Bridging the Gap Between Perception and Reality: A Simulator-Based Study on DUI Risk

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Risk perception of driving under the influence: A study with driving simulators

Abstract

After the spread of the COVID-19 pandemic, the number of young drivers (aged between 18-24 years old) involved in driving under the influence has drastically increased compared to previous years. As a result, avoidable accidents and deaths have increased as well. In the current study, we considered the Theory of Planned Behavior (TPB), to explain this change. We hypothesized that the cognitive biases (optimistic bias and illusion of control) shaping the risk perception of driving under the influence had a major impact for the cohort of people between 18 and 24 years, compared to older/expert drivers. Our goal was to reduce the misperception of the risk of driving intoxicated, by reducing the effects of the illusion of control and the optimistic bias through an experiential study. To do so, we used a drive simulator with a software that mimics driving while intoxicated. In addition to that, at two different time points, we collected quantitative data about the risk perception of driving while intoxicated of a group of young individuals about to obtain the driving license (aged 18-24): i) at least two weeks before having a simulator driving experience; ii) after using the simulator. Moreover, we manipulated the driving experience by having the software set up to simulate a drive under the influence of alcohol for some participants and a drive in a sober state for others. We found that after the experience of driving a simulator the most effective predictors in explaining the difference between the two conditions (sober vs impaired) are the cognitive bias, particularly the illusion of control.

Keywords: risk perception; drunk driving; safety; driving simulator

Introduction

In 2020, countermeasures taken to prevent the spread of Covid-19 have drastically diminished road traffic (Istat, 2021a; ITF, 2021; Wegman & Katrakazas, 2021; Yasin et al., 2021). In consequence to this, in many countries, the rate of accidents drastically decreased (Carson et al., 2024; Istat, 2021a; ITF, 2021; Jima & Sipos, 2023). However, road accidents caused by alcohol have increased dramatically during the pandemic and after it leading to an increase in avoidable deaths, injuries, and causing suffering to thousands of individuals and their families (ITF, 2021; Jima & Sipos, 2023; Lyon et al., 2023; Vanlaar et al., 2021; Watson-Brown et al., 2021). Recent data highlighted an increasing number of car accidents for new drivers between the age of 18 and 24 (European Commission, 2024). Moreover, among Italians, it emerged that the population within this age range (18-24 years) is more prone to alcohol consumption than 10 years ago (going from 69,1% in 2010 to 73,4% in 2020; Istat, 2021b). Unfortunately, alcohol consumption among younger drivers (18-24 years old) who are involved in car accidents is not a new issue (Australian Transport Council, 2011; Istat, 2021b; Mathijssen & Houwing, 2005; Mura, et al., 2003). Previous studies have investigated the factors that lead youngster to drive under the influence (e.g., drive under the use of drugs or alcohol) among this specific population (De Blasiis et al., 2017; Leung & Starmer, 2005; Peck et al., 2008; White et al., 2011), without being able to find a proper solution to this issue. Given the urgency to intervene at the root of the problem, we set up research to investigate how to prevent driving under the influence among young people who are about to obtain a driver's license. Specifically, the project aims to reduce the biases underlying youth involvement in alcohol-related crashes, such as illusion of control and optimistic bias. These biases would lead young drivers to underestimate the risks associated with driving under the influence. There is evidence that this underestimation can be successfully reduced through vivid and direct experience of the consequences of alcohol on driving skills (Brookhuis & De Waard, 2011; Steyvers & De Waard, 1997), thus promoting awareness and the responsible choice not to drive while intoxicated. Considering the effectiveness of this type of programs, our project aims to reduce the impact of biases and improve behavior through an experiential method in which participants drive on a simulator that mimics driving under the influence of alcohol (vs. in a sober state).

Theoretical background

The goal of the project was to reduce the judgment biases that lead to underestimating the danger of drunk driving. Several studies showed that among the various reasons for young drivers' involvement in alcohol-related accidents would be unrealistic ideas on their part about the real consequences of drunk driving (De Blasiis et al., 2017; Leung & Starmer, 2005; Potard et al., 2018; Vankov & Schroeter, 2021; Yadav et al., 2022). These unrealistic ideas would appear to be influenced by the illusion of control and optimistic bias (Vankov & Schroeter, 2021; Vankov et al.,2022).

Specifically, the *illusion of control* consists of the tendency to see the chances of success as higher than the probability warrants (Langer, 1975). Individuals with high illusion of control beliefs tend to overestimate the probability of success associated with their performance and tend to falsely attribute a random outcome to their ability. Research on driver behavior has shown that the illusion of control is also a contributing factor in risky driving behavior (McKenna, 1993; Nees et al., 2021; Stephens and Othsuka, 2014; Svenson, 1981).

Optimistic bias, instead, refers to the decision-makers belief that they are more skilled and less likely to experience negative events than their peers (Weinstein & Klein, 1996). Gosselin and colleagues (2010) found that the optimistic bias effect was consistent in different generations. They not only examined the optimistic bias in three different cohorts, but the authors found that when compared with a greater cohort, the effect of the optimistic bias was higher. In other words, young drivers rated their driving risk as being lower than both their same age peers, and older drivers (Gosselin et al., 2010). Individuals with high levels of optimistic bias, therefore, tend to have biased judgments in favor of the self, and specifically about driving behaviors, DeJoy (1989) argues that it is mainly novice drivers who engage in risky behavior in driving, convinced that their peer group is risk-free.

Both biases fuel a feeling of overconfidence in one's driving abilities and lead individuals to underestimate the weight of random events that may occur in the environment, thus contributing to increased risk-taking by drivers, particularly younger ones (Payani et al 2019; Wholber & Matthews, 2016). These biases are not the only predictors that could explain young drivers' behaviors. Indeed, referring to the Theory of Planned Behavior (TPB, Ajzen 1991) other factors that can predict the impaired driving behavior among young people are: 1) attitude, or how favorable, or unfavorable, the behavior is perceived to be, 2) subjective norm, or whether important others are perceived as approving or disapproving the behavior of interest, and 3) perceived behavioral control (PBC), or how easy, or difficult, performing the behavior is perceived to be (Ajzen 1991; Vankov & Schroeter, 2021). In particular, for this study, we referred to an extended TPB (Vankov & Schroeter, 2021), which included all the demographic variables (gender, age), TPB constructs (instrumental attitude, affective attitude, subjective norm, descriptive norm, self-efficacy and perceived controllability) to assess drivers' intentions to drive under the influence of alcohol or drug (Vankov & Schroeter, 2021).

