both types of attitudes. Conversely, when dealing with topics less influenced by social desirability (e.g., consumer or political preferences) stronger associations are observed and explicit attitudes show better predictive validity (Ajzen & Dasgupta, 2015; Fazio & Towles-Schwen, 1999). In any case, it is particularly relevant that explicit and implicit measures appear to have incremental validity over each other, which could indicate that they predict different aspects of criterion behavior (Greenwald et al., 2009). For this reason, it becomes important to consider the combined use of implicit and explicit measures in applied psychology research.

1.2. Implicit attitudes and the TPB

Jaccard and Blanton (2007) have criticized the manner in which researchers have addressed the incremental validity of implicit attitude measures. The problem is that researchers have failed to take into consideration that the attitude–behavior relationship in classic models is analyzed by including other fundamental theoretical constructs in addition to attitudes. Fig. 1 represents the TPB constructs and their relationships. Briefly, behavior is explained by the *behavioral intention* (i.e., disposition to carry out the behavior) and the perceived *behavioral control* (i.e., perception of internal and external factors capable of providing control over the behavior). At the same time the intention is affected by the *attitude* (i.e., favorable or unfavorable evaluation toward the behavior), the *subjective norm* (i.e., perceived social pressure to carry out the behavior) and the perceived behavioral control. It is indeed the case that research that provides evidence of the incremental validity of implicit measures seldom integrates these important theoretical concepts.

Furthermore, Jaccard and Blanton (2007) state that it is difficult to imagine implicit attitudes as independent of the TPB constructs. These authors suggest various possibilities to conceptualize the relationship between implicit attitudes and the TPB. For example, they posit that implicit attitudes could function as distal variables in the model, associating them with the beliefs that form the attitudes, subjective norms, and perceived behavioral control. They also suggest that implicit attitudes could act as moderator variables between the different TPB constructs (e.g., moderating the relationship between explicit attitudes and intention). Fishbein and Ajzen (2010) have also analyzed the possibility of connecting implicit attitudes with the TPB. For example, they propose that implicit attitudes could be part of background factors, in that we are dealing with general attitudes "assumed to be mediated by more proximal behavior-specific dispositions" (p. 273). In any case, research has not advanced sufficiently as to integrate both perspectives; in part this is because these are two quite distinct theoretical traditions (Jaccard & Blanton, 2007).

Even so, some studies have evaluated health behaviors by integrating implicit and TPB measures. Millar (2011), in a study on dental flossing behavior, found that implicit attitudes increased the predictive power of the TPB. Warfel (2013) studied attitudes toward blood donation and found very low to non-existent correlations between TPB and implicit attitudes. In this particular case, the implicit measure did not show incremental validity over the explicit attitudes. Another study, this time on healthy eating behaviors (Ackermann & Palmer, 2014), concluded that implicit attitudes did not increase the explanatory power of the TPB. Finally, Chevance, Caudroit, Romain, and Boiché (2016) found that implicit attitudes contributed significantly to the prediction of physical activity in persons with obesity, but not in the general population. In summary, the research appears to indicate that implicit measures contribute little or not at all when the full TPB model (as opposed to only explicit attitudes) is taken into account.

1.3. The present study

In this study we analyze implicit and explicit attitudes toward a specific road safety behavior: seatbelt use. Although considered a key road safety behavior, seatbelt use in many countries continues to be low (WHO, 2015). Interestingly, seatbelt use is associated with more general unsafe driving behaviors (e.g., driving errors and violations; Okamura, Fujita, Kihira, Kosuge, & Mitsui, 2012) and even with other health related behaviors (e.g., healthy diet, regular walking, and adequate sleep; Şimşekoğlu & Lajunen, 2009). For this reason, seatbelt use has been seen as reflecting a general safety orientation. Some prior studies have analyzed this behavior by appealing to the TPB in its classic and/or extended version (Ali, Haidar, Ali, & Maryam, 2011; Brijs, Daniels, Brijs, & Wets, 2011; Okamura et al., 2012; Şimşekoğlu & Lajunen, 2008; Tavafian, Aghamolaei, Gregory, & Madani, 2011; Torquato,

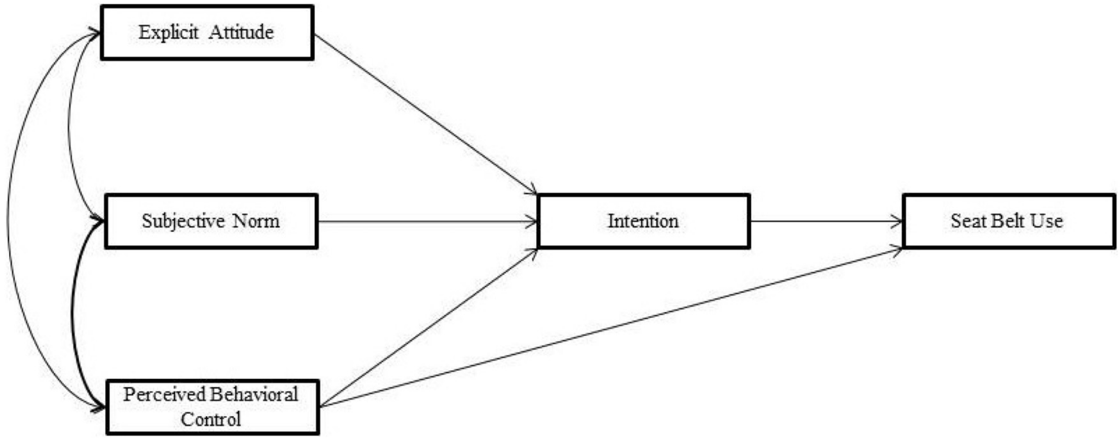

Fig. 1. Schematic representation of the Theory of Planned Behavior.

