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Socio-cognitive factors in road safety monitoring – Cross-national comparison of driving under the influence of alcohol, drugs or medication

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ABSTRACT

The objective of the study is to assess the relation between socio-cognitive factors and unsafe traffic behaviour in different national settings. The study is based on the results of the second edition of ESRA (*E*-Survey of Road users' Attitudes), which was conducted in 32 countries in 2018 (ESRA2). The investigation focuses on the topic *driving under the influence of alcohol, drugs, or medication* (DUI) and related socio-cognitive constructs, i.e., *attitudes*, *norms*, *perceived behaviour control*, *intention*, and *habits,* and *risk perception*. Cross-national differences are assessed upon the example of Australia, Belgium, Canada, Egypt, Japan, Nigeria, and Slovenia. In the analysis, principal component analysis (PCA) was used to test the dimensions of the underlying socio-cognitive constructs and to define composite scores for further analysis. Linear regression models were fitted to investigate the association between these socio-cognitive factors and self-reported DUI. The same set of variables was used for all the linear regression models, i.e., the cross-national model (32 countries), and the seven national models. In total, 25,459 car drivers (at least a few days a month), were included in this analysis. The results show that: (*i*) the considered socio-cognitive factors are able to predict self-reported DUI across the different countries; (*ii*) these socio-cognitive factors are also able to predict DUI on a national level; (*iii*) the impact of socio-cognitive factors on DUI differs across countries. The strongest predictor in all countries was the construct *habits*, followed by *norms* and, to a lesser extent, *attitudes* and *intention*. *Perceived behaviour control* and *risk perception* only showed a significant effect on reported DUI in a few countries. In conclusion, the ESRA2 data offer a unique opportunity to gain valuable insights into cross-national differences in traffic safety. Future research will focus on a more in- depth analysis of cross-national differences to other road safety topics.

1. Introduction

1.1. Socio-cognitive factors in road safety monitoring

The field of Psychology offers a wide range of motivational models to describe the relation between socio-cognitive factors and behaviour [1–3]. Ideally, the selection of socio-cognitive factors in road safety monitoring should be based on a theoretical model, as these models summarize the scientific discussion on the relationship between predictors and dependent variables. The Theory of Planned Behaviour (TPB, [1]) is such a motivational model that is widely used in traffic research. The model states that intention is a direct determinant of one's behaviour [1,4,5] and in turn three sets of factors influence this behavioural intention: *Attitudes*, *Subjective Norms*, and *Perceived Behavioural Control*. The TPB model has been used to predict drunk-driving [6,7], speeding [8–14], and distracted driving by mobile phone use [15,16]. Applying this model to drunk-driving, the predictors of alcohol-impaired driving are (*i*) a positive mindset towards drinking and driving (*Attitudes*), (*ii*) sharing the belief that relatives or friends have a positive attitude towards drinking and driving (*Social Norms*), and (*iii*) feeling confident in one's ability to control one's behaviour (*PBC*). Over the years, the model has been modified and elaborated (e.g., by adding habits [8,17,18] or by specifying different types of norms [7]. Some studies question its validity in cross-cultural applications, especially in developing countries [19].

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Cross-national studies, which use an identical questionnaire and study design to enable national comparisons, are rare.

Socio-cognitive factors, such as attitudes and beliefs, can help to understand the underlying motivations of unsafe traffic behaviour [20]. Therefore, many countries include socio-cognitive factors in their road safety monitoring (e.g., Europe: SARTRE (Social Attitudes to Road Traffic Risk in Europe [21]); USA: Traffic Safety Culture Index [22]; global level: ESRA (*E*-Survey of Road users' Attitudes [23,24]). Studies on socio-cognitive factors like the aforementioned road safety monitoring studies do not only differ in terms of the type of socio-cognitive factors that are considered but also the operationalisation of these constructs, the study design, and the sample vary considerably. The question arises, which socio-cognitive factors should be assessed to best reflect road safety culture and be able to predict unsafe traffic behaviour.

The ESRA2 survey, which was conducted in 2018, assessed the main TPB constructs and unsafe traffic behaviour in 32 countries. This dataset offers the unique possibility to investigate the relation between socio-cognitive factors and unsafe traffic behaviour in different national settings.

1.2. Objective of this study

The objective of the present study is to assess the relation between socio-cognitive factors and unsafe traffic behaviour in different national settings. The study is based on the results of the second edition of the ESRA survey, which was conducted in 32 countries in 2018 (ESRA2).