In line with this theoretical model, some research shows that young and inexperienced drivers between the ages of 18 and 24, especially males, largely overestimate their driving skills by underestimating the risks involved (Brookhuis & De Waard, 2011). However, recent studies have shown promising results of interventions aimed at reducing drunk driving. Some recent studies show that this overestimation of driving abilities by young people can be successfully reduced through specific intervention programs (see Steyvers & De Waard, 1997). Vividly experiencing the consequences of alcohol on driving skills seems to foster a better understanding of the reduced ability to control the vehicle under such conditions, promoting the conscious and responsible choice not to drive while intoxicated. For example, Brookhuis and colleagues (2010) showed the role that direct experience of drunk driving appears to play in effectively deterring this type of behavior. The authors asked a group of people aged between 18 to 27 years, who obtained the driving license in the previous six months, to drive in a closed circuit under the influence of alcohol. Subsequently, these people showed increased awareness of the dangers of impaired driving and a decreased sense of control. Compared to the studies reviewed so far, our study contributes to the literature by testing a new methodology based on a simulation of driving under the influence rather than having individuals consume alcoholic drinks before driving a real car. By doing so we extend the ability of researchers to study the psychological factors related to driving under the influence as well as the potential for institutions to sensibilize prospective drivers about the risk of drinking and driving. The approach based on the use of driving simulators has also the advantage to be more effective in reaching many drivers. For instance, by placing the simulators in the DMVs it would be possible to reach all drivers since they have to go there to obtain their driving license, and it would not require the need to set up a private course to allow intoxicated people to drive in a safe condition. Based on the literature and the above considerations, our project aims to influence risk perception through an experiential method in which participants are asked to get behind the wheel of a driving simulator modified to mimic the state of intoxication. Specifically, we hypothesized that:

H1a: After simulating a drive under the influence (versus a drive in a sober state) participants

should show a higher risk perception of driving under the influence.
H1b: Participants exposed to the experience of driving under the influence should show a higher risk perception of driving under the influence compared with their baseline, while this should not happen for participants who simulate a drive in a sober state.
H2: Participants levels of illusion of control and optimistic bias should be negatively correlated with risk perception so that higher levels of these two biases should correspond to lower risk perception associated with driving under the influence.

Method

Participants

The data collection took place from April 2023 to March 2024, at the local Department of Motor Vehicle (DMV) office, where the two simulators were located. The 228 participants were people about to obtain a B driver's license or newly licensed, aged between 18 and 24 years old (42% female; mean age 19 years ± 1.36 years ranging between 18 and 24 years). They were part of a pool of driving schools that took them to the local DMV office to undergo a test of their knowledge of the rules of the road. The test is mandatory for all people who want to get a driving license in Italy. The data collection was structured in 3 sessions (baseline survey, simulated drive, post-test survey), each stage was mandatory and had to take place to move to the next one. Before starting each session, participants were informed that they could leave the study at any moment and get their data deleted. For each session, we obtained participants' consent, and in all the sessions data were collected anonymously. We discarded all participants who did not complete the baseline or post-test surveys. We did not consider in our analysis incomplete answers and/or double answers. Moreover, minors and people who were over 24 years old were excluded from the study because of the selection criteria required to achieve the sample we needed. In addition, we had to exclude participants who suffered from epilepsy or photosensitive conditions because they could not complete the driving simulation on the simulator. The study was approved by the research team's university ethics committee (protocol number: 5235).

Materials and Procedure

The experiment used a 2 x 3 mixed design with condition (simulated drive under the influence vs. in a sober state) as a two level between-subjects factor and session (baseline, simulated drive, post-test) as a three levels within-subjects factor. Participants were randomly assigned to one of the two between-subjects conditions. At the beginning of the baseline survey, all the participants were asked to create an identification code which they had to report in the following sessions to ensure that we could correctly link their responses to the surveys with the data from the simulator.

Baseline. This was the first session and consisted of an online survey, implemented on Qualtrics, equal to all the participants. Participants were sent the link at least two weeks before the drive on the simulator. The goal of the baseline was to have a baseline of soon-to-be drivers' risk perception. In particular, we collected data on their perception of the risk of driving under the influence by asking *"How risky do you think it is to drive under the influence of alcohol?" and "On a scale of 1 to 10, how safe would you feel driving under the influence of alcohol?"* for which participants had to answer on a scale from 1 (not at all) to 10 (very; González-Iglesias et al., 2014; Marcil et al., 2001; Vankov, & Schroeter, 2021). We also collected data on participants' alcohol-related habits (e.g., "*Have you ever seen your parents or family members driving after consuming alcohol?"*) because the literature shows that it is a relevant predictor of the future drivers' decision to drive under the influence. Then, to gather further measures of the illusion of control, and the optimistic bias of young people in relation to driving under the influence of alcohol and drugs we used two standardized scales: the 30-items DeJoy (1989) scale to measure the optimistic bias and the illusion of control. The DeJoy (1989) scale is subdivided into three subscales: the involvement subscale (α = .89 for both the baseline and the post-test), the seriousness subscale (α = .89 for the baseline and α = .78 for the post-test) and the controllability subscale (α = .64 for the baseline and α = .65 for the post-test). In each subscale, there is a series of car accidents that can happen on roads (e.g., "Losing your life in an accident because you did not give right of way") and for each of them respondents are asked to rate from 1 (not very likely) to 10 (very likely) how much more likely it would be for them to be involved compared to their peers. Depending on the subscale they are answering to, they have to consider the likelihood of being involved in those car accidents (compared to their peers), or the seriousness of the car accident described, or the controllability that they have on the described car accidents. For the risk perception of driving intoxicated among young people we used the Vankov and Schroeter scale (2021; α = .48 for the baseline and α = .35 for the post-test). A sample item of this scale is "*In your opinion, how bad or good would it be if you drove under the influence of alcohol in the next three months?*" and answers were given on a 5-point scale ranging from 1 (very bad) to 5 (very good). Finally, participants answered a series of demographic questions: age, educational level, household income and were asked about their knowledge of the sanctions for driving under the influence of alcohol (e.g., *"What happens if a novice driver is stopped driving a car with a blood alcohol level of 0.3 g/l?"*) and their personal mail address to contact them after six months for the follow-up questionnaire. Because of the low values of the Cronbach's α = .89 the controllability subscale of the Dejoy scale and the risk perception scale by Vankov and Schroeter were not used in the analyses. A complete version of the materials is available in Supplementary Online Materials (SOM).