Franco, & Bianchi, 2012). Results are inconsistent with regard to the general global functioning of the model, but tend to coincide on the predictive value of explicit attitudes. Brijs et al. (2011) posit that, although the formal structure of the TPB model adjusted well to their findings, seatbelt use cannot be exclusively explained in terms of consciously planned behavior. They proposed that seatbelt use is a frequent and repetitive behavior and that the decision implies "recycling an originally reasoned behavior, yet without systematically going through the whole underlying reasoning every time a situation in which the decision to wear a seat belt (or not) presents itself (p. 600)." It is worth noting that, from the perspective of dual-process models, it is precisely in this type of behavior (less deliberate, more spontaneous or automatic) that implicit attitudes could play a more determining role (Blair et al., 2015). Nevertheless, we are not aware of any study to date that has integrated implicit attitude measures to the TPB model to explain road safety behaviors.

This study's main objective is to analyze the predictive ability of implicit and explicit attitudes in explaining seatbelt use. For this purpose, measures of both types of attitudes, as well as measures of the TPB constructs, were included (i.e., subjective norm, perceived behavioral control, and intention). The general hypothesis is that implicit attitudes will contribute to the prediction of seatbelt use even when considering the full TPB model. Based on the previous literature, a moderate to weak relationship between implicit and explicit attitudes is also expected. A secondary objective consists in determining the robustness of both explicit and implicit measures in terms of possible social desirability biases. In line with the previous literature (Greenwald et al., 2009), we expect explicit measures, but not their implicit counterparts, to correlate with social desirability.

2. Method

2.1. Participants

A casual non-probabilistic sample of 100 drivers (63% women) from the city of Mar del Plata, Argentina, was obtained. Inclusion criteria were: being 18 or older, possessing a driver's license, and driving a car regularly. Professional drivers of any kind were excluded. All participants had completed elementary school. Participants' ages ranged from 18 to 59 ($M = 28.75$, $SD = 9.30$).

2.2. Variables and measures

2.2.1. Descriptive data and seatbelt use

A survey was conducted to collect socio-descriptive (age, gender, educational level, and occupation) and driving (driving frequency, type of driver's license, and accident history) data. Four questions were used to assess the frequency of seatbelt use in different conditions (as a driver in the city, as a driver on the highway, as a passenger in the city, as a passenger on the highway). Participants responded to the frequency of seatbelt use by using a five-point scale ("Never," "Almost Never," "Sometimes," "Almost Always," and "Always"). For some of the main data analysis procedures, these questions were added to obtain a single score of seatbelt use for each participant. This simplifies the statistical analysis; as well as provides a more reliable estimate of seatbelt use. The internal consistency of this composite score was satisfactory, as indicated by a Cronbach's alpha of 0.70.

2.2.2. TPB variables: intention (I), explicit attitude (EA), subjective norm (SN), and perceived behavioral control (PBC)

TPB constructs were assessed through 30 items based on two previous instruments: one which measures TPB constructs as applied to seatbelt use (Şimşekoğlu & Lajunen, 2008), and another of attitudes toward helmet use (Ledesma et al., 2015). Table 2 displays each scale's length, internal consistency, and sample items.

2.2.3. Social desirability

Social desirability was measured with the Argentine version (Poó et al., 2010) of the *Driver Social Desirability Scale* (DSDS, Lajunen, Corry, Summala, & Hartley, 1997). The DSDS includes 12 items that evaluate an individual's tendency to provide positively biased descriptions of one's own behavior while driving. It is composed by two sub-scales: Driver Impression Management (DIM) and Driver Self Deception (DSD). The DIM assesses response biases associated with the intention of portraying an image of a prudent driver who always respects norms, and the DSD evaluates excessively positive beliefs toward one's own abilities in making rational and correct decisions when driving. Responses to DSDS are provided on a 7-point scale ranging from (1) "not at all true" to (7) "completely true".

2.2.4. Implicit attitudes (IA)

Implicit attitudes toward seatbelt use were evaluated with the *Implicit Association Test* (IAT, Greenwald et al., 1998). Table 1 summarizes the blocks comprising the task. The target object categories were assessed with images (drivers wearing and not wearing seatbelts). The attributes "Good–Bad" were evaluated using the customary wordlist (love, happiness, hate, sadness, etc.). The development of materials, presentation design, and data analyses were based on Nosek, Greenwald, and Banaji's (2007) recommendations. The images were generated by the researchers. One hundred and thirty-five pictures of drivers wearing and not wearing seatbelts were taken. Twenty-two of these pictures (11 per category) were selected for their clarity and comparison potential between both conditions (use and non-use). Fig. 2 shows examples of the stimuli.

Table 1
IAT's procedure and task sequence.

Block	Number of trials	Task	Instructions	
1	20	Learning (discriminating) target categories	Press on the left key ("E") for seat-belt use	Press on the right key ("I") for non-seat-belt use
2	20	Learning of attribute categories	Press on the left key ("E") for words with positive valence	Press on the right key ("I") for words with negative valence
3	20	Initial combined task	Press on the left key ("E") for seat-belt use and positive words	Press on the right key ("I") for non-seat-belt use and negative words
4	40			
5	20	Reversed learning of target categories	Press on the left key ("E") for non-seat-belt use	Press on the right key ("I") for seat-belt use
6	20	Inverted combined task	Press on the left key ("E") for non-seat-belt use and positive words	Press on the right key ("I") for seat-belt use and negative words
7	40			

2.3. Procedure

To recruit participants, an open announcement via various communication channels (including social networks) was made. Prospective participants emailed the researchers to coordinate a meeting. In the initial contact, the objectives of the study and the task duration were reiterated. Those who decided to participate were provided with an appointment at the research team's office. Conditions were the same for all participants: a calm and quiet environment, without distracting stimuli, and with the presence of a researcher. After providing informed consent, participants completed the IAT and the other instruments. Administration of the IAT and self-reporting measures was counterbalanced. Inquisit (Millisecond Software, 2008) was used to administer the IAT. A notebook computer with a 17-inch screen (1,366 × 768 resolution) was used to present the stimuli. Prior to data analysis, four participants were excluded (two because no information on seat belt use was provided, and two because they experienced external interruptions during the IAT task).