The investigation focuses on the topic driving under the influence of alcohol, drugs, or medication (DUI) and includes the following socio-cognitive constructs: attitudes, norms, PBC, intention, habits, and risk perception. Cross-national differences are assessed upon the example of Australia, Belgium, Canada, Egypt, Japan, Nigeria, and Slovenia.

The following questions were studied: (*i*) Are the socio-cognitive factors that are included in the ESRA2 survey able to predict self-reported DUI across the different countries (overall model)? (*ii*) To what extent are these socio-cognitive factors able to predict DUI on a national level (country-specific models), and (*iii*) to what extent does the effect size of the socio-cognitive factors on DUI differ across countries?

2. Data

2.1. ESRA2 survey

ESRA (*E*-Survey of Road users' Attitudes) is a joint initiative of road safety institutes, research organisations, public services, and private sponsors, aiming at collecting comparable national data on road users' opinions, attitudes, and behaviour with respect to road traffic risks. It is an extensive online panel survey, using a representative sample (at least $N = 1000$) of the national adult populations in each participating country. A common questionnaire was developed and translated into national language versions. The themes covered are, e.g., 'self-reported behaviour', 'attitudes and opinions on unsafe traffic behaviour', 'enforcement experiences', and 'support for policy measures'. The survey addresses different road safety topics (e.g., DUI of alcohol, drugs, and medication, speeding, distraction) and targets all types of road users. The present paper is based on the second edition of this global survey (ESRA2). The questionnaire was first developed in English and subsequently translated into 42 national language versions. The fieldwork was conducted in 32 countries in 2018. Hard quotas were used for the gender and age distribution during the sampling procedure, whereas soft quotas were adopted to monitor the geographical spread of the sample within each country. In total, this survey collected data from more than 35,000 road users (for more information on the methodology, see: [24]).

2.2. Socio-cognitive factors in the ESRA2 questionnaire

The ESRA2 questionnaire is based on the Theory of Planned Behaviour [1], which describes the relation between socio-cognitive factors and self-reported behaviour. According to the TPB, conscious behaviour, i.e., behaviour influenced by human will, is largely determined by the intentions of showing this behaviour. This intention is, in turn, determined by the interaction between three socio-cognitive constructs: attitudes towards the behaviour, subjective norms regarding the behaviour, and PBC (perceived behavioural control) over the behaviour. More specifically, the *attitude* towards the behaviour is defined as the positive or negative evaluation of the expected outcomes of this behaviour. *Subjective norms* refer to the perceived social acceptability of this behaviour as it can be deduced from the behaviour and/or direct feedback of others. The *perceived behavioural control* is the extent to which it is believed that the behaviour itself is under control of the individual [1].

In ESRA2, the original TPB model has been expanded by the constructs *habits* and *risk perception*. Furthermore, the TPB construct *subjective norms* has been assessed in the form of *perceived social acceptability* and *personal acceptability*, which they combined under one construct, which the authors call *norms*. The construct *PBC* has been operationalized in the ESRA2 survey as self-efficacy. The TPB-specific items were all tested during a pilot phase (6 countries on different continents), and following the guidelines for setting up a TPB survey. This pilot phase resulted in a smaller set of items covering all concepts of the TPB model.

2.3. Data preparation

Recall that the main objective of this study is the assessment of the impact of socio-cognitive factors on behaviour in different national settings. The investigation is based on ESRA2 data from 32 countries, collected in 2018 [8]. More precisely, it assesses cross-national differences in the effect of socio-cognitive constructs, such as attitudes, norms, PBC, intention, habits, and risk perception on self-reported DUI (driving under the influence of alcohol, drugs, or medication). The data analyzed in this paper concerns the respondents in the survey who indicated that they drive a car at least a few days per month (regular car-drivers). Besides, androgenic respondents were removed because sample weights could not be determined because of non-existing population data. The assessment of the impact of socio-cognitive factors is performed at two levels: (*i*) at the cross-national level, using the sample of all 32 countries ($N = 25{,}459$), and (*ii*) at individual country level, by focusing on a stratified random sample of seven countries. The continent is used as a stratification variable (two countries from Africa, Asia/Oceania, and Europe; one country from North America) to ensure the different continents in the ESRA2 survey are represented. Those countries were Australia, Belgium, Canada, Egypt, Japan, Nigeria, and Slovenia (for more details on countries see: Table 1). The ESRA2 factsheets of the countries involved can be consulted on the ESRA website [25]. These factsheets contain basic results of the survey, but also contextual information such as information on specific traffic legislations and numbers on exposure or road crash casualties by transport mode.