Driving simulator. To expose participants to the conditions experienced when driving under the influence or in a sober state, we used a drive simulator model Naked provided by Toccafondi Multimedia. The simulator included an adjustable car seat, steering wheel, three car pedals (throttle, break, and clutch), a gear shifter, and a tv screen. Since we were testing participants who had not driven a car yet, we decided to use only some of the available controls. For instance, the gearbox was set to automatic. Moreover, of all possible controls on the wheel, the only ones available to the participants were those to regulate the side mirrors, those to engage first gear and reverse gear, and those controlling the blinkers. When using the software specification that allowed us to simulate a drive under the influence, we had the possibility to set the drunkenness of the driver. This specification of the software introduced a delay between the time in which the driver operated on the controls (e.g., pressing the brake or steering) and the time in which the car started to react to the driver's inputs. This way it was possible to simulate the slower reaction times that characterize the state of driving under the influence of alcohol. In the experimental room there were two drive simulators, placed face to face to each other, to reduce the interaction between two different participants while they were doing the simulation test.

After checking that participants did complete the first survey, we registered them into the driver simulator device using the same identification code of the baseline survey. In this way it was possible to collect for each participant the date about their driving (e.g., speed, missed red lights and so forth). For each participant, we collected data for both the training session and for the experimental one where they simulated either driving intoxicated or sober. The training route was the same for all participants, since its scope was to familiarize with the simulator. This trial had a timer and after 8:02 minutes it ended, otherwise participants could finish it earlier if they reached the finish line. During the training session participants did not receive any feedback about their errors or incidents, since the scope of this trial was to familiarize with the device and not to make people aware of the way they were driving. In all sessions participants were instructed to follow the

arrows on the pavement and reach the finish line without violating the rules of the road.
Once participants were done with the training session, they were randomly assigned to one of the experimental conditions: simulation of driving under the influence or in a sober state. The route used in both conditions was the same and it was different from the training one. The only difference was that in the intoxicated trial participants had a blurred vision and delayed reactivity of the car to their inputs. Indeed, the response of the steering wheel and the pedals was delayed consistently with what would happen to a driver under the influence. Even in the experimental session, there was a time limit of 8:02 minutes and participants could finish earlier if they reached the finish line or because of an accident.

Driving indicators. During the sessions on the simulator, we collected some specific indicators that we used as quantitative data to measure the way participants were driving. We measured the highway infractions (such as failing to give right of way to a pedestrian at a crosswalk, running a red light, driving on the wrong side of the road, and so forth) and whether they respected the speed limit. A list of these indicators is available in the SOM.

Post-test. After finishing the sessions on the simulator, participants completed the post-test survey. Due to time constraints, it was not possible to let them do it immediately at the DMV. Thus, participants were instructed to do it within the end-of-day, if they forgot to do so they received a reminder the following morning. The survey was administered online through a Qualtrics link and took about 10 minutes to complete. Its aim was to evaluate the experience on the simulator and to measure the different impact of the experimental condition on the risk perception, as the illusion of control and optimistic bias, of driving while under the influence. For this reason, in the survey we presented again the standardized scales and questions implemented in the baseline survey. However, we added some questions about the experience with the driving simulator (e.g., *"On a scale of 1= not at all to 10= very much, how effective do you think driving with the simulator: has been in making you more responsible when driving on the road"*). A complete version of the materials is available in the SOM.

Results

Descriptive statistics and correlations

Descriptive statistics are reported in Table 1. Risk perception decreased slightly after the session on the simulator and this change was a little larger for participants who simulated a drive while sober. However, in both conditions, the risk perception related to driving under the influence of alcohol was very high (Ms > 9.27 out of 10, SDs < 1.00 in the baseline and Ms > 9.04, SDs < 1.50 in the post-test). In the post-test some participants had a risk perception score lower than 5.00, the middle point, whereas this did not happen in the baseline.

Table 1. Descriptive statistics for the main variables in the study.

	Simulation of driving in sober state	Simulation of driving under the influence
Baseline		M (SD)
Risk perception M (SD)	9.44 (.89)	9.27 (.91)
Dejoy seriousness M (SD)	3.82 (.55)	3.77 (.57)
Dejoy involvement M (SD)	2.43 (.88)	2.40 (.92)
Illusion of control M (SD)	1.89 (1.42)	1.86 (1.47)
Optimistic bias M (SD)	3.41 (2.49)	3.61 (.87)
Chance of a police check M (SD)	7.28 (2.56)	6.95 (2.80)
Post-test		
Risk perception M (SD)	9.04 (1.46)	9.19 (1.40)

Dejoy seriousness M (SD)	3.83 (.60)	3.87 (.50)
Dejoy involvement M (SD)	2.85 (.88)	2.70 (.81)
Illusion of control M (SD)	1.67 (1.40)	1.53 (1.07)
Optimistic bias M (SD)	3.66 (2.44)	3.57 (2.65)
Chance of a police check M (SD)	7.18 (2.74)	6.85 (2.95)
Additional variables		
Gaming frequency N (%)		
Never	38 (41.3%)	35 (26.7%)
Very rarely	26 (28.3%)	42 (32.1%)
Only once or twice per week	19 (20.7%)	26 (19.8%)
3-4 times per week	2 (2.2%)	10 (7.6%)
Very often/every day	7 (7.6%)	18 (13.7%)
Alcohol consumption in last month N (%)		
Never	20 (21.7%)	25 (19.1%)
Once	31 (33.7%)	43 (32.8%)
2/4 times	34 (37.0%)	57 (43.5%)
2/3 times per week	7 (7.6%)	3 (2.3%)
4/5 times per week	0 (0%)	3 (2.3%)
6 or more times per week	0 (0%)	0 (0%)
Number of drinks N (%)		
None	21 (22.8%)	22 (16.8%)
1-2 drinks	54 (58.7%)	85 (64.9%)
3-4 drinks	11 (12.0%)	22 (16.8%)
5-6 drinks	4 (4.3%)	2 (1.5%)
7-9 drinks	2 (2.2%)	0 (0%)
10 or more drinks	0 (0%)	0 (0%)
Relatives driving under the influence N (%)		
Never	58 (63.0%)	82 (62.6%)
Sometimes	33 (35.9%)	44 (33.6%)
Often	1 (1.1%)	5 (3.8%)
Very often	0 (0%)	0 (0%)