2.4. Data analysis

Descriptive statistics and reliability estimates (Cronbach's alpha) for all variables were obtained. The IAT's internal consistency was estimated with a split-half analysis (D scores were obtained separately for even and odd trials and both scores were correlated). No data were missing. Correlations among variables were estimated with Pearson's *r*. A standard multiple regression analysis was used to assess the contribution of the TPB constructs and implicit attitudes in the prediction of seatbelt use. Subsequently, a path analysis was run to evaluate different inclusion options for implicit attitudes to the TPB model. Parameters were estimated with the ADF (asymptotically distribution free) method, paying attention to the asymmetry display of several variables. Regression coefficients were analyzed and various fit indices were calculated (see Table 6).

3. Results

Table 2 presents descriptive statistics for the variables. Note that the SN and PBC scales obtained lower internal consistency values, in part due to their low number of items. Attitude means suggest a positive global valuation of seatbelt use, both explicitly and implicitly. Nevertheless, use percentages were nowhere near optimal (Table 3); only 34% reported wearing seatbelts in all conditions (as driver and passenger, in highways and in the city). The greatest frequency of use was reported as a driver on highways (always: 78%), and the lowest as a passenger in the city (always: 41%). As previously mentioned, for the purposes of this study a composite score consisting of items from all conditions was computed. Cronbach's alpha value (0.70) suggests this composite score has adequate internal consistency.

Table 4 displays correlations among all variables included in the analyses. Seatbelt use correlated moderately with I, EA, and IA. A

Fig. 2. Examples of IAT seatbelt use and non-use stimuli.

Table 2
Descriptive statistics for use frequency, TPB constructs, implicit attitudes and the social desirability scales.

	Mean	*SD*	Skewness	Kurtosis	Number of items	Internal consistency	Sample items
Seatbelt use	17.40	2.91	−1.15	0.68	4	0.70	"With what frequency do you use the seatbelt when you drive in the city?"
Implicit attitude (IA)	0.64	0.45	−0.75	1.12	–	0.93 ($r = 0.87$)	See Fig. 2
Explicit attitude (EA)	72.59	8.98	−0.99	0.46	17	0.85	"Wearing a seatbelt can save my life in an accident"
Intention (I)	16.55	3.56	−0.99	0.34	4	0.75	"I am willing to use the seatbelt in all situations"
Perceived behavioral control (PBC)	12.71	2.25	−0.69	−0.49	3	0.58	"I have control over seatbelt use"
Subjective norm (SN)	15.13	3.18	−0.11	−0.08	5	0.50	"My loved ones expect me to wear a seatbelt"
DSDS	35.17	7.05			12	0.75	
DIM	19.17	5.66			7	0.82	"Even without police monitoring, I would respect the speed limit"
DSD	16	3.72			5	0.73	"I always know what to do in transit situations"

significant yet low relationship is also observed between seatbelt use and the PBC. With regard to intention, a significant and moderate correlation was observed with the EA, and a weak relationship with the PBC. There were no significant correlations between the I and the SN. On the other hand, the IA correlated significantly, although weakly, with the EA. No significant relationships were observed between the IA and the rest of the TPB constructs. With regard to social desirability, the only significant correlations found were in the DSD subscale with the SN and the PBC.

Table 5 shows results of a multiple regression analysis with seatbelt use as a dependent variable and the TPB components, the IA and the interaction between IA and EA as predictors. Significant effects were observed for the IA, I, and EA (in that order of importance). No significant effects were observed for the remaining variables. The inclusion of the IA in the regression model yielded a significant increase in R^2, from 0.36 to 0.44, $F(1,89) = 13.01$, $p < .01$. Considering some asymmetry in the dependent variable, an ordinal regression analysis was also applied. The result of this analysis was essentially the same.

We also ran the same analysis but included only those participants with inconsistent seatbelt use (those reporting use as *always* in at least 3 of the 4 conditions were excluded). In this case, only the IA showed a significant effect over seatbelt use ($\beta = 0.36$, $p < .01$). In summary, the results indicate that both the IA and the EA made independent and significant contributions to the prediction of the seatbelt use behavior; however, the IA was more important among those with irregular seatbelt use.

In the aforementioned analyses, all of the TPB constructs are positioned at the same level. A more comprehensive description of the relationship among variables is observed in the Path diagram in Fig. 3. This analysis estimates the relationships between the IA and the TPB variables, with the implicit component having a direct effect on the seatbelt use. In this model, the I (path coefficient = 0.45, $p < .001$), the PBC (path coefficient = 0.19, $p < .05$), and the IA (path coefficient = 0.32, $p < .001$) significantly contributed to the explanation of the behavior. On the other hand, the I is explained by the EA (path coefficient = 0.70, $p < .001$), but not by the PBC and the SN. With regard to covariances, a significant relationship was observed only between EA and PBC (path coefficient = 0.25, $p < .05$). The model explained 55% of the intention variance and 47% of the behavior, and its fit was acceptable (see "Model 1" in Table 6).

The model presents a good fit even when all the relationships between the IA and the TPB variables are eliminated (see "Model 2" in Table 6). This makes sense considering that relationships between the IA and the TPB constructs tend to be low or null. In this case, the regression coefficient, which goes from the IA toward the conduct, is 0.28, $p < .01$. In synthesis, a model including the IA as a totally independent component is plausible.

