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Implicit attitudes and road safety behaviors. The helmet-use case

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ABSTRACT

We studied the role of implicit attitudes on road safety behaviors. We also explored the methodological benefits of using implicit measures to complement conventional self-reporting instruments. The results suggest that: (a) implicit attitudes are capable of predicting observed differences in the use of protective devices (helmet use); (b) implicit attitudes correlate with the emotional component of the explicit attitudes (e.g., perception of comfort–discomfort), but appear to be independent of the more cognitive components (e.g., perceived benefits); (c) the emotional component of the explicit attitudes appears to be the major predictor of behavior; and (d) implicit measures seem to be more robust against social desirability biases, while explicit measure are more sensitive to such bias. We conclude that indirect and automatic measures serve as an important complement to conventional direct measures (self-reports) because they provide information on psychological processes that are qualitatively different (implicit) and can also be more robust when it comes to response bias.

1. Introduction

Research on risk behaviors have increasingly included automatic tasks to measure implicit attitudes and to complement conventional methods assessing explicit attitudes (e.g., questionnaires and attitude scales) (Fernandes et al., 2006; Houben et al., 2010; Glock et al., 2014). There are two important reasons for this. First, implicit and explicit attitudes represent differential psychological processes (Gawronski and Bodenhausen, 2011), each one of which may contribute to explain risky and/or protective behaviors. Second, while explicit measures are sensitive to response bias (Briñol et al., 2001), implicit measures provide more robust estimations because subjects are unable to manipulate or voluntarily adjust their responses. Thus, implicit measures may be able to overcome some of the intrinsic problems of traditional explicit techniques that have been the object of criticism in the field of road safety (e.g., af Whalberg, 2010).

This paper focuses on implicit attitudes toward road-safety measures, particularly helmet use. It seeks to show the methodological possibilities of a particular automatic measure, the Implicit Association Test (IAT, Greenwaldet al., 1998), and contribute to a better understanding of the role of implicit and explicit processes on road behavior. This first section is organized as follows. First, we will provide a brief theoretical framework on implicit attitudes. Second, we will describe the IAT as a paradigmatic case of an implicit attitudes measure, and discuss its use in a number of traffic psychology studies. Lastly, we will provide a justification for the present study and state its hypothesis and objectives.

1.1. Distinction between explicit and implicit systems

Studies establishing the distinction between explicit and implicit attitudes are based on concepts and methods derived from dual-process models (Gawronski and Bodenhausen, 2011). These models share the idea that human behavior is determined by two cognitive systems that are qualitatively different but capable of interacting (Strack and Deutsch, 2004; Fazio, 2007). On the one hand, there exists an explicit system based on processes that are controllable, rational and based on rules. And on the other, an implicit system that operates through processes that are more automatized and speedier, and that can occur without conscious awareness. From this perspective, two types of attitudes can be distinguished. On the one hand, we have explicit attitudes that are associated with propositional processes that allow for the construction of deliberate and conscious evaluative judgments on a given object (Gawronski and Bodenhausen, 2006). These types of attitudes can be measured with conventional self-reporting techniques, such as questionnaires and Likert scales. On the other

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hand, we have implicit attitudes that are based more on associative processes and that imply the automatic and spontaneous activation of evaluations that are not necessarily conscious for the subject (Gawronski and Bodenhausen, 2011). Measuring implicit attitudes requires special instruments that automatically activate such "associations" while not permitting the subject to control his or her performance on the task. The IAT is one such implicit attitude measure (Greenwald et al., 1998), and there are others as well, such as semantic priming, evaluative priming, go–no-go association task, affect misattribution procedure and the Stroop task (Blair et al., 2015).

It is important to note that on occasion the two types of attitudes can enter into conflict, each pushing the subject to take a different course of action. In such circumstances, the subject's behavior depends on which of the two processes is strong enough to impose itself on the other (Deutsch and Strack, 2006; Strack and Deutsch, 2004). Some theorists maintain that the implicit system tends to prevail due to its impulsivity and because it is oriented in the present (e.g., Epstein et al., 1996). Others, however, suggest that the determining factor is the opportunity to control the behavior in question (Fazio and Towles-Schwen, 1999; Strack and Deutsch, 2004). The great debate around this point has revived research on attitudes and its possible applications.