Looking at the correlations, in the baseline, risk perception correlated negatively with the illusion of control questions (Table 2). This indicates that increasing levels of risk perception are associated with a decreasing illusion of control both related to one's driving under the influence ($r = -.25$, $p < .001$) and to being a passenger in a car driven by a person who is under the influence ($r = -.17$, $p < .05$). These two questions were highly correlated ($r = .75$, $p < .001$), thus we averaged them and used a single index of illusion of control in the following analyses. In addition, risk perception correlated negatively with the first two questions on the optimistic bias, whereas it correlated positively with the third. These correlations show that increasing risk perception is associated with a decreasing belief by people that they will be less at risk ($r = -.17$, $p < .05$) and have less severe crashes than their peers ($r = -.21$, $p < .01$). These two questions on the optimistic bias correlated ($r = .45$, $p < .001$) and were averaged together for the following analysis. In contrast, increasing levels of risk perception were associated with participants' belief that they would be stopped more than their peers by the police forces ($r = .20$, $p < .01$). Finally, risk perception was correlated negatively with the number of drinks in a typical day when alcohol was consumed ($r = -.16$, $p < .05$) and with the frequency with which participants saw their parents driving after drinking ($r = -.16$, $p < .05$). There was no correlation between risk perception and the frequency with which participants drunk alcoholic drinks in the last month before the survey.

Table 2. Baseline correlations across the whole sample.

	1.	2.	3.	4.	5.	6.
1. Risk perception	--	.32***	-.02	-.34***	-.22**	.20**
2. Dejoy seriousness		--	.16*	-.16*	.03	.12
3. Dejoy involvement			--	.10	.18*	.25**
4. Illusion of control				--	.23***	-.09
5. Optimistic bias					--	.00

Note: * $p < .05$; ** $p < .01$; *** $p < .001$.

In the post-test, participants who simulated driving as sober showed a stronger negative correlation between risk perception and the two questions on illusion of control ($r = -.56$, $p < .001$ for the question about driving under the influence and $r = -.50$, $p < .005$ for the question about being the passenger in a car driven by a person under the influence; Table 3, above the diagonal). The correlations between risk perception and optimistic bias were more or less in line with those found in the baseline ($r = -.27$, $p < .01$ for the question on the risk of crashing, $r = -.21$, $p < .05$ for the question on how serious a crash could be and $r = .25$, $p < .05$ for the question on the likelihood of being stopped by the police forces). For people who simulated driving as sober, in the post-test, risk perception was not correlated with alcohol related behaviors (*p*s = .12 or lower, *p* = n.s.).

Table 3. Post-test correlations for condition sober (above the diagonal) and under the influence (below the diagonal) driving simulation.

	1.	2.	3.	4.	5.	6.	7.	8.
1. Risk perception	--	.31**	-.03	-.29**	-.30**	.25*	.16	.11
2. Dejoy seriousness	.42***	--	.35***	.01	.00	.35***	.14	.16
3. Dejoy involvement	-.10	.03	--	.26*	.11	.25*	-.13	-.15
4. Illusion of control	-.40***	-.17	.14	--	.26*	-.04	-.16	-.10
5. Optimistic bias	-.08	.01	.07	.03	--	-.11	.05	.05
6. Chance of police checks	.29***	.04	.04	-.01	-.12	--	.07	.10
7. Duration	.01	-.17	-.07	-.01	.05	-.02	--	.93***
8. Points lost	-.04	-.17	-.09	-.01	.07	-.05	.96***	--

Note: * $p < .05$; ** $p < .01$; *** $p < .001$.

For the participants who simulated the drive under the influence, risk perception correlated negatively with the two questions on the illusion of control, but these correlations were not as large as for the people who simulated driving in a sober state ($r = -.34$, $p < .01$ for the first question and $r = -.39$, $p < .01$ for the second question; Table 3, below the diagonal). In both conditions, the two questions on the illusion of control were positively correlated with each other ($r = .69$, $p < .001$ and $r = .64$, $p < .001$), therefore we averaged them together in all subsequent analyses. The correlations between risk perception and the questions measuring optimistic bias were not as clear for participants simulating the drive under the influence as much as they were for those simulating the drive in a sober state. For the first questions relative to the chance of being involved in a crash the correlation was negative and significant ($r = -.18$, $p < .05$), whereas for the second question on the likelihood of causing serious crashes the correlation was almost zero ($r < .10$, p = n.s.). Finally, there was a larger, positive correlation between risk perception and the question measuring the likelihood of being stopped by the police forces while driving under the influence (r = .29, p < .001).

Regression analyses

We first restructured the dataset in long form to have pre- and post-test measures in the same column for each participant. Afterwards, we run a series of within-subjects linear regression models in R (R Core Team, 2020) using the *'lme4'* package (Bates et al., 2015). In each model we controlled for the random effect of the participant and included the duration of the simulated drive as a covariate.

In the first model, we included as predictors the condition (driving: sober vs. drunk), the session (pre- vs. post-test), gender and the interaction between condition and session with risk perception as the dependent variable. In the second model, we added the interactions between condition and gender and between session and gender (we also tested a model including the three-way condition x session x gender, but this effect was not significant). Finally, in the third model, we added illusion of control and in the fourth model we added optimistic bias. Results are reported in Table 4. In the first model, there were significant effects of session (X^2 = 5.98, b = -.40, SE = .13, t = -3.02, p < .01) and gender (X^2 = 13.72, b = .52, SE = .14, t = 3.70, p < .001), while the effect of condition was not significant. The interaction between condition and session was quite not so significant (X^2 = 3.59, b = .33, SE = .17, t = 1.90, p < .06). The duration of the session on the simulator was not significant. These results indicate that risk perception was lower after the session in the simulator than before it and it was higher for women than men. Although the interaction was not significant, it shows that the decrease of risk perception after the session in the simulator is almost completely accounted for by the participants in the control condition, those simulating a drive in a sober state.