Alternatively, a model similar to Model 1 was assessed, but changing the IA's direct effect on the behavior for an IA's direct effect on I. The IA's path coefficient for this effect approached zero (0.08, $p > .05$). This model clearly offers a poorer fit as compared with previous models (see Model 3, Table 6). Lastly, a model in which the IA is included as a distal variable was fitted (Model 4, Table 6). This model included effects from the IA to the different TPB constructs, without direct effects on I or on behavior. In this case, the global fit worsened as well.

4. Discussion

The main objective of this study was to analyze the role of implicit and explicit attitudes in seatbelt use: a specific road safety behavior, but one that also reflects a general safety orientation (Şimşekoğlu & Lajunen, 2009). The most significant finding is that both types of attitudes contribute to the explanation of seatbelt use. The contribution of both implicit and explicit attitudes is quite similar when included in a regression model with the rest of the TPB constructs. Furthermore, in the group of those with irregular seatbelt use, implicit attitude is a better predictor than explicit attitude, with the latter failing to show significant results in this sub-sample. On the other hand, causal modeling suggests implicit attitudes as relatively independent from the rest of the TPB constructs, and affirms the idea of a direct effect on seatbelt use. To sum up, our study suggests that implicit attitudes play an important role in road safety behaviors, contributing information on evaluative processes not considered in the TPB. These processes occur at a more automatic, less conscious level, but are equally capable of guiding safety behaviors.

A key question in attitude–behavior studies is whether implicit attitudes can contribute beyond what is explained by explicit attitudes. Research utilizing dual-process models suggests an affirmative response to this question (Greenwald et al., 2009). However, some authors have raised the issue of whether implicit attitudes possess this ability when taking into consideration full attitude–behavior models such as the TPB, as opposed to solely explicit attitude measures (Jaccard & Blanton, 2007). The present study provides new evidence that suggests an effective contribution on the part of implicit attitudes, even when

Table 3
Frequency of seatbelt use under four conditions.

Condition	Frequency of seatbelt use				
	Always	Almost always	Sometimes	Almost never	Never
As a driver in the city	62 (64.6%)	17 (17.7%)	8 (8.3%)	5 (5.2%)	4 (4.2%)
As a driver on the highway	75 (78.1%)	7 (7.3%)	11 (11.5%)	1 (1%)	2 (2.1%)
As a passenger in the city	39 (40.6%)	27 (28.1%)	22 (22.9%)	5 (5.2%)	3 (3.1%)
As a passenger on the highway	69 (71.9%)	14 (14.6%)	8 (8.3%)	3 (3.1%)	2 (2.1%)

Table 4
Correlations among TPB constructs, implicit attitudes, frequency of seat belt use and social desirability scales.

	EA	IA	I	PBC	SN	Seatbelt use	DSDS	DIM
EA	–							
IA	0.22*	–						
I	0.67**	0.15	–					
PBC	0.18*	0.15	0.27**	–				
SN	−0.16	0.01	−0.01	0.07	–			
Seatbelt use	0.53**	0.41**	0.52**	0.27**	−0.07	–		
DSDS	0.09	0.15	−0.01	0.04	−0.12	0.14	–	
DIM	0.13	0.12	0.05	−0.14	0.01	0.14	0.85**	–
DSD	−0.02	0.09	−0.11	0.29**	−0.23**	0.06	0.60**	0.09

** $p < 01$.
* $p < .05$.

considering the full TPB model. This result is in line with previous studies on healthcare-related behaviors (Chevance et al., 2016; Millar, 2011). Nevertheless, we believe that more empirical research is needed in order to solidify these findings. As previously noted by other authors (Jaccard & Blanton, 2007), the field would benefit from the combined study of classic and implicit attitude models.

It is interesting to note that while explicit attitudes were associated strongly with behavioral intention, implicit attitudes were only associated with behavior (but not intention). Considering that behavioral intention is deliberate and it implies a projection into the future, it only makes sense for it to associate more closely to explicit as opposed to implicit attitudes. At the same time, seatbelt use is strongly influenced by past experience, is more repetitive and frequent, and is closer to a habit (Brijs et al., 2011; Okamura et al., 2012). Consequently, it is reasonable to expect that implicit attitudes play a clearer role in this regard. Nevertheless, it is worth mentioning that the relationship between implicit attitudes and behavioral intention is the subject of continuing theoretical debate (Evans & Stanovich, 2013; Gawronski & Bodenhausen, 2011). In any case, it is interesting to highlight the relative independence of implicit attitudes and behavioral intention in our study. This means that the implicit measure would be associated with decision making processes taking place at a more automatic level, also influencing seatbelt use behavior.

Another aspect worth noting is the correlation between implicit and explicit attitudes. Previous literature on road safety has reported conflicting findings, with some studies identifying this relationship as null or weak (Fernandes et al., 2006; Rusu et al., 2017), while others identify it as moderate (Hatfield et al., 2008; Ledesma et al., 2015). In our case the relationship turned out weak. These varying results could be attributed to differences in the behaviors studied (helmet use, speeding, etc.) and also to methodological differences among studies. Even when all of these behaviors are related to road safety, the underlying motivational factors could vary from case to case. On the other hand, among studies using the IAT, the way of configuring the task varies, with some cases being highly questionable (see critiques by Ledesma et al., 2015). More research analyzing the role of possible moderators for different types of behaviors is needed.

Another goal of this study was to determine the robustness of both explicit and implicit measures against social desirability biases. Based on previous findings (Greenwald et al., 2009; Ledesma et al., 2015) we expected explicit but not implicit measures to associate with a social desirability measure. Only two explicit measures (subjective norm and perceived behavioral control) showed low relationships with the *self-deception* dimension. On the other hand, no significant associations were observed between any variables and social desirability for the *impression management* dimension. In summary, explicit measures showed little to no association with the social desirability scale; consequently, a statement regarding the comparative advantage of implicit measures in this regard cannot be made.