Another point of debate revolves around the nature and degree of relationship between explicit and implicit measures. Although early research indicated low to non-existent correlations between the two types of measures, later studies demonstrated that high correlations could be attained (Hofmann et al., 2005), suggesting that there might exist factors that act as moderators in this relationship (Nosek, 2007). Some theorists have proposed interesting explanations as to how explicit and implicit processes might interact (Whitfield and Jordan, 2009), but additional empirical research is still needed.

1.2. The Implicit Association Test (IAT)

The IAT (Greenwald et al., 1998) is the most widely used measure in the evaluation of implicit attitudes. This instrument was initially developed to evaluate social prejudice, but it has been adapted to measure other constructs (self-concept, attitudes, etc.) and areas of behavior (Greenwald et al., 2009). In the IAT, stimuli representing four categories (e.g., helmet use, helmet non-use, good and bad) must be sorted as quickly as possible under two sets of instructions. Under the first set of instructions, items identified as "helmet use" and "good" are to be categorized through a predetermined response (e.g., typing "E" on a computer keyboard) and items identified as "helmet non-use" and "bad" are to be categorized through an alternative response (e.g., typing "I" on a computer keyboard). Under the second set of instructions, items identified as "helmet non-use" and "good" are to be categorized through the predetermined response (e.g., typing "E" on a computer keyboard) and items identified as "helmet use" and "bad" are to be categorized through the alternative response (e.g., typing "I" on a computer keyboard). The difference in response time under one set of instructions and the other is considered indicative of the associative strength between the objects and the evaluations. A quicker response time when "helmet-use" is paired with "good" and "helmet non-use" is paired with "bad" is considered indicative of a preference for helmet use (or of a "positive implicit attitude" toward this safety device).

Previous studies provide evidence in support of this simple procedure as a means of evaluating implicit attitudes. The IAT has shown adequate levels of internal consistency (from .70 to .90, Nosek et al., 2007), and in general it is more reliable than other measures of this type (Bar-Anan and Nosek, 2014). This is important considering that response-time-based measures tend to be less reliable when compared to other psychometric measures. In terms of evidence of the IAT's validity, a meta-analysis by Greenwald et al. (2009) revealed several interesting points. According to the authors, IAT scores are able to predict social behavior in various areas, from political preference to attitudes on drug use. They also suggest that the IAT tends to show better predictive validity than self-reporting instruments in areas considered socially "sensitive" (e.g., racial prejudice). In these cases, both methods tend to be poorly related. On the other hand, in areas less sensitive (e.g., consumer preferences), the IAT and self-reporting techniques seem to generate more convergent results, and explicit measures tend to show greater predictive validity.

If we consider the IAT's convergent validity with other implicit measures, the evidence is not as clear because significant correlations between the IAT and other tasks have not been found (Olson and Fazio, 2003). This is typically attributed to measures reliability problems, which attenuates the correlation between the different techniques (Nosek et al., 2007). It has also been said that the low correlations may be due to differences in the cognitive processes involved by the various measures, and consequently in the constructs they measure. Certainly, some authors point out the need to not only improve the reliability of implicit measures, but also to clarify their conceptual basis (Spence, 2005). What is clear is that of all these measures, the IAT has generated the greatest volume of research in terms of its internal validity. Among other things, researchers have looked at the possible effect of familiarity of stimulus items, order of combined tasks, previous experience with the IAT, intertrial interval duration, fakeability, etc. (Nosek et al., 2007). Variations of the IAT have also been suggested to overcome some of its possible limitations. For instance, some consider it is too long, and a shorter version has been proposed. Additionally, there has been debate on whether the IAT really measures personal evaluations rather than extrapersonal associations, and this has led to a proposed variant called the personalized IAT. However, there is less evidence of validity for these proposed variants and, in the majority of cases, less reliability (Teige-Mocigemba et al., 2010). To sum up, the IAT is the most widely used measure of implicit attitudes, and its measurement properties have been the most studied.