3. Methodology

In terms of analytic methods, first, we describe the sample distribution with respect to socio-demographic characteristics of the respondents (gender, age, education, urbanization level) and exposure (measured as driving frequency) for the whole ESRA2 sample (including 32 countries) and for the selected seven countries. This is followed by the descriptive statistics related to the dependent variable in the linear regression models.

Table 1
Sample composition.

Parameter	Variable	32 countries	Australia	Belgium	Canada	Egypt	Japan	Nigeria	Slovenia
Gender	Male	52%	50%	52%	52%	55%	54%	54%	52%
	Female	48%	50%	48%	48%	45%	46%	46%	48%
Age group	18–34	30%	31%	26%	28%	50%	16%	45%	26%
	35–54	36%	35%	36%	36%	37%	37%	42%	38%
	55+	34%	34%	38%	36%	13%	46%	13%	37%
Education	≤Secondary education	46%	51%	47%	43%	15%	41%	10%	52%
	≥Bachelor	54%	49%	53%	57%	85%	59%	90%	48%
Urbanization level	Urban	36%	28%	28%	28%	40%	44%	36%	16%
	Semi-urban and rural	64%	72%	72%	72%	60%	56%	64%	84%
Driving frequency	At least 4 days a week	67%	73%	67%	71%	58%	56%	56%	79%
	1 to 3 days a week	22%	21%	24%	22%	24%	35%	26%	15%
	A few days a month	11%	6%	10%	7%	18%	9%	19%	5%
Sample size		25,459	778	1532	758	611	623	711	868

Second, we focus on socio-cognitive factors in the ESRA2 survey and their underlying socio-cognitive constructs. Principal component analysis (PCA) was used to test these dimensions of the constructs and to define the underlying construct(s) as (a) composite score(s) for further analysis. The eigenvalue criterion was used to determine the number of factors. *Perceived social acceptability* and *personal acceptability* were included a single composite score, called *norms.* Where less than three items related to DUI were available for an underlying construct, authors extrapolated the test to variables on the same construct in other road safety topics (e.g., attitudes on speeding, seat-belt use, mobile phone use). This was the case for *attitudes*, *intention*, and *risk perception*. The item 'How often do you think each of the following factors is the cause of a road crash involving a car: using a hands-free mobile phone while driving', related to risk perception, was not retained in the final composite score given the different legislation with respect to hands-free mobile phone use across the different ESRA2 countries. The PCA factors were first computed, using the whole sample (32 countries; $N = 25{,}459$) and consequently recomputed individually for the seven selected countries.

In the third part, linear regression models were fitted to investigate the association between the socio-cognitive factors and self-reported DUI. The focus is on DUI (including alcohol, drugs, and medication) and respondents who drive a car at least a few days per month. The models included the PCA-scores of the following socio-cognitive constructs: *attitudes*, *norms*, *PBC, intention* (TPB), and also *habits* and *risk perception*. Moreover, the main socio-demographic characteristics of the respondents (gender, age, education, urbanization level), exposure (driving frequency), and a PCA-score on socially desirable responding (SDR [26]) were taken into account in the analysis (Table 1). The same set of variables was used for all the linear regression models, i.e., the cross-national model (32 countries), and the seven national models. Type III sum of squares analysis was used to measure the contribution of each variable in explaining the variation of DUI. The determination coefficient R^2 was used to assess the fit of the models [27].

Note that a weighting of the data was applied in all analyses of this study. This weighting took into account small corrections with respect to gender and six age groups: 18-24y, 25-34y, 35-44y, 45-54y, 55-64y, 65y+ [28]. All models were analyzed using SAS 9.4.

4. Results

4.1. Descriptive results

4.1.1. Sample description

Table 1 shows the distribution of the weighted sample by gender, age, education, urbanization level, and driving frequency. Recall that gender and age were taken into account in the weighting and represent the distribution in the national population [28] and that driving a car at least a few days per month was used as a selection criterion for this study.