In the second model, we found significant effects for session (X^2 = 6.06, b = -.55, SE = .16, t = -3.48, p < .001) and gender (X^2 = 13.78, b = .52, SE = .23, t = 2.26, p = .02), whereas the effect of condition was not significant. In addition, the interaction between condition and session was significant as well (X^2 = 4.55, b = .37, SE = .17, t = 2.13, p = .03; see Figure 1). Pairwise analyses with Bonferroni correction for multiple comparisons showed that the difference between baseline and post-test was significant for the participants who simulated driving in a sober condition (lower risk perception after the driving session, t = 3.05, p = .003, d = .35), whereas the same difference was not significant for participants who simulated driving under the influence (t = .30, p = .77, d = .03).

In the third model, illusion of control was significant and the effects that emerged in the previous model were still significant as well. People with a higher illusion of control tended to perceive the risk of driving under the influence as lower (X^2 = 30.33, b = -.23, SE = .04, t = -5.51, p < .001). Finally, in the fourth model, the effects of both illusion of control (X^2 = 27.43, b = -.22, SE = .04, t = -5.24, p < .001) and optimistic bias (X^2 = 5.87, b = -.04, SE = .02, t = -2.42, p = .02) were significant. All effects from previous model were also significant except for the interaction between condition and session that was quite not as significant anymore (X^2 = 3.53, b = .34, SE = .18, t = 1.88, p = .06).

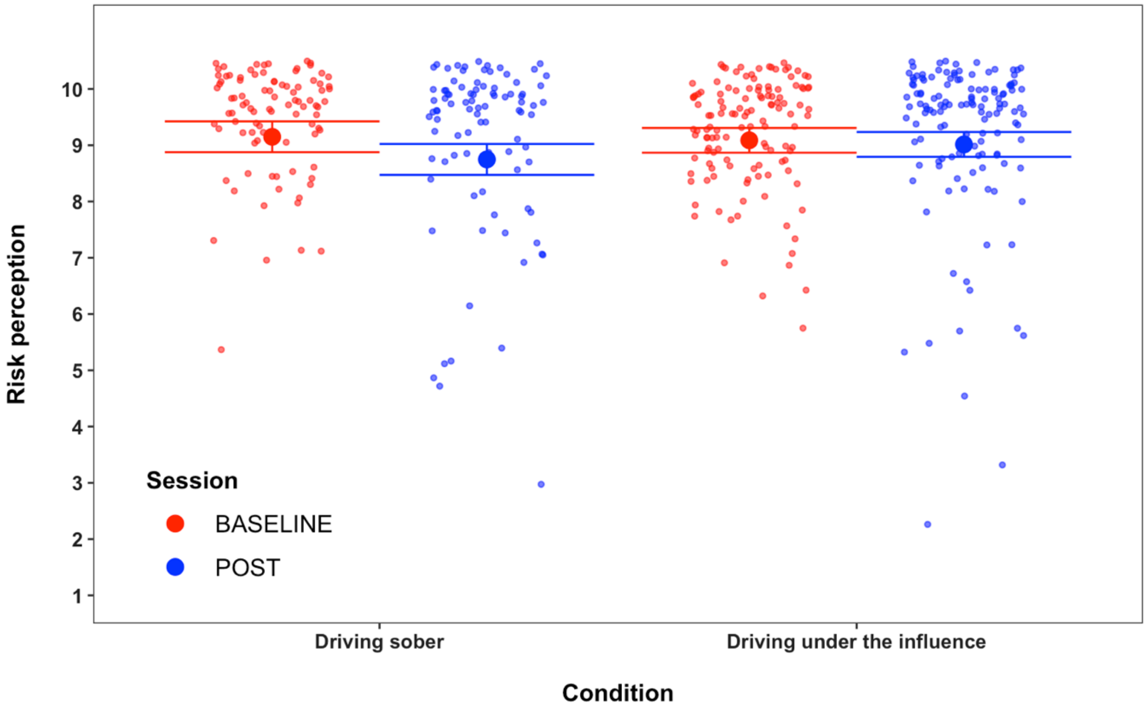

Figure 1. Interaction between condition and session.

Table 4. Within-subject linear regression models.

	(1)			(2)			(3)			(4)		
	β	*b (SE)*	*95% C.I.*	*β*	*b (SE)*	*95% C.I.)*	*β*	*b (SE)*	*95% C.I.*	*β*	*b (SE)*	*95% C.I.*
Intercept	.00	9.02*** (.16)	[8.70, 9.35]	.00	9.02*** (.19)	[8.66, 9.39]	.00	9.57*** (.20)	[9.17, 9.96]	.00	9.70*** (.21)	[9.29, 10.11]
Condition (sober = 0; drunk =1)	-.03	-.06 (.16)	[-.38, .25]	.01	.03 (.20)	[-.39, .42]	-.02	-.04 (.19)	[-.41, .33]	-.02	-.05 (.19)	[-.42, .32]
Session (baseline = 1; post-test = 0)	-.17	-.40** (.13)	[-.66, -.14]	-.23	-.55*** (.16)	[-.87, -.24]	-.27	-.64*** (.16)	[-.96, -.32]	-.26	-.62*** (.16)	[-.94, -.30]
Gender (Male = 0; Female = 1)	.22	.53*** (.13)	[.27, .79]	.22	.52* (.22)	[.09, .96]	.14	.34 (.21)	[-.07, .76]	.12	.29 (.21)	[-.12, .70]
Duration	.10	.33^{+} (.17)	[-.004, .09]	.10	.05^{+} (.03)	[-.003, .10]	.10	.04^{+} (.02)	[-.002, .09]	.10	.04 (.02)	[-.001, .09]
Illusion of control							-.26	-.23*** (.04)	[-.32, -.15]	-.25	-.22*** (.04)	[-.31, -.14]
Optimistic bias										-.11	-.04* (.02)	[-.08, -.14]
Condition x Session	.13	.33^{+} (.17)	[-.01, .67]	.14	.37* (.17)	[.03, .72]	.14	.36* (.18)	[.008, .71]	.13	.34^{+} (.18)	[-.02, .69]
Condition x Gender				-.09	-.25 (.27)	[-.78, .27]	-.06	-.17 (.25)	[-.65, .71]	-.03	-.10 (.24)	[-.58, .38]
Session x Gender				.10	.30 (.17)	[-.05, .64]	.12	.36* (.18)	[.01, .71]	.13	.36* (.18)	[.02, .72]

