Same Risk but Different Attribution: Locus of Control Moderates The Relationship Between Risk Perception and Driver Behaviours

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Keywords: locus of control, external locus of control, risk perception, errors, violations

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Abstract

Understanding the psychological mechanisms behind driver behaviours is critical to road safety. Drivers' level of perceived risk and attribution of road traffic crashes may affect the behaviours. Concerning this, the current study investigated the role of traffic locus of control on the relationship between risk perception and driver behaviours and speed preferences. The sample consisted of 334 drivers (Age M = 26.47, SD = 7.01). Moderation analysis showed significant moderating effects of all four dimensions of traffic locus of control on errors, all three dimensions of external traffic locus of control on ordinary violations, and self and other drivers on inter-city speed preference. The highest number of ordinary violations was reported for drivers with average and low levels of external traffic control focus when their risk perception was also low. The results provide evidence for the interaction effects between risk perception and locus of control while determining driver behaviours. The findings were discussed in light of the related literature.

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Highlights

- The effects of risk perception on self-reported driver behaviour and speed preference were examined.
- The moderating role of traffic locus of control on the above relationship was analysed.
- Traffic locus of control dimensions moderated the relationship between risk perception and errors.
- External traffic locus of control dimensions moderated the relationship between risk perception and ordinary violations.

1. Introduction

Road traffic crashes continue to be a global problem, resulting in 1.19 million road traffic deaths, making it the 12th leading cause of death worldwide (*1*). Among the various human, vehicle, and environmental factors that contribute to these crashes, human factors contribute to the majority of these crashes (*2,3*) Of the various road user groups, drivers are disproportionately affected by and cause these crashes. Aberrant behaviours of drivers create a problem for road safety (*4*). Consequently, delving into psychological mechanisms behind driver behaviours becomes essential in addressing this problem effectively.

1.1. Self-reported driver behaviours

Driver behaviours play an important role in road safety and have been defined as what drivers usually do while driving (*5, 6*). The Driver Behaviour Questionnaire (DBQ) is the most commonly used self-reported instrument to measure aberrant driver behaviours (*7*), which were categorized into two main groups: errors and violations (*8*). Errors, categorized as lapses and mistakes, are defined as "the failure of planned actions to achieve their intended consequences", while violations, identified as aggressive and ordinary violations, are defined as "deliberate deviations from those practices believed necessary to maintain the safe operation of a potentially hazardous system" (*8*). Both types of aberrant behaviours are found to be positively related to crash involvement (*7*).

Speeding, as one of the common ordinary violations, has been considered a main factor increasing the probability and severity of road traffic crashes and fatalities (*9, 10, 11*). The behaviour is intentional in nature in that the speed limit is exceeded deliberately. According to a study focusing on speeding behaviour based on the Theory of Planned Behaviour, speed preference is followed by a conscious intention to engage in the behaviour (*12*). Self-reported speed preference and observed speed have also been correlated positively (*13*). In this study, drivers were asked about their speed preference on urban and interurban roads considering the speeding problem across different residential areas, especially in outside built-up areas (*1*).

In addition to aberrant behaviours (e.g., speeding violations), Özkan and Lajunen (*14*) proposed a new dimension acknowledging polite and helpful behaviours of drivers towards other road users with or without safety intentions, named positive behaviours. Positive behaviours were associated negatively with errors and violations, suggesting its potential role in road safety (*14*).

Studies (e.g., [*15, 16*]) have shown that driving-related contextual factors such as driver behaviours (e.g., [*7*]) are important predictors of road traffic crashes. For this reason, understanding the antecedents of driver behaviours, either driving specific or general factors, is crucial for behavioural studies. The current study examined the relationship between driver behaviour, including speed preference and antecedent factors of risk perception and traffic locus of control.

1.2. Risk perception

The road traffic system is a dynamic and complicated network where drivers are always faced with different risks. Risk perception or perceived risk is one of the central variables in managing these risks on the road and has been found to affect road user behaviour by influencing decision processes (e.g., [*17, 18*]). The term was defined as how individuals subjectively perceive the level of risk in various traffic situations (*17*). It is also influenced by a wide range of variables, such as past experiences, social/environmental factors and personal factors (*18, 19*). Brown and Groeger (*20*) focused on the two determinants of risk perception: information about potentially dangerous situations in the traffic environment and information about the combined abilities of driver and vehicle to prevent potentially dangerous situations from resulting in accidents.

Previous studies have reported that risk perception is a significant predictor of behaviours of the road users such as drivers (e.g., [*17, 21-25*]), cyclists (e.g., [*26*]), pedestrians (e.g., [*27*]), and motorcycle riders (e.g., [*28*]). For example, higher risk perception was positively associated with following traffic rules and avoiding aggressive behaviours and non-driving activities while driving (e.g., [*18*]). Furthermore, high-risk perception was associated with safer behaviours, such as using seat belts and reducing driving speed (*21, 29*). Similarly, higher risk perception was also associated with less risky (e.g., [*30, 31*]) and more positive (*31*) driver behaviour among professional drivers.