The data shows that the configuration of the national samples differ substantially from each other. Thus, these differences will be taken into account during further analyses. Gender is in most countries equally distributed, with a slightly higher share of male respondents, especially in Egypt (55%) and Japan (54%). With respect to age, Egypt and Nigeria have a significantly younger sample than all other selected countries, whereas Japan has the oldest sample. Egypt and Nigeria have a strikingly high percentage of respondents with a bachelor diploma or higher (Egypt: 85%; Nigeria: 90%; all other selected countries: 49%–59%), which might present a selection bias in recruiting for this online survey. Note that internet penetration in these countries is rather low. In Egypt 47% of the population are internet users, and in Nigeria 42% [29]. In all selected countries, more respondents live in semi-urban or rural areas (56–84%) compared to urban areas (16–44%). Japan has the highest share of urban population (44%) and Slovenia the lowest (16%). Most of the selected car drivers use the car every week. Those who use it less than once a week only represent a minority (11%), expect in Egypt and Nigeria, where 18–19% use the car less than once a week. Recall that only regular car drivers were retained for the analysis and that, therefore, all respondents at least use their car a few days per month.

4.1.2. Descriptive statistics of dependent variables

Table 2 shows the mean scores and standard deviation of the four items, which have been combined in this study to a common DUI score using PCA. A different PCA was run for the overall sample and for each of the selected countries. The common DUI score was used in the linear regression models as the dependent variable. The mean scores for the whole sample (32 countries) and for the selected seven countries (mean score on a 5-point scale ranging from 1 'never to 5 '(almost) always') are presented. Note that all these mean scores are very low, which implies that most of the respondents report sober driving in the last 30 days. In most countries driving after drinking alcohol and medication are the most reported DUI behaviours, except for Egypt, Nigeria, and Japan, where driving after using drugs is more often reported than the other substances. Nigeria shows the highest scored for driving one hour after using drugs and Egypt for driving after taking medication. Belgium has the highest mean scores for DUI of alcohol, both for driving after drinking and driving when they may have been over the legal limit. Japan shows the lowest mean scores for DUI of alcohol and Slovenia for DUI of drugs and medication.

4.2. Principle component analysis

Table 3 shows the allocation of ESRA2 variables to the different socio-cognitive constructs and there answer scales. The dependent variable, i.e., self-reported DUI, is presented first, and the other socio-cognitive constructs that will be used to explain the variation in self-

Table 2
Descriptive statistics of dependent variables.

Variable	32 countries		Australia		Belgium		Canada		Egypt		Japan		Nigeria		Slovenia	
Over the last 30 days, how often did you as a CAR DRIVER drive… *(measured on a 5-point scale ranging from 1 'never to 5 '(almost) always')*	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
When you may have been over the legal limit for drinking and driving?	1.20	0.60	1.14	0.52	1.35	0.72	1.26	0.72	1.24	0.70	1.09	0.42	1.19	0.58	1.21	0.52
After drinking alcohol?	1.29	0.67	1.36	0.74	1.47	0.78	1.42	0.83	1.24	0.67	1.07	0.38	1.28	0.71	1.34	0.62
1 h after using drugs (other than medication)?	1.14	0.54	1.1	0.45	1.14	0.56	1.26	0.76	1.36	0.80	1.20	0.59	1.40	0.84	1.05	0.32
After taking medication that carries a warning that it may influence your driving ability?	1.24	0.66	1.22	0.66	1.30	0.75	1.31	0.78	1.33	0.75	1.17	0.54	1.25	0.65	1.09	0.36

reported DUI are presented consequently. The allocation of variables underlying constructs is based on the factor (component) scores obtained by different PCAs. For each of the TPB constructs, all the PCAs (one for the whole sample, 7 country specific PCAs) resulted in a one-factor solution based on the eigenvalue criterion. Thus, all variables listed within one construct represent a single dimension. The PCA component scores for each construct are used in the linear regression models predicting DUI.

4.3. Models results

Table 4 presents the results of the linear regression models predicting self-reported DUI (including alcohol, drugs and medication). The parameter estimates are presented in Table 5. Recall that the analysis was performed for car drivers who drive a car at least a few days per month. Eight linear regression models were constructed using the same set of variables, one overall model for the 32 countries combined, and seven country-specific models. These linear regression models of self-reported DUI explain a satisfactory amount of variation in self-reported DUI in all countries, ranging from $R^2 = 0.39$ in Nigeria to $R^2 = 0.77$ in Canada (see Table 4). Given the potentially high correlation among different socio-cognitive constructs, all models were inspected for multicollinearity, but all variance inflation factors indicated that there was no serious problem of multicollinearity (VIF < 4).

As can be seen in Table 4 and Table 5, socio-demographic variables (gender, age group, level of education and urbanization) play only a marginal role, as they are only significant in some models. Gender and age has only in Nigeria a significant impact on reported DUI. Here, males are more likely to report DUI than females and young and middle-aged respondents (18–54 years) more than older respondents (55+). In the overall model (32 countries), as well as in Japan, respondents with a secondary-, primary- or no diploma report more DUI than respondents with a bachelor degree or higher diploma. The exposure variable driving frequency does not show any significant effect in none of the models.

