sustainability

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Cognitive Biases, Risk Perception, and Risky Driving Behaviour

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Abstract: This study evaluated the relationship between drivers' cognitive biases (i.e., optimism bias, illusion of control) and risky driving behaviour. It also investigated the mediational role of risk perception in the relationship between cognitive biases and self-reported risky driving. The sample included 366 drivers (Mage = 39.13, SD = 13.63 years) who completed scales measuring optimism bias, illusion of control, risk perception, and risky driving behaviour, as well as demographic information. The results showed that risky driving behaviour was negatively predicted by optimism bias and positively predicted by the illusion of control. Further, risk perception negatively correlated with risky behaviour and also mediated the relation between both optimism bias and illusion of control with risky driving. The practical implications of these results for traffic safety and future research are discussed.

Keywords: optimism bias; illusion of control; risk perception; risky behaviour

Citation: Măirean, C.; Havârneanu, G.M.; Barić, D.; Havârneanu, C. Cognitive Biases, Risk Perception, and Risky Driving Behaviour. *Sustainability* **2022**, *14*, 77. https://doi.org/10.3390/su14010077

Academic Editor: Adelino Jorge Lopes Ferreira

Received: 10 November 2021
Accepted: 15 December 2021
Published: 22 December 2021

1. Introduction

Risky driving includes behaviours that pose a threat to the driver and to other road users, such as speeding, red-light running, tailgating, not using safety belts, drunk driving, etc. [1–3]. A body of research suggests that a substantial number of traffic accidents are related to cognitive impairments and decreased driving performance caused by alcohol or other drugs. For example, a comprehensive investigation of driving simulator-based research on alcohol-impaired driving behaviour [4] indicates the growing interest of researchers in investigating the relationship between alcohol and driver behaviour. The study highlights methodological issues observed in the literature and the fact that alcohol-impairment research is a multidisciplinary area that includes engineering, medical, psychological, sociological, and legal aspects. Both the average volume of alcohol and binge drinking are associated with hazardous driving behaviour and traffic crashes [5]. Studies also show that alcohol consumption can influence the driver's self-perception, and suggest that drivers might perceive themselves as more fit to drive after drinking [6]. However, when the driver is not drunk or intoxicated, an important determinant of risky judgment or driving is represented by cognitive biases related to personal driving skills evaluation, personal control and perceived vulnerability in traffic [7–9]. Two common types of biases are represented by the judgement that negative events are more likely to happen to others than to the self, also called optimism bias [10], and the overestimation of personal control over events (i.e., illusion of control) [11]. A limited body of literature suggests that the biases in cognitive appraisal relating to control and optimism about future outcomes are likely to decrease risk perception and increase risky driving [7,12,13]. In order to be effectively targeted in safety campaigns and training programs, more insight is needed about the association of both optimism bias and illusion of control with driving behaviours.

The concept of optimism bias was first used by Weinstein [10] in the field of health psychology, to describe peoples' tendency to believe they are more invulnerable to negative events, compared with their peers. Later research has evaluated optimism bias as the perceived chances of experiencing future life events relative to the chances of peers and supported its presence in other life areas, like marriage, natural disasters, or road traffic [14,15]. Although optimism bias may improve self-esteem and motivation [16], a greater sense of invulnerability may also have harmful consequences, by leading people to engage in risky behaviour or to fail to take adequate precautionary measures [17,18]. However, on the contrary, another study found no association between optimism bias and risk taking [19].

Studies in traffic and transport psychology have shown that many drivers consider themselves less likely to expect a negative event in traffic (e.g., having a car crash, being fined, being injured or losing one's life) compared with their peers, e.g., [15,20]. Moreover, few studies confirmed positive yet weak relations between optimism bias and specific risky driving behaviours, such as not using the seat belt, driving under fatigue, or drunk driving [21,22].

Illusion of control is another related cognitive bias. Individuals with high illusion of control present two types of false beliefs: (i) that one can control the desired outcomes through personal skills, and (ii) that these personal skills are sufficient to prevent negative outcomes, when actually they do not [9,11]. Like optimism bias, illusion of control has been linked to risky behaviours, particularly in the health area [10] and gambling research [23,24]. In the traffic safety domain, illusion of control has been shown to have links with aggressive [7] and risky driving behaviours [3]. While all these studies are based on self-report measures, one can acknowledge that risky driving behaviour can be studied through several other methods such as the analysis of crash statistics, the use of a driving simulator, or naturalistic driving (ND) which uses the advantages of real-world conditions on driver performance and behaviour in normal, impaired and safety-critical situations [25–27].