1.3. Locus of Control

Locus of control is an important psychological construct that relates to how individuals perceive and evaluate life events (*32*). Rotter (*32*) defined internal locus of control as the belief that events in life are controllable and influenced by individuals' behaviour and personal qualities, whereas external locus of control is the belief that events in life are influenced by other factors such as environmental/situational factors, fate, and chance. People with a higher internal locus of control attribute the causes of events to themselves, while people with a higher external locus of control attribute the causes of events to external factors such as fate or powerful others (32).

Locus of control or traffic locus of control may have a reciprocal relationship with risk perception, and its effect on driver behavior has been addressed in different ways in the literature. Measures of individuals' locus of control tendency have focused on either general locus of control addressing life events (*32*) or more context-specific locus of control, for example, driving internality (DI) and driving externality (DE) (*33*). In the traffic context, one of the most context-specific and widely accepted locus of control measures is the Multidimensional Traffic Locus of Control (T-LoC) scale, which was developed to measure the locus of control specific to the driving situations (*34*). The T-LoC measures the extent to which drivers attribute the causes of crashes to *self* (individuals' own behaviours and skills), *other drivers* (other drivers' behaviours and skills), *vehicle/environment factors* or *fate* (fate or bad luck) factors. While the self is perceived to be an internal locus of control, the rest is seen as an external locus of control.

A considerable amount of literature has been focused on the relationship between traffic locus of control and driving outcomes (e.g., [*35, 36, 37*]), but contradictory findings have been reported. For example, external locus of control was positively associated with dissociative and distress-reduction driving styles, whereas internal locus of control was negatively associated with angry and risky driving styles (*36*). On the other hand, in other studies, internal locus of control was positively associated with aberrant driver behaviours and crash involvement (e.g., [*34, 38*]), whereas external locus of control was positively associated with crash involvement and traffic offences (*39*). Another study found that other drivers dimension was positively associated with positive behaviours, while vehicle/environment dimension was negatively associated with positive behaviours. Fate was positively associated with aberrant behaviours (*40*). Furthermore, as for speeding behaviour, self was also associated positively with speed preference on 90km/h roads, while vehicle/environment was associated negatively with speed preference on 90km/h roads (*37*).

1.4. Aim of The Study

As stated above, both risk perception and locus of control are two important psychological constructs to explain driver behaviours. The mechanism behind risk perception and its influence on driver behaviours are not still well understood and subject to ongoing inquiry by the researchers. Investigating the joint contribution of risk perception and locus of control on driver behaviours and speed preference could provide valuable insights into the underlying mechanisms behind road safety outcomes from the driver's perspective. Investigating the joint contribution of these two constructs can advance the understanding of the psychological mechanisms underlying road safety. In light of all these, the present study investigated the effect of traffic locus of control on the relationship between risk perception and driver behaviours/speed preference (Figure 1).

Figure 1. *The moderating role of traffic locus of control between risk perception and driver behaviours*

Although the relationship between risk perception and traffic locus of control with driver behaviour has been addressed separately in previous studies, as discussed above, to the best of the authors' knowledge, no previous study in the literature has addressed this relationship considering the moderating role of traffic locus of control. Previously, traffic locus of control has been found to moderate the relationship between safe driving climate and driver behaviours (*41*). The current model is designed to explore both the relationship between risk perception and traffic locus of control and the moderating role of locus of control between individual factors and behavioural outcomes on the road based on the studies in the literature (e.g., [*41, 42, 43*]). This study aims to fill this gap by examining the potential moderating effect of traffic locus of control.

2. Method

2.1. Participants

A total of 334 drivers (Male = 179; Female = 155) aged between 18 and 52 years (M = 26.47, SD = 7.01) participated in the study. Details of the demographic characteristics of the sample are given in Table 1.

2.2. Measurements

2.2.1. Demographic Information

A demographic information form was used to obtain demographic information such as age and gender and some driving-related information such as last year and lifetime kilometres, number of crashes, and licensing year.

2.2.2. Speed Preference

Participants were asked about their preferred speed on urban and interurban roads. Participants were asked to answer the following two questions "*At what speed (in km/h) would you prefer to drive on urban roads when the weather and road conditions are appropriate*?" and "*At what speed (in km/h) would you prefer to drive on interurban roads when the weather and road conditions are appropriate*?".

2.2.3. Risk Perception Inventory (RPI)

The 34-item Risk Perception Inventory was developed to measure participants' subjective risk assessment in the traffic environment (*44*), and it was translated into Turkish by Erkuş (*45*). The scale consists of 34 items representing 34 different driving situations (e.g., eating while driving and speeding up when approaching a yellow light). Participants were asked to rate the level of perceived risk for each situation on a 5-point Likert scale (from 1: not risky at all to 5: very risky). The Cronbach's Alpha coefficient was .89 in the present study.