1.3. The Implicit Association Test in road safety research

Previous studies have used the IAT to explore attitudes toward risky driving behaviors. Fernandes et al. (2006) evaluated implicit attitudes toward several behaviors (i.e., speeding, drunk driving, driving while fatigued and driving while not wearing a seat belt) and their relationship with explicit measures based on the Health Belief Model (e.g., severity and perceived susceptibility, barriers and perceived benefits). The results varied substantially by the type of behavior analyzed, but low to null correlations between the IAT and the explicit measures were generally observed. A problem we observed in this study is the manner in which the researchers defined the verbal stimuli used in the IAT to refer to risk behaviors. For example, when evaluating "drunk driving" behavior, the stimuli used included "irresponsible" and "dangerous." Not only are these stimuli not specific to the behavior being evaluated (object of the attitude), they also have a negative connotation in and of themselves. The authors themselves admit this is an issue; in our opinion, it poses a significant construct validity problem.

Another important study involving the IAT was undertaken by Hatfield et al. (2008). They used the IAT to evaluate attitudes toward speeding, together with self-reporting measures (attitudes and behaviors related to speeding) and performance measures using a driving simulator. The IAT was positively correlated with a "Feeling thermometer" and with semantic differential item measures of speeding-related attitudes ($r = .44$ and $r = .45$,

respectively). Negative implicit attitudes were significantly associated with a stronger belief that speed limits are too high ($r = .38$), a higher perceived risk of being caught speeding ($r = .37$), and a lower self-reported likelihood of speeding ($r = -.45$. Also, the IAT tended to correlate negatively, from a slight to moderate degree, with several measures of speeding on the driving simulator. The strongest relationship was between the IAT and the percentage of recordings in excess of the speed limit in the 70 and 80 km/h speed zones ($r = -0.47$).

One possible critique of the above-cited studies is that the target behaviors being predicted were not directly documented or observed in a natural context. In fact, they were evaluated through self-reports, thereby introducing possible measurement biases. Further, although the use of simulators allowed for a more objective evaluation of conduct, it might also present problems in terms of external validity (Carsten and Jamson, 2011). A more valid approach to assess the IAT's predictive ability would be to evaluate the behaviors being predicted in a more direct way; for example, via observation in a natural context. Obviously, this is not easy for some behaviors and can also prove costly, but it would provide a more solid basis on which to judge the usefulness of the IAT to predict real behavior.

1.4. Justification and objectives of the present study

Research on implicit attitudes may further our understanding of the psychological processes that explain risk behaviors. First of all, it is important to determine if and to what extent implicit attitudes contribute to an explanation of risk behaviors independently of what can be explained by explicit attitudes. In driving behavior research, the evidence generated by the IAT is limited to certain areas and, given the IAT's potential, it deserves further study. Some of the important questions that require further research include: Is the IAT able to discriminate between known risk groups? How is it related to conventional explicit measures? Is it robust in terms of response biases such as social desirability? These are some of the general questions that guide our research.

In this study, we evaluated explicit and implicit attitudes toward a particular safety measure: helmet use. We selected this behavior for two reasons. First, over the past several years, Argentina has experienced a pronounced increase in motorcycle crashes, a phenomenon that is also common to other developing countries in both Latin America and Asia (WHO, 2013). The problem is aggravated by the low rate of helmet use, which is associated with higher indices of morbidity and mortality (Ledesma et al., 2014). The second reason is an important methodological one: helmet use can be observed in a simple and reliable manner, without needing to resort to self-reporting techniques. As previously mentioned, direct observation is important to adequately evaluate the validity of the IAT's scores in predicting real road behaviors. In our case, the degree to which the IAT's scores are capable of differentiating subjects who do not use helmets and subjects who do.