In terms of socio-cognitive factors, the results show that *habits* have the strongest relation with self-reported behaviour followed by a significant effect of *norms* in all models. Those respondents who rather accept DUI or perceive a strong social acceptability of DUI, as well as those who rather have the habit to 'drink alcohol and drive' are more likely to report DUI. The construct *attitudes* also shows a significant effect on DUI, except for Japan, Nigeria, and Slovenia. Respondents who have risky road safety attitudes report more DUI. *Intention* appears to have a significant effect on reported DUI in Australia, Belgium, Egypt, and Slovenia. Respondents with a strong intention to behave safely in traffic are less likely to report DUI in comparison to others, except for Australia, where the effect is in the opposite direction. *PBC* only appears to have a significant effect in Egypt. Those car drivers, who think that they are still able to drive safely, after drinking alcohol are more likely to report DUI than those who do not think so. Concerning *risk perception*, the analysis shows that this construct significantly influences DUI in the overall model (32 countries) and in Japan. The effects in these two models go in opposite directions: in the overall model, respondents with high risk perception values are less likely to report DUI, whereas in Japan this is the other way around. The construct on risk perception, which is used in this study reflects the opinion of the respondents on how often they think unsafe traffic behaviour is the cause of a car accident. The question arises if this construct measures the un-safety feeling rather than risk-perception. If this is the case, effects could go in both directions. It could be that unsecure respondents rather do not DUI, but it could also mean that unsecure respondents are more likely to use alcohol, drugs or medication and as such are also more likely to DUI.

The *SDR* construct shows significant effects on reported DUI in most selected countries (Australia, Belgium, Egypt, Nigeria, and Slovenia), but not in the overall model, Canada, and Japan. The identified effect go in most cases in the expected direction: those, respondents, who have a higher tendency to answer social desirable are less likely to report DUI, except for Belgium, where it is the other way around, which might have to do with the high acceptability of DUI in Belgium because of the beer-drinking culture.

5. Discussion and conclusions

The ESRA2 data offers a unique possibility to investigate the relation between socio-cognitive factors and unsafe traffic behaviour in different national settings. The survey covers the main TPB constructs and some additional socio-cognitive constructs across different road safety topics, such as DUI, speeding, and mobile phone use. Representative data for the national adult population of 32 countries was collected in 2018. The present study focuses on predicting self-reported DUI and cross-national differences in the effect of socio-cognitive factors, such as *attitudes*, *norms*, *PBC*, *intention*, *habits*, and *risk perception*. To investigate cross-national differences, linear regression models were fitted on the whole sample (32 countries) and on seven randomly selected countries, i.e., Australia, Belgium, Canada, Egypt, Japan, Nigeria, and Slovenia.

The results show that: (*i*) socio-cognitive factors, as included in the ESRA2 survey, are able to predict self-reported DUI across the different countries ($R^2 = 0.56$ in the overall model); (*ii*) these socio-cognitive factors are also able to predict DUI on a national level (R^2 values ranging from 0.39 to 0.77 in the country-specific models); (*iii*) the impact of socio-cognitive factors on DUI differs across countries (effect size of factors differ between the country-specific models).

The strongest predictor in all countries was the construct *habits*, followed by *norms* and, to a lesser extent, *attitudes* and *intention*. *PBC* and *risk perception* only showed a significant effect on reported DUI in a few countries. The fact that *habits* show such a strong effect on behaviour underlines the importance of considering this socio-cognitive factor when trying to explain differences in behaviour. This is in line with, e.g., Pelsmacker & Janssens (2007, [8]) that incorporate habits in their model predicting self-reported speeding or Bruijn et al., (2009, [18]) that added *habit strength* in their model predicting bicycle use. The result with respect to norms, seems at first glance, contradictory

Table 3
Allocation of ESRA2 variables to underlying (socio-cognitive) constructs, and their factor scores.