2.2.4. Multidimensional Traffic Locus of Control Scale (T-LoC)

The T-LoC is a 17-item scale that aims to measure the extent to which an individual attributes the causes of crashes to four factors: self with five items, others with six items, vehicle and environment with three items, and fate with three items (*34*). Participants were asked to rate the items on a 5-point Likert scale (from 1: not at all possible to 5: highly possible) regarding their likelihood of causing a crash, given their driving style and conditions. The Cronbach's Alpha coefficients for the subscales were .81 for self, .81 for others, .62 for vehicle and environment, and .74 for fate.

2.2.5. Driver Behavior Questionnaire (DBQ) and Positive Driver Behaviors Scale (PDBS)

Self-reported driver behaviours were measured by using the DBQ and PDBS. The 28-item DBQ was developed to measure drivers' aberrant behaviours in traffic (*8*). The Turkish version by Sümer and Özkan (*46*) was used in the current study. In addition to aberrant driver behaviours, positive driver behaviours were measured using the 14-item PDBS developed by Özkan and Lajunen (*14*). The total scale of 42 items was rated on a 6-point Likert scale (0: From never to 5: Always) representing five subscales as lapses (8 items), errors (8 items), aggressive violations (3 items), ordinary violations (9 items) and positive behaviours (14 items). The Cronbach's Alpha coefficients for the subscales are .72 for lapses, .74 for errors, .64 for aggressive violations, .80 for ordinary violations, and .77 for positive behaviours.

2.3. Procedure

Prior to data collection, ethical approval was obtained from the Middle East Technical University Human Research Ethics Committee (Protocol Number: 287-ODTU-2019). Snowball and convenience sampling methods were used to reach participants. The questionnaire package was distributed using Qualtrics (online data collection method) through social media channels. At the same time, the Middle East Technical University Department of Psychology Research Sign-Up System, a platform for university students to earn bonus points for their courses by participating in studies, was used to recruit participants. An informed consent form was provided to ensure anonymity and confidentiality at the beginning of the study. Furthermore, informed consent also included the aim of the current study (to examine the relationship between risk perception, traffic locus of control, and driver behaviours). Participants completed the questionnaires in the order presented in section 2.2. Participants were required to have a valid driving license and to be actively driving.

2.4. Analyses

Data management and analyses were conducted by using the Statistical Package for Social Science (SPSS) v.28. Before carrying out the analyses, a data screening and cleaning process was performed to improve the quality of the data. For this purpose, an outlier analysis was carried out, and outliers were removed from the data set (z-score > 3.29) ($N = 11$). After the data cleaning procedure, descriptive analyses and correlation analyses were performed. Following the correlation analyses, 28 moderation analyses were conducted to examine the role of traffic locus of control in the relationship between risk perception and driver behaviours and speed preference for urban and interurban roads. The moderation analyses were conducted by using PROCESS macro for SPSS (Model 1) by Hayes (*47*) with 5000 bootstrapping where age, gender, and last year kilometre were controlled. In order to examine the moderating role of the traffic locus of control, risk perception was entered as an independent variable, and the four dimensions of the traffic locus of control were entered as moderator variables during the analyses. The DBQ, the PDBS, and speed preference for urban and interurban roads were entered as dependent variables. The significant effects of each moderator were tested and presented by plotting the three levels (the mean and one standard deviation below and above the mean; e.g., [*35*]). Only significant moderation results were reported. When analysing the interaction effects, statistical power might be lower. For this reason, the significance value (p) was accepted as .10 (*48*).

3. Results

3.1. Descriptive Statistics and Correlations

Descriptives and bivariate correlation coefficients for variables are presented in Table 1. Risk perception was correlated positively with four factors of traffic locus of control and negatively with ordinary violations and speed preference on interurban roads. Self was correlated positively with other drivers, vehicle and environment, and errors. Other drivers factor was correlated positively with vehicle and environment and positive behaviours and negatively with ordinary violations. Vehicle and environment factor was correlated negatively with ordinary violations and interurban speed preference and positively with fate and lapses. The fate aspect of traffic locus of control was correlated positively with lapses, errors, and aggressive violations and negatively with positive behaviours.