Lastly, the objectives of this study are to: (a) evaluate the capacity of the IAT to discriminate between groups of drivers defined according to observable differences in terms of a risk behavior (i.e., subjects who do and do not use a helmet); (b) analyze the relationship between explicit and implicit attitude measures; and (c) determine the robustness of both explicit and implicit measures in terms of possible social desirability biases. We expect that subjects who use helmets will have more positive implicit and explicit attitudes toward this safety measure. Based on previous studies, we also expect a low to moderate positive relationship between implicit and explicit measures. Lastly, we expect explicit attitudes to correlate with a social desirability measure, and implicit measures to show themselves to be independent.

2. Method

2.1. Participants

A total of 194 motorcyclists, all legal adults, initially participated in the study. All were administered an explicit self-reporting instrument, which allowed us to perform an analysis of this measure's factorial structure. Of this sample, a subsample of respondents were also administered the IAT ($n = 53$). In this subsample, two comparison groups were formed: (a) safe group: comprised of 27 helmet-using motorcyclists; and (b) risk group: comprised of 26 helmet-non-using motorcyclists. Both groups had similar distributions in terms of gender and age. Additionally, the IAT was also administered to a group of 10 road-safety and traffic–injury–prevention experts, which served as a comparison group and which we expected to show strong and positive implicit attitudes toward helmet use.

2.2. Instruments

2.2.1. Self-reporting instrument

A questionnaire was designed to capture the following informations: (a) socio-descriptive data (age, gender and education level) and behavior (helmet use habits, motorcycle use patterns, etc.); (b) data on intention to use a helmet; and (c) explicit attitudes toward helmet use. The latter were evaluated by a set of items that contained varying statements on helmet use (see Table 1). A Likert-type response scale was used (from 1 "totally disagree" to 5 "totally agree"). In principle, an attempt was made to cover a wide gamut of issues, from the usefulness to the

Table 1
IAT on attitudes toward helmet use. Task sequence.

Block	Number of trials	Task	Response key assigned	
			Left key "E"	Right key "I"
1	20	Discriminating object categories	Helmet use	Non-helmet use
2	20	Discriminating attributes	Positive	Negative
3	20	Initial combined task	Helmet-use, positive	Non-helmet use, negative
4	40	Initial combined task	Helmet-use, positive	Non-helmet use, negative
5	20	Discriminating inverted object categories	Non-helmet use	Helmet use
6	20	Inverted combined task	Non-helmet use, positive	Helmet use, negative
7	40	Inverted combined task	Non-helmet use, positive	Helmet use, negative

functionality of helmet use. Helmet-use intention was evaluated by four items (e.g., "I am willing to always use a helmet") with high internal consistency (Cronbach's alpha = .87).

2.2.2. Implicit Association Test

In order to measure implicit attitudes, we developed an IAT based on the recommendations and procedures of Nosek et al. (2007). We used the IAT template found in the Inquisit software's library (Milisecond Software, 2008) as a starting point to develop and administer the test. The IAT basically consists of measuring the reaction times of subjects in a stimuli classification task. In this study, the target attitude (helmet use) was presented via 22 photographs of motorcyclists (11 using and 11 not using a helmet). The photographs were obtained from a variety of online public domain image banks. Additionally, we used words with positive and negative valences ("good" vs. "bad" categories) drawn from the standard version of the IAT (e.g., love, happiness, hate, sadness, etc.). The IAT task consisted of seven blocks (see Table 1). Blocks 1 and 2 served as practice blocks. Participants were instructed to categorize target objects and evaluative attributes. For block 1, subjects were told to press the "E" key on a keyboard when presented with stimuli representing the category "helmet use" and the "I" key when the stimuli represented "non-helmet use." In the second block, subjects were instructed to press the "E" key to categorize stimuli consist of words with positive valence, and the "I" key for "negative" stimuli. In blocks 3 and 4, the four categories were combined in the two response keys (compatible blocks). For these blocks, subjects were to press the "E" key for stimuli that were "positive" or represented "helmet use," and the "I" key for those that were "negative" or represented "non-helmet use." Block 5 is a practice block again, this time with the categories switched. Participants were to press the left key for "non-helmet use" and the right key for "helmet use." Lastly, for blocks 6 and 7, the attributes and attitude objects were inversely combined (incompatible blocks). Participants were to press the "E" key for "positive" or "non-helmet use" stimuli, and the "I" key for "negative" or "helmet use" stimuli. IAT results are based on the difference in response time between compatible blocks (3 and 4) and incompatible blocks (6 and 7). Results indicate the relative preference for helmet use over non-helmet use. A positive score is interpreted as a positive implicit attitude toward helmet use (preference for helmet use) and a negative score as a negative implicit attitude (preference for non-helmet use).