The theoretical nature of these two cognitive biases concepts would point towards a relation between optimism bias, illusion of control and risky driving, but there is little or outdated empirical evidence for this relation. In addition, there is no clear understanding about how these two biases may jointly interact and make drivers take more risks. Moreover, although there is some evidence for the relations between optimism bias, illusion of control, and risky driving, there is a lack of understanding for the factors that may account for the relations between these cognitive biases and risky behaviours in traffic. One mechanism that can explain the relation between cognitive biases and risky driving behaviour may be risk perception. Risk perception in traffic is a widely studied variable in relation to risky driving behaviour, e.g., [28,29]. Different theoretical models, like the theories of reasoned action and planned behaviour [30], claim that the decision to engage in risky driving behaviours occurs through evaluating the risks and benefits of a given action. Most empirical studies report negative associations between risk perception and risky driving, e.g., [28,31–33]. Moreover, previous research documented the mediating role of risk perception in the relation between personal factors (e.g., self-efficacy, time perspective) and risky driving behaviours [32,34].

In order to better inform road safety campaigns about the implications of cognitive biases for traffic safety, the first aim of this study was to investigate the relation of optimism bias and illusion of control with risky driving behaviour in a sample of Romanian drivers. In line with the literature reviewed above, a positive association was expected between the two types of biases and risky driving (Hypothesis 1).

In Romania, according to the Association of road traffic crashes' victims (AVAC, Iași, Romania, 2016), every year, over 9000 people are seriously injured and are affected for the rest of their life, after a crash. Moreover, the Romanian context is of particular importance given the fact that Romania is a country with weak road safety records in the EU and is

in second position concerning the number of victims in road crashes (almost twice the number compared with the mean of EU) [35].

The second objective of the study was to explore whether risk perception mediates the relation between these two cognitive biases and risky driving behaviour. The expectation was that risk perception would mediate the relations between cognitive biases and risky behaviour (Hypothesis 2). Specifically, the expectation was that both optimism bias and illusion of control would be related with a low level of risk perception, which would be further related with a high level of the tendency to engage in risky driving. This hypothesis is based on the literature which indicates that individuals with high optimism bias and illusion of control may perceive that they are not at risk [12,20]. This belief may further determine drivers to be less motivated to adopt precautionary driving behaviours, and more likely to engage in risky behaviours [3,18,21].

2. Method

2.1. Participants

A total of 366 drivers took part in this study (Mage = 39.13; SD = 13.63). From the total sample, 50.8 % were women. The participants had been driving for 13.23 years on average (range 1–55, SD = 10.52 years). They reported that they had been involved in 0.45 active accidents (range 0–11, SD = 0.99), and in 0.81 passive accidents (range 0–10, SD = 1.31) on average during their lifetime.

2.2. Instruments

Optimism bias was measured using DeJoy's 10 short scenarios [12] that describe a crash-related situation that may occur while driving (e.g., "Bumping another vehicle while pulling from a parking lot"). For each scenario, the participants rated the likelihood of the event happening to them when compared with the average driver. Ratings were made on a 5-point Likert scale, ranging from 1 (much higher) to 5 (much lower). Higher scores indicated higher levels of optimism bias. In this sample, Cronbach's alpha coefficient is 0.71.

Illusion of control beliefs were measured using the same 10 DeJoy's scenarios [12]. For each of the 10 crash-related situations, participants were asked to rate the amount of control they would have, on a 5-point Likert scale ranging from 1 (no control, it is up to chance) to 5 (completely controllable). Higher scores on the scale indicated a stronger illusion of control beliefs. The scale had acceptable reliability in the current study (Cronbach's = 0.70). The Cronbach's alpha coefficient was comparable with that reported in a previous study [4].

Risk Perception Inventory [36] was used to assess the degree of risk perceived in different driving situations. The scale consisted of 35 items rated on a 5-point Likert scale ranging from 1 (not risky at all) to 5 (very risky). A total score was computed in this sample. Higher scores on the scale indicated a high level of risk perception. The Cronbach's alpha coefficient was 0.88. The scale was previously used on Romanian samples and showed adequate psychometric properties [37].