Construct	ESRA2 variable	32 countries	Australia	Belgium	Canada	Egypt	Japan	Nigeria	Slovenia
		Loading	Loading	Loading	Loading	Loading	Loading	Loading	Loading
Dependent variable									
Self-reported DUI[1]	*Over the last 30 days, how often did you as a CAR DRIVER dive ...*								
	- when you may have been over the legal limit for drinking and driving?	0.837	0.857	0.836	0.901	0.834	0.892	0.765	0.856
	- after drinking alcohol?	0.784	0.692	0.816	0.808	0.766	0.887	0.776	0.759
	- 1 h after using drugs (other than medication)?	0.752	0.824	0.722	0.845	0.756	0.789	0.666	0.580
	- after taking medication that carries a warning that it may influence your driving ability?	0.700	0.724	0.674	0.848	0.707	0.797	0.702	0.480
TPB constructs									
Attitudes[2,3]	*To what extent do you agree with each of the following statements?*								
	- For short trips, one can risk driving under the influence of alcohol.	0.512	0.628	0.566	0.747	0.426	0.666	0.677	0.559
	- I have to drive fast; otherwise, I have the impression of losing time.	0.701	0.770	0.719	0.766	0.720	0.684	0.700	0.658
	- Respecting speed limits is boring or dull.	0.545	0.547	0.514	0.574	0.670	0.589	0.673	0.532
	- For short trips, it is not really necessary to use the appropriate child restraint.	0.496	0.577	0.499	0.756	0.528	0.674	0.578	0.308
	- I use a mobile phone while driving, because I always want to be available.	0.733	0.733	0.752	0.813	0.718	0.720	0.491	0.711
	- To save time, I often use a mobile phone while driving.	0.756	0.800	0.774	0.826	0.702	0.733	0.743	0.753
Norms[4]	*Where you live, how acceptable would most other people say it is for a car driver to drive ...*								
	- when he/she may be over the legal limit for drinking and driving?	0.726	0.752	0.737	0.830	0.695	0.745	0.671	0.712
	- 1 h after using drugs (other than medication)?	0.738	0.794	0.771	0.818	0.683	0.722	0.680	0.760
	How acceptable do you, personally, feel it is for a CAR DRIVER to drive ...								
	- when he/she may be over the legal limit for drinking and driving?	0.779	0.813	0.784	0.869	0.715	0.807	0.726	0.725
	- 1 h after using drugs (other than medication)?	0.771	0.846	0.772	0.880	0.730	0.805	0.605	0.715
	- after taking a medication that may influence the ability to drive?	0.692	0.727	0.715	0.844	0.713	0.784	0.658	0.598
PBC[3]	*To what extent do you agree with each of the following statements?*								
	- I trust myself to drive after having a glass of alcohol	0.773	0.704	0.827	0.715	0.819	0.845	0.830	0.819
	- I have the ability to drive when I am a little drunk after a party.	0.855	0.853	0.868	0.861	0.839	0.846	0.843	0.859
	- I am able to drive after drinking a large amount of alcohol (e.g. half a litre of wine).	0.815	0.812	0.844	0.868	0.768	0.837	0.748	0.791
Intention[2,3]	*To what extent do you agree with each of the following statements?*								
	- I will do my best not to drive after drinking alcohol in the next 30 days.	0.745	0.735	0.769	0.710	0.755	0.791	0.761	0.705
	- I will do my best to respect speed limits in the next 30 days.	0.766	0.788	0.765	0.721	0.824	0.746	0.768	0.754
	- I will do my best not to use my mobile phone while driving in the next 30 days.	0.790	0.790	0.768	0.762	0.817	0.814	0.747	0.764
Additional constructs									
Habits[3, 1]	*To what extent do you agree with each of the following statements?*[3]								
	- I often drive after drinking alcohol.	0.834	0.789	0.846	0.905	0.737	0.847	0.835	0.738
	- Even when I am a little drunk after a party, I drive.	0.815	0.798	0.857	0.861	0.812	0.853	0.830	0.794
	- It sometimes happens that I drive after consuming a large amount of alcohol (e.g. a litre of beer or half a litre of wine).	0.822	0.766	0.844	0.873	0.751	0.849	0.741	0.804
	Over the last 12 months, how often did you as a car driver drive ...[1]								
	- after drinking alcohol?	0.758	0.706	0.800	0.780	0.721	0.647	0.684	0.759
Risk perception[2,5]	How often do you think each of the following factors is the cause of a road crash involving a car?								
	- driving after drinking alcohol	0.913	0.878	0.858	0.899	0.938	0.920	0.932	0.870
	- driving after taking drugs (other than medication)	0.891	0.873	0.844	0.889	0.933	0.903	0.908	0.839
	- driving faster than the speed limit	0.814	0.824	0.712	0.777	0.933	0.864	0.898	0.741
	- using a hand-held mobile phone while driving	0.868	0.857	0.851	0.872	0.874	0.927	0.826	0.819
	- inattentiveness or day-dreaming while driving	0.857	0.823	0.777	0.828	0.937	0.874	0.893	0.820
	- driving while tired	0.876	0.858	0.830	0.848	0.908	0.843	0.871	0.847
SDR[6]	To what extent are the following statements true?								
	- I always respect the highway code, even if the risk of getting caught is very low.	0.804	0.798	0.801	0.800	0.866	0.77	0.825	0.795
	- I would still respect speed limits at all times, even if there were no police checks.	0.772	0.776	0.752	0.780	0.858	0.731	0.802	0.735
	- I have never driven through a traffic light that had just turned red.	0.623	0.572	0.551	0.596	0.772	0.657	0.659	0.620
	- I do not care what other drivers think about me.	0.356	0.425	0.428	0.345	0.464	0.332	0.288	0.476
	- I always remain calm and rational in traffic.	0.720	0.703	0.684	0.710	0.807	0.759	0.785	0.711
	- I am always confident of how to react in traffic situations.	0.597	0.611	0.582	0.638	0.783	0.691	0.701	0.626