Table 5
Multiple regression predicting seatbelt use with IA and TPB constructs.

Predictor variables	B	S.E.	Standardized beta	*t*	*p*
IA	1.936	0.542	0.299	3.574	.001
EA	0.080	0.036	0.247	2.211	.030
I	0.234	0.091	0.286	2.566	.012
SN	−0.038	0.075	−0.042	−0.508	.612
PBC	0.144	0.109	0.111	1.320	.190
EA × IA	0.016	0.197	0.007	0.079	.937

With regard to seatbelt use behavior, it is important to compare our results with those of previous studies that employed the TPB. Explicit attitudes played a significant role in our study as in previous studies (Ali et al., 2011; Okamura et al., 2012; Şimşekoğlu & Lajunen, 2008; Tavafian et al., 2011; Torquato et al., 2012); this indicates the relevance of the evaluative component for this behavior. We also found a significant effect for perceived behavioral control, a construct whose role has been less clear in previous literature. While some studies have reported findings similar to ours (Ali et al., 2011; Tavafian et al., 2011), others have obtained non-significant (Şimşekoğlu & Lajunen, 2008) and even inverse (i.e., higher perceived control, lower seatbelt use) results (Okamura et al., 2012). Lastly, we did not find a relationship between subjective norm and behavioral intention as hypothesized by the TPB and as found in other studies (e.g. Tavafian et al., 2011). Nevertheless, it should be noted that the cited research presented some differences in the measurement of TPB constructs and the criterion behavior, which could explain the variation in results. It is also relevant to mention that several past studies have unsuccessfully included other normative, affective, and automatic components with the goal of improving the explanatory ability of the TPB. It appears that to date, implicit attitude would be the only variable capable of improving the explanatory power of the model.

4.1. Practical applications

Based on our findings it would make sense to develop intervention aimed at both types of attitudes: explicit and implicit. Even though there is considerable research on interventions targeted at attitudes and beliefs at the explicit level (Steinmetz, Knappstein, Ajzen, Schmidt, & Kabst, 2016), implicit attitudes have received less attention and research-based recommendations are limited. Sibley and Harré (2009) showed that one-off exposure to a positively framed driving advertisement exerted an immediate effect on explicit self-enhancement biases, while implicit biases remained unchanged across conditions. Similarly, Vingilis et al. (2015) found that a brief exposure to a risky driving motor-vehicle commercial did not have a short term effect on implicit risk attitudes, but it did affect explicit measures in a sub-sample (i.e. men). These results suggest that implicit attitudes appear not to respond to conventional interventions. However, it must be noted that the brevity of the exposure to the intervention is a problem in these studies. Previous research suggests that implicit attitudes are more resistant to persuasive messages, and that these require a higher amount of "counter-attitudinal" information to generate change (Rydell & McConnell, 2006). This can be attributed to implicit attitudes being the result of slower learning, based on associative processes. In any case, there are studies that show that implicit attitudes can change when adequate interventions and designs to study such changes are implemented (Lai, Hoffman, & Nosek, 2013). In the area of road safety, more specific and sophisticated studies are needed.

Another interesting practical consideration is the potential use of implicit attitude measures in the education and training of drivers. For example, the IAT result could be used to provide feedback to drivers on their implicit attitudes toward safety behaviors. This feedback could help them learn about their attitudes (which they may be unaware of), and eventually suggest the need for changes. Some authors, in analyzing this potential use of the IAT, have identified several potential challenges that would need to be addressed (i.e. defensive responses from individuals under certain circumstances, Menatti, Smyth,

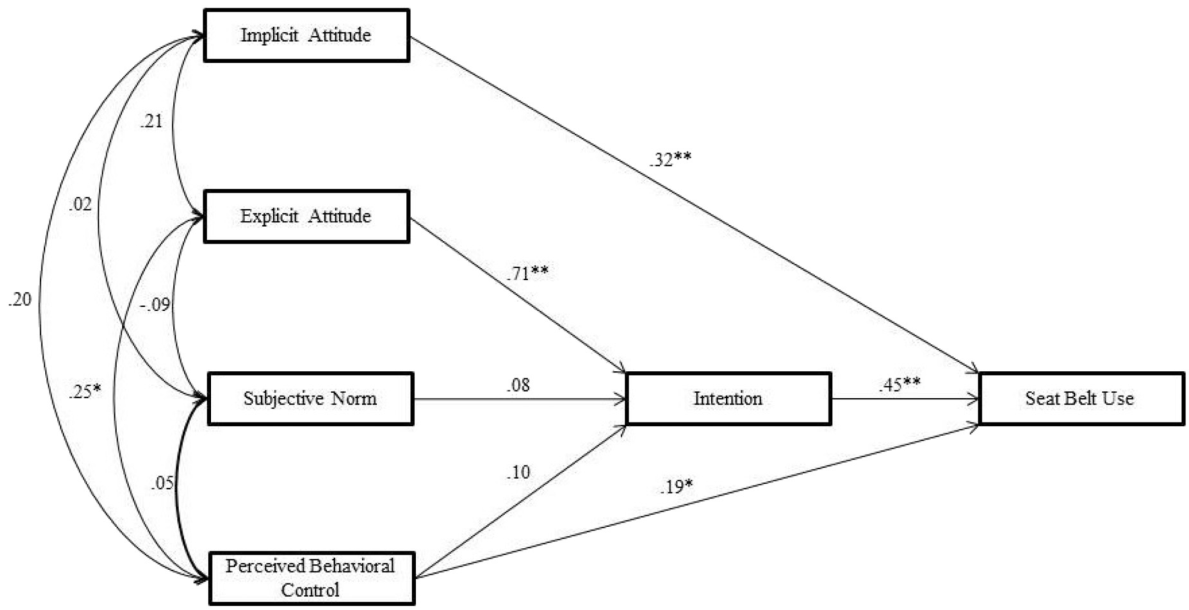

Fig. 3. Model 1: Theory of Planned Behavior and implicit attitudes as predictors of seat belt use.