Additional analyses

A last within-subjects linear regression model was run including condition, session, the seriousness subscale of the Dejoy inventory (DeJoy, 1989), gender, and the two-way interactions between condition, session, and the Dejoy (DeJoy, 1989) seriousness subscale (a model with the three-way showed that this effect was not significant). We also included the same covariate as in previous analyses. The results showed significant effects of session (X^2 = 11.66, β = -.91, *b* = -2.17, *SE* = .64, *t* = -3.41, *p* < .001, *95% C.I.* = [-3.42, -.92]), gender (X^2 = 12.77, β = .18, *b* = .45, *SE* = .12, *t* = 3.57, *p* < .001, *95% C.I.* = [.20, .69]), and Dejoy seriousness subscale (X^2 = 3.94, β = .16, *b* = .34, *SE* = .17, *t* = 1.99, *p* < .05, *95% C.I.* = [.002, .67]). This last effect indicated that participants expecting to incur in more serious events while driving perceived a higher risk. Finally, both the interaction between condition and session (X^2 = 4.33, β = .13, *b* = .35, *SE* = .17, *t* = 2.08, *p* = .04, *95% C.I.* = [.02, .68]) and the interaction between session and Dejoy seriousness subscale (X^2 = 8.05, β = .75, *b* = .46, *SE* = .16, *t* = 2.84, *p* = .005, *95% C.I.* = [.14, .68]) were significant. In relation to the latter, we run a slope analysis showing that the effect of the subscale was significant both sessions but more so in the post- than in the baseline (respectively, *b* = .43, *SE* = .12, *t* = 3.47, *p* < .001, *95% C.I.* = [.001, .67] for the baseline and *b* = .90, *SE* = .13, *t* = 7.00, *p* < .001, *95% C.I.* = [.48, 1.11] for the post-test; see Figure 2).

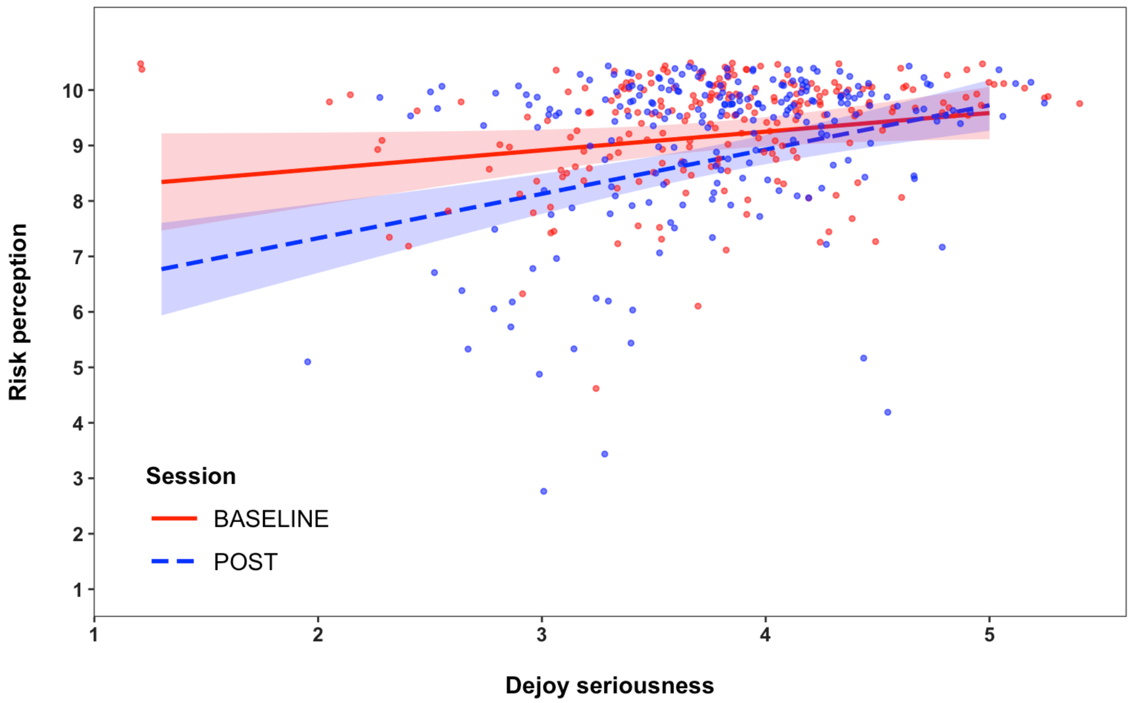

Figure 2. Interaction between session and seriousness subscale of the Dejoy.

Discussion

In the present study we investigated whether asking soon-to-be drivers to complete a drive on a simulator could impact their risk perception about driving under the influence and the biases that are associated with it (e.g., illusion of control and optimistic bias). Specifically, we measured the baseline risk perception and biases before randomly assigning the participants to one of two between-subjects conditions: drive simulating a sober versus intoxicated state. Afterwards, we assessed risk perception and biases again to assess the effect of the simulated drive. Our results partially confirmed our hypothesis. We found that, overall, the risk perception of driving under the influence was quite high therefore making it unlikely to find that simulating a drive under the influence could increase it significantly. However, what we found was a significant interaction between condition and session (baseline versus post drive on the simulator). Participants in the control condition, where they were simulating driving in a sober state, had a lower risk perception after the drive than at baseline (while no difference emerged for participants in the experimental condition, where they were simulating a drive under the influence). A potential explanation for the high level of risk perception is that participants have not had a real-world driving experience since the survey on the knowledge of the rules of the road is done before in-car practice starts. This could also explain the reduction in risk perception among participants in the control condition. Simulating a drive in a sober state could have been the first driving experience and it may have made participants underestimate the risk of driving under the influence. In contrast, simulating the condition of driving while intoxicated seem to have achieved the goal of at the very least avoiding a decrease in risk perception.

Furthermore, in the first regression model we found an effect of gender showing that risk perception was higher among women than men. This result is consistent with previous work on risk perception, and particularly work related to the risk associated with driving (Brookhuis & De Waard, 2011; González-Iglesias et al., 2014; Marcil et al., 2001). Finally, once we added to the model both the illusion of control and the optimistic bias, the interaction between condition and session was not significant anymore indicating that these two variables' effect on risk perception explained a portion of the variable that was explained also by our independent factors. This result is consistent with literature showing that drivers, and more so younger ones, tend to feel excessively in control and to think that negative events on the road are more likely to happen to other drivers. Indeed, higher risk perception was associated with a lower illusion of control and a lower optimistic bias.