Risky driving behaviour was measured using items from two scales containing self-reported risky behaviours in a variety of traffic situations [38,39]. From the two scales, only 18 items were selected, specifically those which measured five classes of risky behaviours: speeding, drunk-driving, not wearing a seat belt, reckless driving, and violation of different traffic rules. The current version of the scale was previously adapted for the Romanian population [8,37]. The participants rated how frequently they manifested risky behaviours, using a 6-point scale from 0 (never) to 5 (very often). A total score was computed with high scores indicating a high level of engaging in risky behaviour. In this context, risky behaviour was considered a unidimensional construct in this study. In this sample, Cronbach's alpha coefficient was 0.75.

The demographic questionnaire asked participants to report their age, gender, the year they obtained their driving license, their total mileage, the number of accidents they

produced (i.e., active accidents), and the number of accidents they were involved in without being guilty (i.e., passive accidents).

2.3. Procedure

The protocol for the study was approved by the Ethical Committee of Alexandru Ioan Cuza University of Iași, Romania. Drivers selected from the general Romanian population were invited to take part in a study about traffic behaviour and perceptions. The sample was collected among personal acquaintances using the snowball technique, and aimed to achieve gender balance and a fair level of driving experience. After signing the informed consent form, the participants completed the self-report questionnaires in the following order: risk perception, risky driving, optimism bias, illusion of control, and demographics. They were informed that their participation was voluntary. Confidentiality of information was also assured. Only persons with a valid driving license were included in the study. There were no other exclusion criteria or restrictions based on demographic variables.

2.4. Overview of Statistical Analysis

First, preliminary analysis and correlational analysis were conducted to assess the relations between demographic information and the main study variables. Second, in order to verify the research hypotheses, a structural equation model (SEM) using Amos Graphic 22 was performed. For the evaluation of the overall model fit, four different fit indices were used: the chi-square statistic ($\chi 2$), the normative fit index (NFI), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA). A RMSEA < 0.05, $\chi 2/df < 3$, NFI and CFI > 0.90 indicated a very good model fit [40]. The significance of the mediation effects was assessed using the Tofighi and MacKinnon method [41], computing the confidence interval for the mediated effect. When zero was not in the confidence interval, the indirect effect was significant.

3. Results

3.1. Preliminary Analysis and the Associations among Main Study Variables

Descriptive statistics for the study variables are presented in Table 1. Participants' age and driving experience did not significantly correlate with optimism bias, illusion of control, risk perception, and risky driving behaviour, rs < 0.08, *p*s > 0.05. The independent sample t-test revealed significant gender differences in risky driving, $t(364) = -3.27$, $p < 0.001$, with a higher level of risky driving reported by men (men: M = 1.47, SD = 0.60; women: M = 1.27, SD = 0.51). Concerning optimism bias, illusion of control, and risk perception, there were not significant differences between men and women, all *p*s > 0.05. The associations among the main study variables are presented in Table 2. Optimism bias and illusion of control were negatively related to risk perception. Further, illusion of control was negatively related to risky driving behaviour. Risk perception was also negatively related to risky driving behaviour. The significant relations were small to medium [42].

Table 1. Means, standard deviations, and minimum and maximum values of the main study variables.

Variables	Mean	SD	Minimum	Maximum
1. Optimism bias	3.40	0.81	1.00	5.00
2. Illusion of control	2.21	0.92	1.00	5.00
3. Risk perception	3.20	0.49	1.47	4.35
4. Risky driving behaviour	1.37	0.56	0.17	3.44
5. Age	39.13	13.63	18	81
6. Driving experience	13.23	10.52	1	55

Table 2. Correlations among study variables.

Variables	1	2	3	4	5	6
1. Optimism bias	1					
2. Illusion of control	0.22 ***	1				
3. Risk perception	−0.16 **	−0.15 **	1			
4. Risky driving behaviour	−0.09 †	0.16 *	−0.20 ***	1		
5. Age	−0.06	0.007	0.08	−0.01	1	
6. Driving experience	−0.02	−0.02	0.03	0.05	0.78 ***	1

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, † $p = 0.062$.

3.2. Path Analysis Testing the Study Hypotheses

Next, the main effects of optimism bias, illusion of control, and risk perception were simultaneously tested on risky driving behaviour and the mediating role of risk perception on these relations. Gender, age, and driving experience were entered in the model as control variables. The fit for our overall model was very good: $\chi 2(7) = 10.93$, $p = 0.142$; NFI = 0.97; CFI = 0.99; RMSEA = 0.03, 95% CI (0.00–0.08). Standardized path estimates are presented in Figure 1. The model explained 12.8% of the variance in risky driving. Both optimism bias and illusion of control significantly predicted risk perception (β = −0.13, $p = 0.014$; β = −0.13, $p = 0.016$ respectively) and risky driving (β = −0.18, $p < 0.001$; β = 0.18, $p < 0.001$ respectively). Further, risk perception significantly negatively predicted risky driving behaviour (β = −0.19, $p < 0.001$).