Teachman, & Nosek, 2012; Howell & Ratliff, 2016). We are not aware of any road safety studies addressing this issue, and thus it would be interesting to advance this line of inquiry. Another key issue to consider for any application is the IAT's scoring system. The IAT is a relative measure, thus positive or negative scores cannot be easily and directly interpreted as suggesting a positive or negative attitude. Additionally, it is worth clarifying that it seems premature to use the IAT to arrive at conclusions that could have legal consequences for individuals (e.g. not obtaining a driver's license).

Finally, this study has several limitations worth mentioning. First, self-report was used to assess the criterion behavior (seatbelt use), and we know that this type of instrument can introduce response biases and measurement errors (Nelson, 1996; Vivoda & Eby, 2011; Zambon et al., 2008). For example, as compared to naturalistic observations, the self-report measures can overestimate the true rate of seatbelt use (e.g., Nelson, 1996; Prada, Cohn, Gonzalez, Byrd, & Cortes, 2001; Zambon et al., 2008). In addition, we did not set a time frame for the questions (e.g., asking for seatbelt use in the last month), which might have offered a more reliable estimate of seatbelt use (Vivoda & Eby, 2011). In the future, it would be important to use observational methods to assess the criterion behavior, as it was done, for example, in a previous study on implicit attitudes toward helmet use (Ledesma et al., 2015).

Another shortcoming is that the sample is culture-specific, as road behaviors are strongly influenced by the socio-cultural context. In this regard the study's external validity could be affected. Complementary studies with other populations are needed. Lastly, we are aware that many safety behaviors – such as seatbelt use – are influenced by age, gender, and other socio-demographic variables (Vivoda & Eby, 2011). Unfortunately, and based on the study's sample size, we excluded these variables from our main analyses. Notwithstanding these limitations, we believe our study makes a significant contribution to the existing knowledge of the role of explicit and implicit attitudes on road safety behaviors. In this regard, the findings advance the idea of adding implicit attitudes to variables from the TPB model in order to increase the explanatory power of models used to predict road safety behaviors.

Table 6
Fit indices for the tested models.

Goodness of fit indices	Model 1	Model 2	Model 3	Model 4
x^2	4.34 (3), $p = .23$	7.85 (6) $p = .25$	12.43 (3), $p = .006$	17.10 (7), $p = .017$
x^2/df	1.448	1.309	4.145	2.444
AIC	40.34	37.85	48.43	45.10
RMSEA	0.069	0.057	0.18	0.12
GFI	0.98	0.97	0.96	0.94
AGFI	0.90	0.91	0.72	0.83
IFI	0.96	0.95	0.77	0.73
CFI	0.95	0.93	0.68	0.65
PNFI	0.18	0.32	0.14	0.28
PCFI	0.19	0.37	0.13	0.30

Note: Akaike Information Criterion (AIC), absolute fit: root-mean-square error of approximation (RMSEA), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), the comparative fit index (CFI), and the chi-square test statistic; (b) comparative fit: incremental fit index (IFI); and (c) parsimonious fit: parsimony normed fit index (PNFI) and parsimony normed CFI (PCFI).

Acknowledgments

Our Traffic Psychology Research Group is supported by Universidad Nacional de Mar del Plata (ID/Number: PSI238/15) and Consejo Nacional de Investigaciones Científicas y Técnicas (ID/Number: PIP-11220110100218) (Argentina). We express our gratitude to these institutions for their support.

References

Ackermann, C. L., & Palmer, A. (2014). The contribution of implicit cognition to the Theory of Reasoned Action Model: A study of food preferences. *Journal of Marketing Management*, *30*(5–6), 529–550. https://doi.org/10.1080/0267257X.2013.877956.

Ajzen, I., & Dasgupta, N. (2015). Explicit and implicit beliefs, attitudes, and intentions: The role of conscious and unconscious processes in human behavior. In P. Haggard, & B. Eitam (Eds.), *The sense of agency* (pp. 115–144). New York: Oxford University Press. https://doi.org/10.1093/acprof:oso/9780190267278.003.0005.

Ali, M., Haidar, N., Ali, M. M., & Maryam, A. (2011). Determinants of seat belt use among drivers in Sabzevar, Iran: A comparison of theory of planned behavior and health belief model. *Traffic Injury Prevention*, *12*(1), 104–109. https://doi.org/10.1080/15389588.2010.535227.

Bar-Anan, Y., & Nosek, B. A. (2014). A comparative investigation of seven indirect attitude measures. *Behavior Research Methods*, *46*, 668–688. https://doi.org/10.3758/s13428-013-0410-6.

Blair, I. V., Dasgupta, N., & Glaser, J. (2015). Implicit attitudes. In M. E. Mikulincer, P. R. Shaver, J. F. Dovidio, & J. A. Simpson (Eds.), *Handbook of personality and social psychology. Attitudes and social cognition*, *Vol. 1*. (pp. 665–691). Washington, DC, US: American Psychological Association. https://doi.org/10.1037/14341-021.

Brijs, K., Daniels, S., Brijs, T., & Wets, G. (2011). An experimental approach towards the evaluation of a seat belt campaign with an inside view on the psychology behind seat belt use. *Transportation Research Part F: Traffic Psychology and Behaviour*, *14*(6), 600–613. https://doi.org/10.1016/j.trf.2011.07.003.