Table 1. *Descriptives and Bivariate Correlations of Study Variables*

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Age	1																		
2	Gender (1=Female, 2=Male)	.05	1																	
3	Licensing year	**.92****	.10	1																
4	Last-year km	**.32****	**.18****	**.35****	1															
5	Life-time km	**.58****	**.22****	**.64****	**.56****	1														
6	Active crash	-.01	-.01	-.01	**.14***	.00	1													
7	Passive crash	.03	.02	.07	.06	.05	**.21****	1												
8	Risk perception	**.24****	**-.16****	**.19****	-.03	.07	-.1	-.01	1											
9	Self	**.12***	-.05	.06	.00	.01	-.03	-.06	**.26****	1										
10	Other drivers	**.15****	-.07	**.13***	-.03	.00	**-.14****	.04	**.32****	**.44****	1									
11	Vehicle/environment	.09	**-.21****	.06	**-.12***	-.04	**-.15****	-.03	**.35****	**.41****	**.50****	1								
12	Fate	-.01	-.02	-.05	-.05	-.03	-.04	-.03	**.12***	.03	-.03	**.18****	1							
13	Lapses	**-.13***	**-.15****	**-.12***	-.07	.03	.07	-.02	.08	.07	-.08	**.16****	**.24****	1						
14	Errors	-.07	.05	-.07	.03	.10	**.11***	-.03	.08	**.14****	-.08	.03	**.26****	**.67****	1					
15	Aggressive violations	.01	**.16****	.01	**.15****	**.15****	**.15****	**.14***	-.01	-.01	.02	-.06	**.19****	**.31****	**.36****	1				
16	Ordinary violations	**-.16****	**.25****	-.10	.08	.07	**.18****	.05	**-.27****	-.02	**-.24****	**-.17****	.08	**.47****	**.55****	**.44****	1			
17	Positive behaviours	**.16****	.03	**.17****	**.14***	**.12***	-.04	.07	.01	-.07	**.17****	.01	**-.20****	**-.21****	**-.36****	-.09	**-.26****	1		
18	Interurban speed	.01	**.17****	.05	**.25****	**.12***	**.18****	.08	**-.17****	.02	-.01	**-.16****	-.02	-.04	.09	**.16****	**.25****	.00	1	
19	Urban speed	.00	.02	.04	**.14****	**.11***	.06	.03	-.08	-.04	-.02	-.09	-.10	.02	.05	**.12***	**.21****	.02	**.42****	1
	Mean	26.47		6.43	7358.79	47817.42	.62	.41	3.73	3.52	4.15	3.63	2.48	.97	.82	1.33	.99	3.35	113.45	68.67
	Standard Deviation	7.01		5.94	9853.05	85106.14	.93	.86	.44	.89	.55	.67	.93	.63	.62	.96	.66	.65	18.68	16.36

Note. $^{*}p < .05$; $^{**}p < .01$.

3.2. Moderation Analyses

A total of 28 moderation analyses were conducted to examine the role of traffic locus of control in the relationship between risk perception and driver behaviours. Of these, 13 models showed a significant interaction effect (see Appendix A).

3.2.1. Interaction effect on errors

The model testing the moderating role of self on the relationship between risk perception and errors was significant (R^2 = .06, F(6, 324) = 3.40, p = .003). The interaction effect of self and risk perception was significant (b = .18, t(324) = 2.07, p = .039, 95% CI [.01, .36]). Among people who attribute crashes to their own behaviours more (Figure 2), increased risk perception is associated with increased errors (t(324) = 2.57, b = .31, p = .011).

Figure 2. Risk perception on errors through self

The model testing the moderating role of other drivers on the relationship between risk perception and errors was significant (R^2 = .05, F(6, 324) = 2.77, p = .012). The interaction effect of other drivers and risk perception was significant (b = .23, t(324) = 2.04, p = .043, 95% CI [.01, .46]. Increased risk perception is associated with increased errors at moderate (t(324) = 3.04, b = .26, p = .003) and high (t(324) = 3.25, b = .42, p = .001) levels of other drivers attribution (Figure 3).

Figure 3. *Risk perception on errors through other drivers*

The model testing the moderating role of vehicle and environment on the relationship between risk perception and errors was significant (R^2 = .05, F(6, 324) = 2.68, p = .015). The interaction effect of vehicle and environment and risk perception was significant (b = .28, t(324) = 2.57, p = .011, 95% CI [.07, .49]. Increased risk perception is associated with increased errors at moderate (t(324) = 2.41, b = .21, p = .017) and high (t(324) = 3.20, b = .39, p = .002) levels of vehicle and environment (Figure 4).

Figure 4. Risk perception on errors through vehicle and environment

The model testing the moderating role of fate on the relationship between risk perception and errors was significant (R^2 = .10, F(6, 324) = 5.72, p < .001). The interaction effect of fate and risk perception was significant (b = .14, t(324) = 1.84, p = .067, 95% CI [-.01, .28]. Only for high levels of fate, increased risk perception is associated with increased errors (t(324) = 2.44, b = .24, p = .015) (Figure 5).