Since more and more driving simulators are available at home (as videogames) or in driving schools (as learning tools), the finding that simulating a drive in a sober state leads to a reduced risk perception leads to call into question their use, at least before a young driver has not yet started driving a real car. The psychological literature suggests that a good driving simulator can speed up learning by allowing people to repeat the same actions many more times than what they could do on the road when, early on, they also need someone to supervise them. However, the simulator may also take away the physical sensation of driving and the feeling that one could be hurt if something goes wrong. Therefore, future work should investigate more systematically whether the simple drive on the simulator could be a predictor of a reduced risk perception of driving under the influence and whether this happens to all drivers or only to those who have no actual experience of real-world driving. In other words, is the simulator creating a feeling of familiarity with the act of driving that reduces the perception of risk in novice drivers or is it something related to the lack of physical consequences that could be applied to all drivers? Understanding these implications is fundamental to understand how and when to use a driving simulator as a teaching tool.

The results of the analyses with the Dejoy scale seem to confirm our conclusion that driving the simulator can influence risk perception through a reduction of the perception of the seriousness of the negative events that can happen on the road. We found a general effect of the seriousness subscale, such that increasing perception of the seriousness of the events that can happen on the road is associated with higher risk perception. However, the drop in risk perception for participants that perceived seriousness as low was larger in the post-test compared to the baseline. This suggests that indeed driving the simulator could cause a reduction of risk perception when people perceive the seriousness of the consequences as low. Importantly, our work also showed that simulating a drive in an intoxicated state can prevent this drop in risk perception of driving under the influence, thus showing that simulators can indeed have a useful role with younger drivers.

Limitations and future directions

Among the limitations of this study, there are our limited ability to recruit participants, and the inherent limitations of the software used to simulate driving under the influence. Regarding recruiting, we were able to maximize it under the circumstances in which we were operating, thus testing two participants at the time. Since there are batches of 15-20 prospective drivers that take the quiz at each time slot, a dedicated space with more personnel and simulators would have allowed to reach an even larger group of people. Regarding the simulation of the intoxicated driving, one of the modifications to the software was to delay and exaggerate the effect of the inputs made by the driver thus simulating the slowed reaction times. Of course, this is the opposite of what happens when a driver is under the influence. In a real-world scenario, the slowed reaction times and presence of mind would lead to delayed reactions to what is happening on the road. However, the manipulation of the way the controls react is the easiest way to manipulate this aspect of driving but for making the drivers drink alcoholics (something that would have not received the approval of our ethical committee). Still, future work may try to make the experience even more real, potentially increasing the likelihood of having the desired effect to increase risk perception regarding driving under the influence. In this respect, a possible direction would be to use virtual reality (VR) to create an even more immersive experience. We considered this option when building the study but ultimately decided against it on the basis that it would have required a longer training session, and that VR could cause nausea in people that are not used to it.

Despite these limitations, we believe that our work provides an important contribution to the literature showing that driving simulators can be used with goals that go beyond the mere teaching of how to operate the controls of a car – indeed, in this regard simulators can be a source of reduced risk perception at least among driver without experience on real cars and roads. Developing software that simulates the experience of being under the influence could be an effective way to sensibilize prospective drivers since it can be done in places like the DMV where all young people have to go to take their knowledge test. Furthermore, it does not require to make the drivers drink real alcohol or to set up a private course to ensure that participants would drive in safe and controlled conditions.

References

Australian Transport Council. 2011. National Road Safety Strategy 2011–2020. Canberra: Australian Transport Council.

Ajzen I. 1991. The theory of planned behavior. *Organizational Behavioral and Human Decision Processes, 50*, 179–211. Doi: 10.1016/0749-5978(91)90020-T

Bates D, Mächler M, Bolker B, Walker S (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, *67*, 1–48. Doi: 10.18637/jss.v067.i01

Carson, J., Jost , G., & Meinero, M. (2024, June 19). *18th Annual Road Safety Performance Index (PIN Report) – ETSC*. Etsc.eu. https://etsc.eu/18th-annual-road-safety-performance-index-pin-report/

De Blasiis, M. R., Ferrante, C., Veraldi, V., & Santilli, A. (2017). Effects of alcohol on risk perception: A driving simulation study. *Road Safety and Simulation RSS Proceedings*.

DeJoy, D. M. (1989). The optimism bias and traffic accident risk perception. *Accident Analysis & Prevention*, *21*, 333-340. Doi: 10.1016/0001-4575(89)90024-9

European Commission (2024). Facts and Figures Main Figures. European Road Safety Observatory. Brussels, European Commission, Directorate General for Transport. Retrieved from: https://road-safety.transport.ec.europa.eu/document/download/8980a141-423e-4d2e-a083-f81c7e70ea00_en?filename=ff_young_people_20240326.pdf

González-Iglesias, B., Gómez-Fraguela, J. A., & Sobral, J. (2014). Potential Determinants of Drink Driving in Young Adults. *Traffic Injury Prevention*, *16*, 345–352. Doi: 10.1080/15389588.2014.946500

Gosselin, D., Gagnon, S., Stinchcombe, A., & Joanisse, M. (2010). Comparative optimism among drivers: An intergenerational portrait. *Accident Analysis & Prevention*, *42*, 734-740. Doi: 10.1016/j.aap.2009.11.001

Istat. (2021a). Incidenti Stradali in Italia 2020. In *Istat* (p. 23). https://www.istat.it/wp-content/uploads/2021/07/Incidenti-stradali_2020.pdf

Istat. (2021b). *Indagine conoscitiva sulle dipendenze patologiche diffuse tra i giovani Indagine conoscitiva sul funzionamento e la gestione dei servizi sociali con particolare riferimento all'emergenza epidemiologica da Covid-19 Audizione del Presidente dell'Istituto nazionale di statistica*. https://www.istat.it/it/files/2021/05/Istat-AudizioneCommissione_infanzia_adolescenza_27-maggio_2021.pdf