Loading: factor (principal component) loading.
[1] Answered on a 5-point scale ranging from 1 'never' to 5 '(almost) always'.
[2] Expanded to other road safety topics (e.g., speeding, mobile phone us, seat belt use).
[3] Answered on a 5-point scale ranging from 1 'disagree' to 5 'agree'.
[4] Answered on a 5-point scale ranging from 1 'unacceptable' to 5 'acceptable'.
[5] Answered on a 6-point scale ranging from 1 'never' to 6 '(almost) always'.
[6] Answered on a 5-point scale ranging from 1 'very untrue' to 5 'very true'.

Table 4
Type III analysis of effects on self-reported DUI (only significant effect are presented).

Parameter	32 countries		Australia		Belgium		Canada		Egypt		Japan		Nigeria		Slovenia	
	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F
Socio-demographic variables & exposure																
Gender	---	---	---	---	---	---	---	---	---	---	---	---	8.2	0.004	---	---
Age group	---	---	---	---	---	---	---	---	---	---	---	---	4.4	0.013	---	---
Education	5.6	0.010	---	---	---	---	---	---	---	---	5.5	0.019	---	---	---	---
Urbanization level	11.2	0.001	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Driving frequency	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TPB constructs																
Attitudes[1]	253.8	<0.001	8.1	0.005	24.6	<0.001	28.3	<0.001	18.8	<0.001	---	---	---	---	---	---
Norms	2279.2	<0.001	59.4	<0.001	80.9	<0.001	133.5	<0.001	14.8	<0.001	49.5	<0.001	62.0	<0.001	42.2	<0.001
PBC	---	---	---	---	---	---	---	---	13.4	<0.001	---	---	---	---	---	---
Intention[1]	---	---	7.9	0.005	6.8	0.009	---	---	6.8	0.010	---	---	---	---	7.1	0.008
Additional constructs																
Habits	7842.7	<0.001	268.9	<0.001	434.1	<0.000	176.7	<0.001	150.9	<0.001	141.6	<0.001	107.2	<0.001	289.4	<0.001
Risk perception[1]	6.9	0.009	---	---	---	---	---	---	---	---	4.0	0.046	---	---	---	---
SDR	---	---	5.6	0.019	5.3	0.021	---	---	6.7	0.010	---	---	14.6	<0.001	12.0	0.001
Model fit																
R^2	0.56		0.64		0.58		0.77		0.58		0.47		0.39		0.56	

— included in the model but not significant ($p > .05$).
[1] Expanded to other road safety topics (e.g. speeding, mobile phone us, seat belt use).

to the TPB meta-analysis of Armitage & Conner (2001, [30]), who found that *subjective norms* were generally found to be the weakest predictor of intentions compared to the *attitude* and *PBC*. Armitage & Conner (2001, [30]) attributed this weakness to a combination of poor measurement and the need for expansion of the normative component. Parker et al. (1992, [31]) furthermore, point out that the predicting power of norms strongly depends on the considered behaviours. As driving is a highly social performance, we can expect that social norms have a greater impact on this intentional behaviour. They found that intentions to drink and drive, to speed, to follow closely and overtake in dangerous circumstances were well predicted by *subjective norms*. For the two last behaviours, normative beliefs were even the main predictor of the intention. Furthermore, the construct *norms* in our study includes 'personal and perceived acceptability of other related of DUI behaviour', which is an expansion of the original definition of *subjective norms* in the TPB [1], but which has proven high value as a predictor in the current study.