Figure 5. Risk perception on errors through fate

3.2.2. Interaction effect on lapses

The model testing the moderating role of self on the relationship between risk perception and lapses was significant (R^2 = .06, F(6, 324) = 3.49, p = .002). The interaction effect of self and risk perception was significant (b = .16, t(324) = 1.83, p = .068, 95% CI [-.01, .34]. Increased risk perception is associated with increased lapses at moderate (t(324) = 1.99, b = .18, p = .047) and high (t(324) = 2.31, b = .27, p = .021) levels of self-attribution (Figure 6).

Figure 6. *Risk perception on lapses through self*

3.2.3. Interaction effect on aggressive violations

The model testing the moderating role of self on the relationship between risk perception and aggressive violations was significant (R^2 = .05, F(6, 324) = 3.05, p = .007). The interaction effect of self and risk perception was significant (b = .26, t(324) = 1.93, p = .055, 95% CI [-.01, .53]. However, none of the pairwise comparisons were significantly different.

The model testing the moderating role of fate on the relationship between risk perception and aggressive violations was significant (R^2 = .09, F(6, 324) = 5.62, p < .001). The interaction effect of fate and risk perception was significant (b = .24, t(324) = 2.15, p = .032, 95% CI [.02, .46]. However, none of the pairwise comparisons were significantly different.

3.2.4. Interaction effect on ordinary violations

The model testing the moderating role of other drivers on the relationship between risk perception and ordinary violations was significant (R^2 = .16, F(6, 324) = 10.62, p < .001). The interaction effect of other drivers and risk perception was significant (b = .20, t(324) = 1.75, p = .082, 95% CI [-.03, .43]. Increased risk perception is associated with decreased ordinary violations at low (t(324) = -3.14, b = -.29, p = .002) and moderate (t(324) = -2.16, b = -.19, p = .032) levels of other drivers attribution (Figure 7).

Figure 7. Risk perception on ordinary violations through other drivers

The model testing the moderating role of vehicle and environment on the relationship between risk perception and ordinary violations was significant (R^2 = .15, F(6, 324) = 9.19, p < .001). The interaction effect of vehicle and environment and risk perception was significant (b = .20, t(324) = 1.82, p = .070, 95% CI [-.02, .41]. Increased risk perception is associated with decreased ordinary violations at low (t(324) = -3.69, b = -.37, p < .001) and moderate (t(324) = -2.78, b = -.24, p = .006) levels of vehicle and environment (Figure 8).

Figure 8. Risk perception on ordinary violations through vehicle and environment

The model testing the moderating role of fate on the relationship between risk perception and ordinary violations was significant (R^2 = .16, F(6, 324) = 10.20, p < .001). The interaction effect of fate and risk perception was significant (b = .16, t(324) = 2.14, p = .033, 95% CI [.01, .31]. Increased risk perception is associated with decreased ordinary violations at low (t(324) = -4.17, b = -.50, p < .001) and moderate (t(324) = -4.16, b = -.34, p < .001) levels of fate attribution (Figure 9).

Figure 9. Risk perception on ordinary violations through fate

3.2.5. Interaction effect on positive behaviours

The model testing the moderating role of fate on the relationship between risk perception and positive behaviours was significant (R^2 = .08, F(6, 324) = 4.83, p < .001). The interaction effect of fate and risk perception was significant (b = .24, t(324) = 2.15, p = .088, 95% CI [-.28, .02]. However, none of the pairwise comparisons were significantly different.

3.2.6. Interaction effect on speed preference

The model testing the moderating role of self on the relationship between risk perception and interurban speed was significant (R^2 = .12, F(6, 322) = 7.21, p < .001). The interaction effect of self and risk perception was significant (b = -5.51, t(322) = -2.15, p = .033, 95% CI [-10.55, -.46]. Increased risk perception is associated with decreased interurban speed at moderate (t(322) = -2.81, b = -6.73, p = .005) and high (t(322) = -3.38, b = -11.66, p = .001) levels of self-attribution (Figure 10).

Figure 10. Risk perception on interurban speed through self

The model testing the moderating role of other drivers on the relationship between risk perception and interurban speed was significant (R^2 = .12, F(6, 322) = 7.35, p < .001). The interaction effect of other drivers and risk perception was significant (b = -8.13, t(322) = -2.45, p = .015, 95% CI [-14.66, -1.60]. Increased risk perception is associated with decreased interurban speed at moderate (t(322) = -3.08, b = -7.66, p = .002) and high (t(322) = -3.58, b = -12.12, p < .001) levels of other drivers attribution (Figure 11).

Figure 11. Risk perception on interurban speed through other drivers

4. Discussion

In the present study, the role of traffic locus of control in the relationship between risk perception, and driver behaviour, and speed preference of drivers was examined. The results of the study supported findings in the literature on the linear relationships of risk perception and traffic locus of control with aberrant driver behaviour (e.g., [*21, 23, 39, 49*]), and provided some evidence for the interaction effect between these two variables.