2.2.3. Social desirability measure

An abridged version of the Marlowe–Crowne Social Desirability Scale (MC-SDS) (Strahan and Gerbasi, 1972) was used to evaluate social desirability bias. This instrument has twenty dichotomous items ("True" or "False") that evaluate an individual's need for social approval as reflected in responses that are culturally appropriate and acceptable (Crown and Marlowe, 1960) (example item: "I am always courteous even to people who are disagreeable").

2.3. Procedure

Although participants were recruited at several locations, most were recruited from the parking areas of the National University of Mar del Plata. Before approaching a potential subject, the recruiter observed whether or not the individual used a helmet, and then invited him or her to volunteer for the study. Those observed not using a helmet were assigned to the risk group, while those observed using a helmet were assigned to the safe group. Those who agreed to participate were led to the research team's office, where they were asked for their informed consent and then given the instruments to complete.

The IAT was administered on a Toshiba Satellite C645 Notebook computer with a 14 inch screen. The IAT and the self-reporting instrument were administered in alternating order. The conditions under which both were administered were uniform for all participants. Participants were evaluated in a peaceful environment free of stimuli that might interfere with the task, and with a researcher present throughout. The data were managed and analyzed with SPSS.

3. Results

3.1. Exploratory factor analysis of attitudes questionnaire

The attitudes questionnaire administered to the overall sample ($n = 194$) was subjected to a first factor analysis

Table 2
Factor loads for items in the Discomfort and Safety Factors.

The helmet	Factor	
	Discomfort	Safety
1. Makes me feel really uncomfortable	.88	
2. Is something I do not like using	.80	
3. Ruins the feel of riding a motorcycle	.79	
4. Is bothersome when it is hot	.76	
5. Might be mandatory on highways, but not on city streets	.75	
6. Is not necessary when riding at low speeds	.73	
7. Is not very practical (it is a bother to carry around, etc.)	.72	
8. Can reduce the driver's field of vision	.54	
9. Looks aesthetically bad	.53	
10. Should not be mandatory	.48	
11. Reduces one's ability to hear	.47	
12. Makes me feel ridiculous	.46	
13. Makes driving a motorcycle more comfortable	−.34	
14. The municipality should do more to enforce its use	−.33	
15. Is not good for anything		−.95
16. In an accident, it can lessen head injuries		.94
17. In an accident, it can save my life		.54
18. Is necessary only in terms of avoiding fines	.32	−.51
19. Is an indispensable safety measure		.46
20. Makes me feel safer		.37
21. There are various models, but the full-face helmet is the safest		.34
22. It is best if it has vivid, light colors and is made of reflective material		.30

Extraction method: maximum likelihood. Rotation method: varimax.

(extraction: maximum likelihood, rotation: varimax). A clear two-factor solution was obtained (based on the scree plot and the parallel analysis results), with 22 items having factors loadings greater than .30 in the first two factors. Later, a factor analysis was again applied, but only to these 22 items. This second factor analysis revealed two factors that accounted for 46.7% of the variance and were theoretically interpretable (KMO = .75, Bartlett's test; Chi-square (231) = 769,808, $p < .001$) (see Table 2).