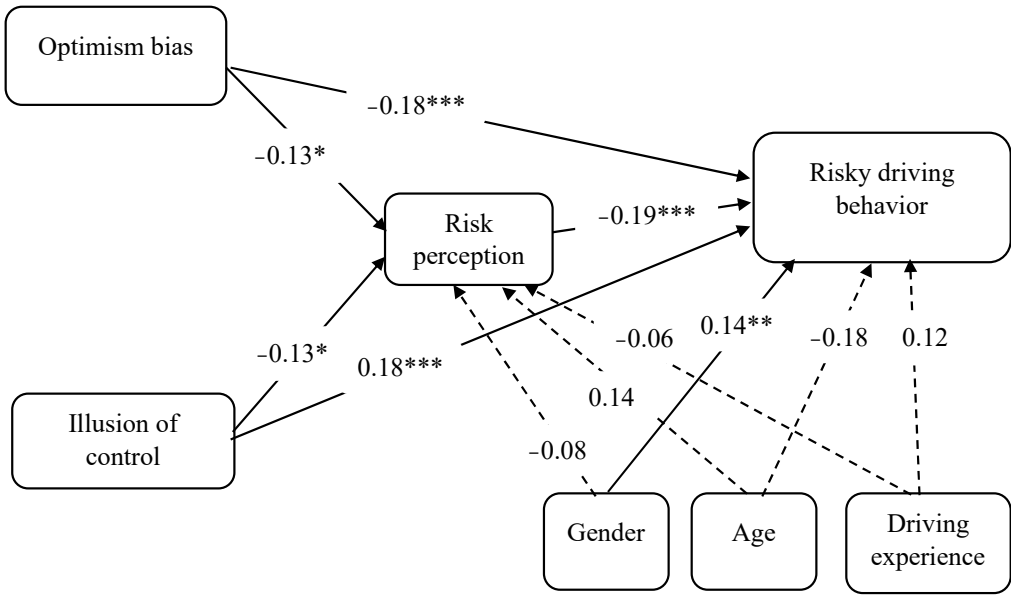

Figure 1. Path analysis of the determinants of risky driving behaviour (n = 366). Standardized path coefficients are reported. Non-significant paths are indicated with dotted lines. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

When the mediating paths were assessed, the results showed that risk perception mediated the relation of optimism bias with risky driving behaviour, estimate (SE) = 0.015 (0.008), 95% CI (0.002, 0.032). Moreover, risk perception mediated the relation of illusion of control with risky driving behaviour, estimate (SE) = 0.013 (0.005), 95% CI (0.004, 0.025).

4. Discussion

The present study investigated the relations of optimism bias and illusion of control with risky driving behaviour. Further, it explored whether risk perception mediates the relation between these two types of cognitive biases and the risky behaviour of drivers.

The results revealed that optimism bias was negatively predicted, whereas illusion of control positively predicted risky driving behaviours. Thus, contrary to expectations

(Hypothesis 1) and to previous research, e.g., [21,22], a high level of optimism bias was related to a low level of risky driving behaviour. This result suggests that drivers' belief that they are more invulnerable to negative events in traffic compared with their peers did not determine them to adopt risky driving behaviours. Perceived causal attributions for car crashes may moderate the relation between optimism bias and risky driving. Previous studies showed that optimism bias is more pronounced for events perceived as controllable (i.e., internal attribution) [10]. Further, perceived controllability is associated with desirable outcomes (see [43] for a review) and with a low tendency to engage in risky driving (e.g., [37]). It is possible that optimism bias cumulated with perceived controllability may be associated with positive outcomes, by facilitating safety goal attainment [16]. In other words, optimism bias may motivate drivers to take higher risks because they would feel less vulnerable; however, this may not be the case when drivers perceive the causes of a potential collision to be outside of their area of responsibility. Only if drivers evaluate themselves as having control over the situation and being responsible for traffic accidents, they may avoid risky driving, despite their optimism bias. However, future studies should assess this assumption and bring more evidence for the relation between optimism bias and risk taking in traffic by analysing the in-depth effects of perceived causal attributions.