To look at the results in more detail, firstly, the results showed a clear pattern of association for errors. According to this, a positive relationship was found between risk perception and errors for drivers whose crash attributions were high on any dimension (including moderate for other drivers and vehicle and environment). For drivers with higher crash attribution, higher risk perception was associated with experiencing more errors. Considering that the study results are based on correlational findings and a causal interpretation is not conclusive, the findings point to groups with high locus of control (higher attribution to internal or external factors) and the relationship between risk perception and errors. However, it is not possible to say whether the increase in risk perception for this group causes drivers to make more errors or whether their risk perception acts in a protective role because they have a tendency to make more errors. Nonetheless, the relationship here suggests that drivers may be relatively negatively affected by this interaction. Errors are, by their nature, unintentional behaviours (*8*), and in this context, it can be argued that drivers' higher risk perceptions and awareness of the causes of crashes may predispose them to make errors or may make them more aware of their errors. Factors such as age, experience, driving skills, and confidence may also play an additional role. Although the present study covers a wide age sample, it is, on average, a younger sample. As noted in the meta-analysis by de Winter and Dodou (*7*), errors may show different patterns for different age groups. Taking into account age, experience and physiological development, drivers from different age groups may exhibit different behaviours that are considered to be errors. For this reason, future studies comparing different age groups in terms of existing relationships may provide detailed information on the nature of the relationships.

As for ordinary violations, the overall relationship pattern showed that ordinary violations decrease as risk perception increases (*39*), but when we look at the interaction effects, a pattern emerges that provides more detailed information about the nature of the relationship. In all three dimensions of external traffic locus of control, there was a significant and negative relationship between risk perception and ordinary violations in low and moderate external locus of control. In other words, the highest number of ordinary violations was observed for drivers with average and low levels of external traffic control focus when their risk perception was also low. In this case, the fact that drivers attribute crashes less to external factors and have a low level of risk perception may create a kind of illusion of control. As stated by Măirean et al. (*49*), the illusion of control is directly positively related to risky driver behaviour, while the introduction of risk perception into the equation suppresses this negative effect. Similarly, it can be argued that drivers with a low external locus of control experience an illusion of control, and increased risk perception plays a protective role here.

While no significant relationship was found for urban speed, for inter-urban speed, two different factors play a role in the relationship between risk perception and inter-urban speed preference: average or above self and other drivers dimensions traffic locus of control. Two important discussion points for speed behaviour should perhaps be emphasized here. Firstly, neither risk perception nor locus of control played a role in speed preference on urban roads. One of the reasons for this may be the low average speed on urban roads. Although this logic seems to be linear, the relationship between speed and crash rate on urban roads (*50*) actually shows how biased drivers can be about this issue. Aarts and van Schagen (*50*) found that as speed increases on minor roads, the crash rate increases faster than the speed changes on major roads. However, neither risk perception nor traffic locus of control showed the expected direct or interactive relationships with drivers' speed preference on minor roads, suggesting that drivers' speed preference on minor roads needs to be better understood.

The second, perhaps related to the first point, is that the negative relationship between risk perception and speed preference was observed in drivers who attributed accidents to themselves or other drivers as average or above. In other words, the highest speed preference on inter-urban roads was seen for drivers with low-risk perception in this group. It can be argued that drivers who believe that crashes are caused by their own behaviour or the behaviour of other drivers oversee risky situations and, therefore, drive faster if their risk perception is low. On the contrary, the perception of higher risk in this group of drivers may lead them to prefer lower speeds to protect themselves from limitations in their own and other drivers' behaviour and attitudes. In this respect, it can be argued that drivers who attribute the causes of accidents to persons (either themselves or other drivers) would benefit greatly from training and information on risk perception.

The present study has some limitations due to the research methods and the nature of the sample. First, as mentioned above, the study is a correlational study based on retrospective behaviour. Therefore, talking about the causal relationship of the findings may be misleading in this respect. In addition, methodological issues such as relying on self-reported data which might lead to social desirability (e.g., *51*) or memory errors (e.g., *52*) and technical issues due to online data collection (e.g., *53*) need to be considered when interpreting the results of the present study. Anonymity and confidentiality were ensured to participants to mitigate these effects. Finally, the generalisability of the study is limited, given the size of the sample and the distribution of this sample in terms of age, gender and experience. For this reason, it is recommended to replicate the current research with larger samples and use different sampling techniques to address different driver groups. Furthermore, incorporating more experimental and objective measurements, such as driving simulator or on-road assessment of the findings of the current study, is also encouraged to test the validity and generalisability of the findings.