The weak effect of *intentions* in the present study is rather surprising and might be an artefact of having only a single DUI-related intention indicator. Notwithstanding, the PCA analysis performed on the construct *intention*, shows the single dimensionality of the construct. Further analyses across different road safety domains (e.g., speeding and

Table 5
Parameter estimates linear regression model predicting self-reported DUI (only significant effect are presented).

Parameter (reference category)	32 countries	Australia	Belgium	Canada	Egypt	Japan	Nigeria	Slovenia
	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
Intercept	−0.016	−0.101	−0.114	0.066	−0.254	−0.073	−0.532	0.055
Socio-demographic variables & exposure								
Gender (Female)								
Male	---	---	---	---	---	---	0.178	---
Age (55+)								
35–54	---	---	---	---	---	---	0.286	---
18–34	---	---	---	---	---	---	0.244	---
Education (≥Bachelor)								
≤Secondary education	0.020	---	---	---	---	0.146	---	---
Urbanization level (Urban)								
Semi-urban and rural	0.030	---	---	---	---	---	---	---
Driving frequency (A few days a month)								
1 to 3 days a week	---	---	---	---	---	---	---	---
At least 4 days a week	---	---	---	---	---	---	---	---
TPB constructs								
Attitudes[1]	0.083	0.091	0.111	0.168	0.132	---	---	---
Norms	0.230	0.229	0.187	0.304	0.117	0.251	0.242	0.169
PBC	---	---	---	---	0.142	---	---	---
Intention[1]	---	0.068	−0.048	---	−0.079	---	---	−0.070
Additional constructs								
Habits	0.563	0.579	0.568	0.488	0.466	0.533	0.499	0.564
Risk perception[1]	−0.011	---	---	---	---	0.062	---	---
SDR	–	−0.056	0.042	–	−0.078	–	−0.116	−0.087

— included in the model but not significant ($p > .05$).
[1] Expanded to other road safety topics (e.g. speeding, mobile phone us, seat belt use).

seat-belt use) can provide additional insight into the fact whether this finding is particular for speeding, or whether the operationalisation of intention in the future ESRA surveys needs to be revisited.

The socio-demographic variables show so little effect in the presented models, but this might have been caused by the fact that the respondents who declare DUI (including alcohol, drugs, and medication) are a very heterogeneous group. We know, e.g., that driving under the influence of alcohol and drugs is more common among male drivers than female drivers, but that the share of female drivers who drive under the influence of medication is larger. Furthermore, the age groups differ depending on the substance. Driving under the influence of drugs is rather reported by young drivers, while driving under the influence of alcohol and medications is more common by older drivers [21,31,32].

The observation that the exposure variable *driving frequency* does not show any significant effect in none of the models might have been caused by the fact that the analyzed subset concerns car drivers who at least drove a few times in the last months.

As (questionnaire) surveys rely on self-reported information, it is important to take the effect of SDR (social desirable responding) into account in the analysis [33]. For this purpose, the ESRA2 survey included an SDR scale, which was 6-item version of the Driver Social Desirability Scale of Lajunen et al. (1997, [26]). This used SDR construct had a significant effect on self-declared DUI in five out of the seven selected countries. This underlines the importance of assessing SDR in (questionnaire) surveys and using it in further analysis.

From a methodological perspective, linear regression models were used to predict DUI behaviour. A disadvantage of this approach is that only the direct effects of the considered factors on DUI are analyzed, and no indirect effects are considered, such as in the original TPB model. Notwithstanding, the methodological choice can be defended because of different reasons. First, the approach allowed for the identification of different contributing socio-cognitive factors. Given that the correlation among these socio-cognitive factors did not cause severe multicollinearity (variance inflation factors smaller than four), the indirect effects would not be large. Secondly, the evaluation of the traditional TPB model using a covariance-based structural equations modelling (SEM) analysis yielded Haywood cases, indicating that the classic TPB structure seems unfit for predicting DUI. The aforementioned non-significance of intention is an important contributing factor to this. Therefore, the combination of different PCAs with linear regression was a valid and appropriate way of addressing the three research questions.

To conclude, the ESRA2 data offer a unique opportunity to gain valuable insights into cross-national differences in traffic safety and provides us with the opportunity to compare socio-cognitive factors and self-declared unsafe traffic behaviour between different countries. Future research will focus on more in-depth analysis of national differences and expand this study to other road safety topics and more countries.

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