Chevance, G., Caudroit, J., Romain, A. J., & Boiché, J. (2016). The adoption of physical activity and eating behaviors among persons with obesity and in the general population: The role of implicit attitudes within the Theory of Planned Behavior. *Psychology, Health & Medicine*, 1–6. https://doi.org/10.1080/13548506.2016.1159705.

Evans, J. S. B., & Stanovich, K. E. (2013). Dual-process theories of higher cognition: Advancing the debate. *Perspectives on Psychological Science*, *8*(3), 223–241. https://doi.org/10.1177/1745691612460685.

Fazio, R. H., & Towles-Schwen, T. (1999). The MODE model of attitude–behavior processes. In S. Chaiken, & Y. Trope (Eds.), *Dual process theories in social psychology* (pp. 97–116). New York: Guilford Press.

Fernandes, R., Hatfield, J., & Job, R. F. S. (2006). Examination of different predictors of different risky driving behaviours in young NSW drivers. *Final report for the Motor Accidents Authority of NSW*.

Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behavior: The reasoned action approach*. Taylor & Francis.

Gawronski, B., & Bodenhausen, G. V. (2011). The associative–propositional evaluation model: Theory, evidence, and open questions. In M. P. Zanna, & J. M. Olson (Eds.), *Advances in experimental social psychology* (pp. 59–127). Amsterdam, The Netherlands: Elsevier. https://doi.org/10.1016/B978-0-12-385522-0.00002-0.

Gawronski, B., & De Houwer, J. (2014). Implicit measures in social and personality psychology. In H. T. Reis, & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology*, *2*. (pp. 283–310). New York: Cambridge University Press.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology*, *74*(6), 1464–1480.

Greenwald, A. G., Poehlman, T. A., Uhlmann, E. L., & Banaji, M. R. (2009). Understanding and using the implicit association test: III. Meta-analysis of predictive validity. *Journal of Personality and Social Psychology*, *97*(1), 17–41. https://doi.org/10.1037/a0015575.

Hatfield, J., Fernandes, R., Faunce, G., & Job, S. R. F. (2008). An implicit non-self-report measure of attitudes to speeding: Development and validation. *Accident Analysis & Prevention*, *40*(2), 616–627. https://doi.org/10.1016/j.aap.2007.08.020.

Hofmann, W., Gschwendner, T., Nosek, B. A., & Schmitt, M. (2005). What moderates implicit–explicit consistency? *European Review of Social Psychology*, *16*(1), 335–390. https://doi.org/10.1080/10463280500443228.

Howell, J. L., & Ratliff, K. A. (2016). Not your average bigot: The better-than-average effect and defensive responding to Implicit Association Test feedback. *British Journal of Social Psychology*, 1–21. https://doi.org/10.1111/bjso.12168.

Jaccard, J., & Blanton, H. (2007). A theory of implicit reasoned action: The role of implicit and explicit attitudes in the prediction of behavior. In I. Ajzen, D. Albarracin, & J. Hornik (Eds.), *Prediction and change of health behavior: Applying the reasoned action approach* (pp. 69–91). Mahwah, New Jersey: Erlbaum.

Lai, C. K., Hoffman, K. M., & Nosek, B. A. (2013). Reducing implicit prejudice. *Social and Personality Psychology Compass*, *7*, 315–330. https://doi.org/10.1111/spc3.12023.

Lajunen, T., Corry, C., Summala, H., & Hartley, H. (1997). Impression management and self-deception in traffic behavior inventories. *Personality and Individual Differences*, *22*, 341–353. https://doi.org/10.1016/S0191-8869(96)00221-8.

Ledesma, R. D., Tosi, J., Poo, F., Montes, S., & López, S. (2015). Implicit attitudes and road safety behaviors. The helmet-use case. *Accident Analysis and Prevention*, *79*, 190–197. https://doi.org/10.1016/j.aap.2015.03.030.

Menatti, A. R., Smyth, F. L., Teachman, B. A., & Nosek, B. A. (2012). Reducing stigma toward individuals with mental illnesses: A brief, online intervention. *Stigma Research and Action*, *1*, 9–21.

Millar, M. G. (2011). Predicting dental flossing behavior: The role of implicit and explicit responses and beliefs. *Basic and Applied Social Psychology*, *33*, 7–15. https://doi.org/10.1080/01973533.2010.539949.

Nelson, D. E. (1996). Validity of self-reported data on injury prevention behavior: Lessons from observational and self-reported surveys of safety belt use in the US. *Injury Prevention*, *2*, 67–69.

Nosek, B. A. (2005). Moderators of the relationship between implicit and explicit evaluation. *Journal of Experimental Psychology: General*, *134*(4), 565.

Nosek (2007). Implicit–explicit relations. *Current Directions in Psychological Science*, *16*(2), 65–69. https://doi.org/10.1111/j.1467-8721.2007.00477.x.

Nosek, B. A., Greenwald, A. G., & Banaji, M. R. (2007). The implicit association test at age 7: A methodological and conceptual review. In J. A. Bargh (Ed.), *Automatic processes in social thinking and behavior* (pp. 265–292). Psychology Press.

Okamura, K., Fujita, G., Kihira, M., Kosuge, R., & Mitsui, T. (2012). Predicting motivational determinants of seatbelt non-use in the front seat: A field study. *Transportation Research Part F: Traffic Psychology and Behaviour*, *15*(5), 502–513. https://doi.org/10.1016/j.trf.2012.05.001.

Poó, M., Ledesma, R. D., & Montes, S. (2010). Propiedades psicométricas de la Escala de Deseabilidad Social del Conductor (versión en español) [Psychometric properties of the Driver Social Desirability Scale (spanish version)]. *Avaliação Psicológica*, *9*(2), 299–310.