The first factor was comprised of 14 items that referred to feelings of discomfort, lack of functionality and practicality in the use of a helmet. We called this the "Discomfort Factor." This factor has a strong emotional component and is associated to feelings of pleasure–displeasure in the use of a helmet. The second factor was comprised of 8 items that referred to perceptions of the helmet's usefulness as a preventive measure. This factor is more evaluative and cognitive, given that it involves arguments in favor and against helmet use. We called this the "Safety Factor".

Based on these results, the attitudes questionnaire was handled as a measure formed by two sub-scales. We worked with the scores each subject obtained in each one of the two factors. High factorial scores in the Discomfort Factor indicated a more negative attitude, and low scores a more positive attitude. Conversely, high scores in the Safety Factor indicated a more positive attitude and vice versa.

3.2. Helmet use, implicit and explicit attitudes

The safety group, though, had a greater implicit preference in favor of helmet use (see Table 3) than the risk group $t(51) = 1.79$, $p = .039$, Cohen's $d = 0.5$. We also observed that the expert group's preference for helmet use tended to be greater than that of the two other groups. For example, the difference of means between the expert and risk groups was Cohen's $d = .59$. These differences, however, were not significant, possibly due to the small size of the expert sample. With respect to the explicit measures, the risk group had a greater perception of discomfort than the safety group, $t(51) = -5.75$, Cohen's $d = -1.58$; and a lesser perception of Safety, $t(51) = 1.54$, Cohen's $d = .42$.

A more refined analysis using MANCOVA generated similar results. The risk and safe groups were compared ("Group" factor) across three variables simultaneously (IAT, Discomfort Factor and Safety Factor), along with other control variables (gender, age, years of driving experience and the order in which the instruments were administered). The MANCOVA showed significant differences for the Group factor, $F(3, 41)$ 8.763, $p < .001$. The univariate ANOVAs indicated significant differences in the three variables: IAT, $F(1, 43) = 4782$, $p < .05$; Discomfort, $F(1, 43) = 17{,}166$, $p < .001$; and Safety, $F(1, 43) = 5279$, $p < .05$.

3.3. Intention to use a helmet

First of all, and as logic would dictate, the safe group showed greater helmet-use intention than the risk group, $t(51) = 7.53$. An analysis of the relationship between use intention and attitudes revealed the results shown in Table 4. We found that helmet-use intention increases with a more positive implicit attitude. A similar though somewhat weaker correlation was found between use intention and the Safety Factor. Lastly, a strong, negative correlation was found between use intention and the Discomfort Factor. In other words, the greater the perception of discomfort, the lesser the use intention.

3.4. Correlation between implicit and explicit attitudes

The results suggest a moderate negative correlation between the IAT and the Discomfort Factor ($r = -.45$, $p < .01$). In other words, the implicit preference for helmet use increases as the perception of discomfort from its use decreases, and vice versa. On the other hand, with respect to the Safety Factor, the implicit measure proved to be independent of the explicit measure ($r = -.16$, $p > .05$).

3.5. Social desirability

Pearson correlations between the social desirability scale and the different measures were obtained (Table 4). The only significant correlation, albeit weak, was found with the Discomfort Factor. Additionally, we also looked at the relationship between the desirability scores and the helmet-use observation. No difference in desirability was found between those using and those not using a helmet, $t(51) = .73$, $p = .47$.

3.6. Actual vs. self-reporting frequency of helmet wearing

Finally, an interesting result arises when comparing actual vs. self-reporting helmet wearing. Table 5 shows the reported frequency of use (according to the questionnaire responses) between those who wore helmet and those who did not at the moment of the observation. It can be observed an important difference in the latter group.

4. Discussion

This study presents various interesting results on the relationship between risky behavior and implicit and explicit attitudes. One important finding is that implicit attitudes are associated with behavioral intention and, what is even more significant, with actual helmet-use behavior itself. In effect, the IAT was capable of discriminating between those who were observed using a helmet and those who were observed not using a helmet, with those using a helmet having more positive implicit attitudes. This result is consistent with previous studies that found a relationship between implicit attitudes and risky road behaviors (e.g., Hatfield et al., 2008), but adds value to this finding because the behavior was directly observed in a natural context, which, in our opinion, provides greater internal and external validity to the study. In this sense, an interesting complementary result emerged when

Table 3
Summary statistics for the groups.