ITF. (2021). Italy: Road Safety Country Profile, 2021. In *International Transport Forum (itf-oecd)* (p. 14). https://www.itf-oecd.org/sites/default/files/italy-road-safety.pdf

Jima, D., Sipos, T. (2023). Long Term, Pre, and Post Impacts of SARS-CoV-2 Pandemic on Road Traffic Crashes in the Case of Budapest, Hungary. *Periodica Polytechnica Transportation Engineering, 51*, 311–321. Doi: 10.3311/PPtr.20765

Langer, E. J. (1975). The illusion of control. *Journal of Personality and Social Psychology*, *32*, 311-328. Doi: 10.1037/0022-3514.32.2.311

Leung, S., & Starmer, G. (2005). Gap acceptance and risk-taking by young and mature drivers, both sober and alcohol-intoxicated, in a simulated driving task. *Accident Analysis & Prevention, 37*, 1056-1065. Doi: 10.1016/j.aap.2005.06.004

Lyon, C., Vanlaar, W., & Robertson, R. D. (2023). The impact of COVID-19 on transportation-related and risky driving behaviors in Canada. *Transportation Research Part F: Traffic Psychology and Behaviour*, *100*, 13–21. Doi: 10.1016/j.trf.2023.11.011

Marcil, I., Bergeron, J., & Audet, T. (2001). Motivational factors underlying the intention to drink and drive in young male drivers. *Journal of Safety Research*, *32*, 363-376. Doi: 10.1016/S0022-4375(01)00062-7

Mathijssen, R., & Houwing, S. (2005). The prevalence and relative risk of drink and drug driving in the Netherlands: a case-control study in the Tilburg police district. *SWOV Institute for Road Safety Research*.

McKenna, F. P. (1993). It won't happen to me: Unrealistic optimism or illusion of control?. *British Journal of Psychology*, *84*, 39-50. Doi: 10.1111/j.2044-8295.1993.tb02461.x
Mura, P., Kintz, P., Ludes, B., Gaulier, J. M., Marquet, P., Martin-Dupont, S., ... & Pourrat, O. (2003). Comparison of the prevalence of alcohol, cannabis and other drugs between 900 injured drivers and 900 control subjects: results of a French collaborative study. *Forensic Science International*, *133*, 79-85. Doi: 10.1016/S0379-0738(03)00052-5
Nees, M. A., Herwig, K., Quigley, L., & Zhang, J. (2021). Relationships among driving styles, desire for control, illusion of control, and self-reported driving behaviors. *Traffic Injury Prevention*, *22*, 372–377. Doi: 10.1080/15389588.2021.1909728
Payani, S., Hamid, H., & Law, T. H. (2019). A review on impact of human factors on road safety with special focus on hazard perception and risk-taking among young drivers. In *IOP Conference Series: Earth and Environmental Science* (Vol. 357, No. 1, p. 012041). IOP Publishing.
Peck, R. C., Gebers, M. A., Voas, R. B., & Romano, E. (2008). The relationship between blood alcohol concentration (BAC), age, and crash risk. *Journal of Safety Research*, *39*, 311-319. Doi: 10.1016/j.jsr.2008.02.030
Potard, C., Kubiszewski, V., Camus, G., Courtois, R., & Gaymard, S. (2018). Driving under the influence of alcohol and perceived invulnerability among young adults: An extension of the theory of planned behavior. *Transportation Research Part F: Traffic Psychology and Behaviour*, *55*, 38-46. Doi: 10.1016/j.trf.2018.02.033
R Core Team (2020). R: A Language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/
Stephens, A. N., & Ohtsuka, K. (2014). Cognitive biases in aggressive drivers: Does illusion of control drive us off the road?. *Personality and Individual Differences*, *68*, 124-129. Doi: 10.1016/j.paid.2014.04.016
Steyvers, F. J. J. M., & De Waard, D. (1997). *Effecten van alcohol op rijgedrag: een gecontroleerde replicatie van de ervaringsproeg in het project "Alcoholvrij op Weg"*. Centrum voor Omgevings- en Verkeerspsychologie.
Svenson, O. (1981). Are we all less risky and more skillful than our fellow drivers?. *Acta Psychologica*, *47*(2), 143-148. Doi: 10.1016/0001-6918(81)90005-6
Vankov, D., & Schroeter, R. (2021). Driving under the influence of drugs or alcohol: Predicting the intentions of young drivers. *Traffic Injury Prevention*, *22*, 97-101. Doi: 10.1080/15389588.2020.1869953
Vankov, D., Chiers, J., & Vankov, B. (2022). If others drive intoxicated, so may I: Determinants for young drivers in Bulgaria. *Safety Science*, *145*, 105480. Doi: 10.1016/j.ssci.2021.105480
Vanlaar, W. G., Woods-Fry, H., Barrett, H., Lyon, C., Brown, S., Wicklund, C., & Robertson, R. D. (2021). The impact of COVID-19 on road safety in Canada and the United States. *Accident Analysis & Prevention*, *160*, 106324. Doi: 10.1016/j.aap.2021.106324
Watson-Brown, N., Truelove, V., Parker, E., & Davey, J. (2021). Drink driving during the COVID-19 pandemic. *Transportation Research Part F: Traffic Psychology and Behaviour*, *78*. Doi: 10.1016/j.trf.2021.02.020
Wegman, F., & Katrakazas, C. (2021). Did the COVID-19 pandemic influence traffic fatalities in 2020? A presentation of first findings. *IATSS Research*, *45*. Doi: 10.1016/j.iatssr.2021.11.005
White, M. J., Cunningham, L. C., & Titchener, K. (2011). Young drivers' optimism bias for accident risk and driving skill: Accountability and insight experience manipulations. *Accident Analysis & Prevention*, *43*, 1309-1315. Doi: 10.1016/j.aap.2011.01.013
Yadav, A. K., Choudhary, S. S., Pawar, N. M., & Velaga, N. R. (2022). Can't drive, I'm drunk– Exploring factors influencing the intention to drink and drive among Indian drivers. *IATSS Research*, *46*, 467-478. Doi: 10.1016/j.iatssr.2022.07.004
Yasin, Y. J., Grivna, M., Abu-Zidan, F. M. (2021) "Global impact of COVID-19 pandemic on road traffic collisions", *World Journal of Emergency Surgery, 16*, 51. Doi: 10.1186/s13017-021-00395-8