Another interesting result of this study was that optimism bias is negatively related with risky driving, although it is positively related with risk perception in traffic. Therefore, drivers with a high level of optimism bias perceive low risks but do not engage in risky behaviours. Further, the results indicated an indirect effect of optimism bias on risky behaviour through risk perception, showing that risk perception acted as a suppressor variable for the negative relation between optimism bias and risky behaviour. This mediation suggests that optimism bias is negatively related with risk perception, and this perception suppressed the overall negative relation between optimism bias and risky driving behaviour. It is not the cognitive bias itself which determines risky driving; it is rather the perception about risks in different driving situations that emerges out of this bias which has an important role in driving behaviour. These findings confirm previous results that risk perception could be the specific way through which cognitive biases exert their influence on driving behaviour [20], and also extend previous literature by highlighting these relations in traffic psychology.

Concerning illusion of control, the findings are more straightforward. The results confirm the limited previous literature about its positive relation with risky driving [3]. As expected, a high illusion of control is related to a high tendency to engage in risky driving. Further, risk perception mediated the relation between illusion of control with risky behaviour. A high level of illusion of control is associated with a low level of risk perception, that is further associated with a high level of risky driving. Therefore, when participants present a high level of illusion of control, they are more prone to perceive low risk in different traffic situations, which further leads to a higher tendency to engage in risky behaviour. This type of cognitive bias should be addressed through safety campaigns and training, since literature shows that it generally appears when control is low (for a review, see [44]). The low level of control associated with low-risk perception and high engagement in risky driving behaviour may have detrimental consequences for traffic safety. Road safety campaigns and driver training programs could also target this particular scenario.

Certain limitations need to be considered when interpreting these results. First, the design was cross-sectional, and causal relations cannot be established between variables. As an example, the possibility that frequent engagement in risky driving increases the illusion of control cannot be excluded. Second, a global measure of risky driving was used, without differentiating between different types of risky behaviours. Although it would be easy to overcome this limitation by computing scores for each type of risky behaviour and re-run the analyses, it was decided to only use the global score of the scale to assure the same level of specificity in the measure of risk perception. The items from the scale designed to measure risk perception [36] are related to different types of risky driving behaviour, and the scale was designed as a unidimensional one. In other words, in this

study, risky driving behaviour was evaluated as a broad construct, and future studies could further focus on specific risky driving behaviours such as speeding, driving under influence, violation of other specific traffic rules, etc. Future studies should also investigate the explanatory mechanisms and buffering variables for the relation between cognitive biases and different types of risky driving behaviours on a larger sample. In addition, future studies can be conducted using research methods which can overcome the inherent limitations of self-report methods. For example, simulator- or ND-based research can reduce potential participant subjectivity by recording direct behaviours and can facilitate results extrapolation to real world conditions.

Despite the above limitations, the present findings help to extend the limited literature about cognitive biases and risky driving behaviour. Moreover, they can stimulate future research in order to increase our understanding about the relation between cognitive biases and risky driving. A challenging result consists in the negative association between optimism bias and risky driving, that deserves attention in future studies. From a practical point of view, the results inform practitioners working in road safety that, in order to reduce cognitive biases, we must also reduce risk perception. The differential associations between various cognitive biases and risky driving behaviour should also receive attention and be used to design traffic safety programs.

In summary, the current study showed an unexpected negative relation between optimism bias and risky driving and also a positive expected relation between illusion of control and risky driving. Moreover, the relation between the two cognitive biases and risky driving is mediated by risk perception: while risk perception explains the positive relation between illusion of control and risky driving behaviour, it also suppresses the negative relation between optimism bias and risky driving. Future studies should attempt to clarify under what circumstances cognitive biases are associated with risky driving behaviours.

Author Contributions: Conceptualization, C.M., G.M.H. and C.H.; methodology, C.M., G.M.H. and C.H.; software, C.M.; validation, C.M., G.M.H., D.B., C.H.; formal analysis, C.M.; investigation, C.M., G.M.H., D.B., C.H.; resources, C.M., G.M.H. and D.B.; data curation, C.M.; writing—original draft preparation, C.M.; writing—review and editing, G.M.H. and D.B.; visualization, C.M. and D.B.; funding acquisition, D.B. All authors have read and agreed to the published version of the manuscript.

Funding: The APC was funded by the University of Zagreb, Faculty of Transport and Traffic Sciences.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board Ethical Committee of the Faculty of Psychology and Educational Sciences, Alexandru Ioan Cuza University of Iasi, Romania (number: 1510, date: 23 May 2018).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Acknowledgments: This work has been partially supported by the EC2U Alliance and its Erasmus + Grant n° 101004065-EC2U.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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