	Implicit measure IAT Mean (SD)	Explicit measure Discomfort Factor Mean (SD)	Explicit measure Safety Factor Mean (SD)	Age Mean (SD)	Gender (% male)
Risk group (helmet non-use) $n = 26$	0.42 (.78)	0.69 (0.94)	−0.24 (1.4)	30.1 (6.77)	74.1
Safe group (helmet use) $n = 27$	0.74 (.44)	−0.53 (0.55)	0.18 (.20)	28.5 (6.77)	81.5
Expert group $n = 10$	0.80 (.41)	–	–	44 (14.12)	50

Table 4
Pearson correlations between use intention, IAT scores, Discomfort and Safety Factors, social desirability and actual helmet wearing.

	Implicit attitude (IAT)	Explicit attitude (Discomfort Factor)	Explicit attitude (Safety Factor)	Intention to use a helmet	Actual helmet wearing[a]
Implicit attitude (IAT)	–				
Explicit attitude (Discomfort Factor)	−.45**	–			
Explicit attitude (Safety Factor)	−.16****	−.014****	–	–	
Intention to use a helmet	.30*	−.80**	.25*	.25*	–
Actual helmet wearing[a]	.25*	.62**	.20***	.71**	–
Social desirability	.19***	−.27*	−.12***	−.19***	.08***

[a] r is estimated via Cohen's d in order o provide comparative effect sizes. d is computed by comparing safety and risk groups.
* $p < .05$.
** $p < .01$.
*** $p > .05$.

Table 5
Actual vs. self-reporting frequency of helmet wearing.

How often do you wear a helmet when you ride a motorcycle?	Actual helmet wearing	
	Helmeted ("Safety Group") (%)	Unhelmeted ("Risk Group") (%)
Always	85.2	37.0
Almost always	14.8	18.5
Occasionally	.0	11.1
Rarely	.0	14.8
Never	.0	18.5
Total	100.0	100.0

comparing the observed behavior with the self-reported behavior. For instance, of those observed not using a helmet, 55% self-reported using it always or almost always, in stark contrast to the observed behavior.

Explicit attitudes were also capable of differentiating between the safe and risk groups, and to do so in its two dimensions: emotional (perception of discomfort) and cognitive (perception of safety). Perception of discomfort was associated negatively with helmet use, while perception of safety was correlated positively. However, the emotional component was clearly the stronger of the two. The emotional dimension showed a strong correlation with behavioral intention and was capable of clearly discriminating between those who use and those who do not, even better than the IAT itself. Evidently, the emotional component plays a critical role in the adoption of this safety measure. As shown in previous studies, negative feelings associated with helmet use (e.g., inconvenience) tended to be an argument put forth by those who do not use a helmet (Orsi et al., 2012; Zamani-Alavijeh et al., 2011).

Another interesting finding is that implicit attitudes were associated with the emotional component of explicit attitudes (a strong negative correlation with Discomfort Factor was found), but not with the cognitive component (Safety Factor). This result is consistent with what some theorists in this area have suggested (e.g., Smith and Nosek, 2011). One possible explanation is that the IAT measures responses based mainly on emotional information and, consequently, correlations increase when the self-reporting instrument is focused on the emotional component of the attitudes (Hofmann et al., 2005). However, there is not general agreement on the existence of a relationship between implicit attitudes and emotional processes. While some maintain that implicit processes are defined in emotional terms (Gawronski and Bodenhausen, 2011), others believe that they may be based on diverse sources of information, both cognitive and emotional (Fazio, 1995). In any event, it would be interesting for future research to further explore the relationship between emotions and implicit attitudes toward risky road behavior.