Prada, M. A., Cohn, L. D., Gonzalez, E., Byrd, T., & Cortes, M. (2001). The validity of self-reported seatbelt use: Hispanic and non-Hispanic drivers in El Paso. *Accident Analysis & Prevention*, *33*(1), 139–143. https://doi.org/10.1016/S0001-4575(00)00012-9.

Rusu, A., Sârbescu, P., Moza, D., & Stancu, A. (2017). Implicit attitudes towards risky driving: Development and validation of an affect misattribution procedure for speeding. *Accident Analysis & Prevention*, *100*, 15–22. https://doi.org/10.1016/j.aap.2016.12.022.

Rydell, R. J., & McConnell, A. R. (2006). Understanding implicit and explicit attitude change: A systems of reasoning analysis. *Journal of Personality and Social Psychology*, *91*(6), 995. https://doi.org/10.1037/0022-3514.91.6.995.

Sheeran, P., Bosch, J. A., Crombez, G., Hall, P. A., Harris, J. L., Papies, E. K., & Wiers, R. W. (2016). Implicit processes in health psychology: Diversity and promise. *Health Psychology*, *35*(8), 761. https://doi.org/10.1037/hea0000409.

Sheeran, P., Maki, A., Monanaro, E., Bryan, A., Klein, W., Miles, E., & Rothman, A. (2015). The impact of changing attitudes, norms, and self-efficacy on health-related intentions and behavior: A meta-analysis. *European Health Psychologist*, *17*, 598. https://doi.org/10.1037/hea0000387.

Sibley, C. G., & Harré, N. (2009). The impact of different styles of traffic safety advertisement on young drivers' explicit and implicit self-enhancement biases. *Transportation Research Part F: Traffic Psychology and Behaviour*, *12*(2), 159–167. https://doi.org/10.1016/j.trf.2008.11.001.

Şimşekoğlu, Ö., & Lajunen, T. (2008). Social psychology of seat belt use: A comparison of theory of planned behavior and health belief model. *Transportation Research Part F: Traffic Psychology and Behaviour*, *11*(3), 181–191. https://doi.org/10.1016/j.trf.2007.10.001.

Şimşekoğlu, Ö., & Lajunen, T. (2009). Relationship of seat belt use to health and driver behaviors. *Transportation Research Part F: Traffic Psychology and Behaviour*, *12*(3), 235–241. https://doi.org/10.1016/j.trf.2008.12.001.

Steinmetz, H., Knappstein, M., Ajzen, I., Schmidt, P., & Kabst, R. (2016). How effective are behavior change interventions based on the theory of planned behavior? A three-level meta-analysis. *Zeitschrift für Psychologie*, *224*, 216–233. https://doi.org/10.1027/2151-2604/a000255.

Tavafian, S. S., Aghamolaei, T., Gregory, D., & Madani, A. (2011). Prediction of seat belt use among Iranian automobile drivers: Application of the theory of planned behavior and the health belief model. *Traffic Injury Prevention*, *12*(1), 48–53. https://doi.org/10.1080/15389588.2010.532523.

Torquato, R., Franco, C., & Bianchi, A. (2012). Seat belt use intention among Brazilian undergraduate students. *Revista Colombiana de Psicología*, *21*(2), 253–263.

Vingilis, E., Roseborough, J. E., Wiesenthal, D. L., Vingilis-Jaremko, L., Nuzzo, V., Fischer, P., & Mann, R. E. (2015). Experimental examination of the effects of televised motor vehicle commercials on risk-positive attitudes, emotions and risky driving inclinations. *Accident Analysis & Prevention*, *75*, 86–92. https://doi.org/10.1016/j.aap.2014.11.008.

Vivoda, J. M., & Eby, D. W. (2011). Factors influencing safety belt use. In B. Porter (Ed.), *The handbook of traffic psychology* (pp. 215–229). San Diego, CA: Elsevier Inc. https://doi.org/10.1016/B978-0-12-381984-0.10016-5.

Warfel, R. M. (2013). *An examination of the use of implicit blood donation attitude and social identity measures among current nondonors*. (Doctoral dissertation) Ohio University.

Wiers, R. W., Houben, K. M. P. I., Roefs, A., Jong, P., Hofmann, W., & Stacy, A. W. (2010). Implicit cognition in health psychology: Why common sense goes out of the window. In B. Gawronski, & B. K. Payne (Eds.), *Handbook of implicit social cognition: Measurement, theory, and applications* (pp. 463–488). Guilford Press.

World Health Organization (WHO) (2015). *Global status report on road safety*. Geneva: World Health Organization.

Zambon, F., Fedeli, U., Marchesan, M., Schievano, E., Ferro, A., & Spolaore, P. (2008). Seat belt use among rear passengers: Validity of self-reported versus observational measures. *BMC Public Health*, *8*, 233. https://doi.org/10.1186/1471-2458-8-233.

Rubén D. Ledesma is a doctor in Psychology and researcher of the National Scientific and Technical Research Council (CONICET). He is a professor at the National University of Mar del Plata. His principal areas of research include traffic psychology, road safety, injury prevention, research methods and psychological assessment.

Jeremías D. Tosi is a Psychology doctoral student at the National University of Mar del Plata and the National Scientific and Technical Research Council (CONICET). His research interests include traffic psychology, road safety and injury prevention.

Carlos M. Díaz-Lázaro earned his Ph.D. in Counseling Psychology from the University at Buffalo. He is a contributing faculty at Walden University. His primary research interests are in the areas of multicultural psychology and intergroup relations.

Fernando M. Poó is a doctor in Psychology and researcher of the National Scientific and Technical Research Council (CONICET). He is a professor at the National University of Mar del Plata. His research focuses on the traffic psychology, road safety and injury prevention.