The findings provide valuable insights into the interplay between risk perception, locus of control and driver behaviours. Based on the findings, several practical recommendations and implications can be drawn. Firstly, the current study demonstrates that the positive effect of risk perception, as emphasised in the literature, can interact with different variables within the context, such as the traffic locus of control in the present study. Regarding traffic locus of control, although the factors did not show strong relationships, greater emphasis on the traffic locus of control in road safety studies may be needed to explain intentional behaviours such as speeding or unintentional behaviours such as errors. As discussed in various studies (*39, 54*), factors like risk perception or traffic locus of control can be modified through training and intervention programs. Therefore, training and education programs aimed at improving drivers' ability to perceive danger and incorporating discussions on traffic locus of control could be recommended based on the findings to raise awareness about how these psychological factors influence decision-making processes while driving. Finally, the technological interventions, including real-time monitoring systems, can leverage the findings to provide personalized feedback and guidance based on each drivers' risk perception and traffic locus of control profiles, thereby promoting safe driving. It can be suggested that these individual differences be taken into account when designing interventions aimed at improving road safety.

5. Conclusion

In conclusion, this study examined the role of traffic control focus in the relationship between risk perception and driver behaviour/driver speed preferences. The findings suggest that different dimensions of the traffic locus of control play a significant role in explaining the relationship between risk perception and driver behaviour, especially errors and ordinary violations. In this respect, the present study adds to the existing literature by examining the interaction effect between risk perception and traffic locus of control, which is an important point for practitioners and researchers to consider. Nevertheless, similar to the literature (*39*), traffic locus of control showed a small relationship with driver behaviour. Based on the findings, it can be argued that this variable should not be ignored and, if properly calibrated through education and training, can make a positive contribution to traffic safety. By taking a comprehensive approach and drawing upon the literature, the study contributes significantly to the field and fills an important gap in the literature.

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The authors do not have any conflict of interest to declare. For the purpose of open access, the author has applied a Creative Commons Attribution (CC BY) license to the author-accepted manuscript version arising from this submission.

Data access statement

The data that support the findings of this study are available on request from the corresponding author (N.B., nesrin.budak@metu.edu.tr).

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Author Contributions

Nesrin Budak: Project administration; Methodology, Conceptualisation, Data curation, Formal analysis, Writing – original draft, Writing – review & editing; **İbrahim Öztürk:** Methodology, Conceptualisation, Data Curation, Formal analysis, Writing – original draft, Writing – review & editing; **Türker Özkan:** Methodology, Conceptualisation, Writing – review & editing, Supervision

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Appendix **A**

The moderation models with significant interaction effects

Table A1. The moderation model of risk perception and self for errors

	Errors					
Variable	*b*	*se*	*t*	*p*	95% CI	
Risk perception	-.50	.31	-1.60	.112	-1.12	-.50
Self	-.59	.33	-1.75	.080	-1.25	-.59
Interaction	.18	.09	2.07	.039	.01	.18
Age	-.01	.01	-2.47	.014	-.02	-.01
Gender (0: Female, 1 Male)	.10	.07	1.39	.166	-.04	.10
Last year km	.00	.00	1.22	.222	.00	.00

Table A2. The moderation model of risk perception and other drivers for errors

	Errors					
Variable	*b*	*se*	*t*	*p*	95% CI	
Risk perception	-.71	.46	-1.53	.127	-1.63	0.20
Other drivers	-.99	.43	-2.29	.023	-1.85	-.14
Interaction	.23	.11	2.04	.043	.01	.46
Age	-.01	.01	-2.09	.038	-.02	.00
Gender (0: Female, 1 Male)	.08	.07	1.22	.224	-.05	.22
Last year km	.00	.00	.99	.323	.00	.00

Table A3. The moderation model of risk perception and vehicle and environment for errors

	Errors					
Variable	*b*	*se*	*t*	*p*	95% CI	
Risk perception	-.82	.39	-2.10	.037	-1.59	-.05
Vehicle and environment	-1.04	.42	-2.48	.014	-1.86	-.21
Interaction	.28	.11	2.57	.011	.07	.49
Age	-.01	.01	-2.34	.020	-.02	.00
Gender (0: Female, 1 Male)	.09	.07	1.29	.198	-.05	.23
Last year km	.00	.00	1.02	.309	.00	.00

Table A4. The moderation model of risk perception and fate for errors

	Errors					
Variable	*b*	*se*	*t*	*p*	95% CI	
Risk perception	-.21	.20	-1.04	.299	-.61	.19
Fate	-.34	.28	-1.23	.219	-.89	.20
Interaction	.14	.07	1.84	.067	-.01	.28
Age	-.01	.01	-2.12	.035	-.02	.00

Gender (0: Female, 1 Male)	.09	.07	1.27	.204	-.05	.22
Last year km	.00	.00	1.41	.158	.00	.00

Table A5. The moderation model of risk perception and self for lapses

	Lapses					
Variable	*b*	*se*	*t*	*p*	95% CI	
Risk perception	-.44	.32	-1.39	.165	-1.06	.18
Self	-.57	.34	-1.68	.093	-1.23	.10
Interaction	.16	.09	1.83	.068	-.01	.34
Age	-.01	.01	-2.72	.007	-.02	.00
Gender (0: Female, 1 Male)	-.15	.07	-2.14	.033	-.29	-.01
Last year km	.00	.00	.09	.929	.00	.00