Lastly, another objective of this study was to determine the relative independence of both measures, explicit and implicit, with respect to possible social desirability bias. The data indicate that explicit evaluations were slightly associated with a social desirability measure, but not with the IAT scores. This result is methodologically important and, in principle, supports the idea that implicit measures can be more robust when exploring behaviors, preferences and attitudes that may be socially unacceptable (Greenwald et al., 2009). In the case of road behavior, this finding appears to be particularly relevant considering that risky behaviors generally involve traffic violations. However, it is also important to make the following point about social desirability measures like the Marlowe–Crowne scale. Although the use of this type of instrument is recommended for road safety research (e.g., af Wählberg, 2010), some specialists have criticized this measure, maintaining that it does not necessarily measure response bias (Uziel, 2010). In the future, it would be good to devise alternative ways to evaluate possible response biases in both explicit and implicit measures. For instance, it would be interesting to determine if the conditions under which the instrument is administered can generate greater desirability (e.g., face-to-face vs. self-administered), and determine to what degree this effect is more or less pronounced in implicit compared to explicit measures.

4.1. Limitations and future lines of research

Various aspects related to the study of implicit attitudes in road safety deserve to be further explored in future research. First, our study did not consider possible factors that might moderate the relationship between explicit and implicit processes. Some dual process theories (Fazio, 2007; Gawronski and Bodenhausen, 2011) suggest there are important moderators, such as the degree of cognitive elaboration associated with the topic. For example, in the field of road safety, the degree of cognitive elaboration could vary significantly depending on whether the object of the attitude is a relatively simple "habit"—such as helmet use—or a more complex

behavior—such as drinking and driving. We believe future research should focus on clarifying the conditions under which the systems are related and in what manner they interact to explain specific road behaviors.

There are also methodological lines of future study. First, it is necessary to continue reviewing and improving the techniques used to measure implicit processes in order that these techniques effectively measure what they are meant to measure (Payne et al., 2008; Han et al., 2010). Additionally, in the field of traffic psychology, it is important to continue promoting multi-method approaches that use other sources of data (e.g., observations in natural setting, driving simulators, etc.) to validate the results of automatic measures. The main advantage this study has over previous ones is the application of such an approach; mainly, the use of direct observation of the behavior being studied as a way to differentiate distinct groups. The information provided by the direct observation of the behavior enabled us to estimate with greater precision the predictive validity of the IAT and the explicit measures.

Lastly, another limitation of our study is that we focused on a specific population and behavior (helmet use by motorcyclists). Additionally, we are aware that our sample was small and was obtained in a particular socio-cultural context. Consequently, it is important to continue studying the possibilities, and the advantages and disadvantages, of the IAT with other populations and in different areas of road safety. It would also be interesting to study the possibilities of these types of measures to assess other constructs related to road safety (e.g., drivers' self-concept, gender prejudice among drivers, implicit risk perception, etc.).

4.2. Regarding the use of the IAT in road safety

Besides their usefulness for scientific research, measures like the IAT have the potential for other, interesting applications. Certainly, it would not be difficult to develop tools to evaluate in an automatic/implicit way key aspects for road safety that are difficult to evaluate in a reliable fashion with self-reporting methods (for example, attitudes toward drinking and driving). The principal discussion would be on the scope and areas of application. Should measures like the IAT be used, for instance, for diagnostic purposes or for driver selection?

Nosek et al. (2007) warn that although the evidence of validity for the IAT is convincing, we are a long way from understanding its practical applications. The authors state that it would be "premature to use the IAT as a diagnostic indicator for conclusions that have important, direct, and personal consequences," which would be the case when an individual seeks to obtain a drivers' license. In this sense, they suggest that the IAT could be regarded "as a useful adjunct to diagnosis than to treat it as a self-sufficient procedure." The authors also propose using the IAT for educational purposes, where it could serve "to afford insight into automatic associative processes that are introspectively inaccessible." It could be used, for example, in a driver's education course as a self-evaluation tool to give students insight into their preferences for certain risky road and safety behaviors.

In conclusion, the possibilities are myriad, but greater evidence of its validity is indispensable before it is used in specific contexts, such as in the evaluation or education of drivers. We hope to see new advances in this field in the near future.

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