Table A6. The moderation model of risk perception and self for aggressive violations

	Aggressive Violations					
Variable	*b*	*se*	*t*	*p*	95% CI	
Risk perception	-.83	.48	-1.73	.085	-1.78	.12
Self	-.99	.51	-1.92	.055	-2.00	.02
Interaction	.26	.14	1.93	.055	-.01	.53
Age	-.01	.01	-.99	.322	-.02	.01
Gender (0: Female, 1 Male)	.27	.11	2.52	.012	.06	.48
Last year km	.00	.00	2.52	.012	.00	.00

Table A7. The moderation model of risk perception and fate for aggressive violations

	Aggressive Violations					
Variable	*b*	*se*	*t*	*p*	95% CI	
Risk perception	-.61	.31	-1.96	.051	-1.21	.00
Fate	-.70	.43	-1.65	.100	-1.54	.13
Interaction	.24	.11	2.15	.032	.02	.46
Age	-.01	.01	-.83	.407	-.02	.01
Gender (0: Female, 1 Male)	.26	.10	2.50	.013	.06	.47
Last year km	.00	.00	2.75	.006	.00	.00

Table A8. The moderation model of risk perception and other drivers for ordinary violations

	Ordinary Violations					
Variable	*b*	*se*	*t*	*p*	95% CI	
Risk perception	-1.02	.46	-2.20	.029	-1.93	-.11
Other drivers	-.93	.43	-2.16	.032	-1.79	-.08
Interaction	.20	.11	1.75	.082	-.03	.43
Age	-.01	.01	-2.47	.014	-.02	.00

Gender (0: Female, 1 Male)	.28	.07	3.98	.000	.14	.41
Last year km	.00	.00	1.28	.202	.00	.00

Table A9. The moderation model of risk perception and vehicle and environment for ordinary violations

	Ordinary Violations					
Variable	*b*	*se*	*t*	*p*	95% CI	
Risk perception	-.97	.39	-2.47	.014	-1.75	-.20
Vehicle and Environment	-.80	.42	-1.89	.059	-1.62	.03
Interaction	.20	.11	1.82	.070	-.02	.42
Age	-.01	.01	-2.71	.007	-.02	.00
Gender (0: Female, 1 Male)	.27	.07	3.82	.000	.13	.41
Last year km	.00	.00	1.26	.207	.00	.00

Table A10. The moderation model of risk perception and fate for ordinary violations

	Ordinary Violations					
Variable	*b*	*se*	*t*	*p*	95% CI	
Risk perception	-.72	.21	-3.48	.001	-1.13	-.31
Fate	-.53	.28	-1.86	.064	-1.09	.03
Interaction	.16	.08	2.14	.033	.01	.31
Age	-.01	.01	-2.62	.009	-.02	.00
Gender (0: Female, 1 Male)	.28	.07	4.05	.000	.15	.42
Last year km	.00	.00	1.62	.106	.00	.00

Table A11. The moderation model of risk perception and fate for positive behaviours

	Positive Behaviours					
Variable	*b*	*se*	*t*	*p*	95% CI	
Risk perception	.34	.21	1.59	.112	-.08	.75
Fate	.36	.29	1.24	.218	-.21	.93
Interaction	-.13	.08	-1.72	.087	-.28	.02
Age	.01	.01	2.30	.022	.00	.02
Gender (0: Female, 1 Male)	-.02	.07	-.22	.827	-.16	.12
Last year km	.00	.00	1.46	.144	.00	.00

Table A12. The moderation model of risk perception and self for interurban speed preference

	Interurban Speed Preference					
Variable	*b*	*se*	*t*	*p*	95% CI	
Risk perception	12.59	9.13	1.38	.169	-5.37	30.55
Self	22.29	9.72	2.29	.023	3.17	41.42
Interaction	-5.51	2.57	-2.15	.033	-10.55	-.46

Age	-.13	.15	-.83	.406	-.43	.17
Gender (0: Female, 1 Male)	4.23	2.02	2.10	.037	.26	8.20
Last year km	.00	.00	4.21	.000	.00	.00

Table A13. The moderation model of risk perception and other drivers for interurban speed preference

	Interurban Speed Preference					
Variable	*b*	*se*	*t*	*p*	95% CI	
Risk perception	26.06	13.46	1.94	.054	-.41	52.53
Other drivers	32.52	12.55	2.59	.010	7.83	57.21
Interaction	-8.13	3.32	-2.45	.015	-14.66	-1.60
Age	-.13	.15	-.84	.401	-.43	.17
Gender (0: Female, 1 Male)	4.41	2.02	2.19	.029	.45	8.38
Last year km	.00	.00	4.38	.000	.00	.00