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Asymmetric relationship between driving and safety skills

Nebi Sümer [a,*], Türker Özkan [b], Timo Lajunen [a]

[a] *Department of Psychology, Middle East Technical University, 06531 Ankara, Turkey*

[b] *Human Factors and Safety Behavior Group, Department of Psychology, University of Helsinki, Helsinki, Finland*

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Abstract

We hypothesized that the combination of self reported high ratings of driving skills and low ratings of safety skills creates a serious risk for road accident involvement. This study was aimed at investigating the asymmetric interplay between driving and safety skills among Turkish drivers ($N = 785$) using the Driving Skills Inventory [Lajunen, T., Summala, H., 1995. Driver experience, personality, and skill and safety motive dimensions in drivers' self-assessments. Pers. Indiv. Differ. 19, 307–318]. The assumed asymmetric interactions were tested on a number of outcome variables representing risky driving using moderated regression analyses. The results revealed that driving skills moderated the effects of safety skills on six out of the eight outcome variables including the number of accidents, tickets, overtaking tendencies, speed on motorways, and aggressive driving style. Results suggested that high levels of safety skills buffer the negative effect of overconfidence resulting from exaggerated ratings of self-reported driving skills.

Keywords: Driving skills; Safety skills; Accidents; Risky driving; Aggressive driving

1. Introduction

Road traffic accidents have become a serious threat to the public health in Turkey by killing almost 9000 persons and resulting in a devastating human and economic cost (SWEROAD Report, 1999). Considering the overarching role of human factors in road accidents, previous studies have shown that a number of individual differences variables including driving behaviors, driving performance, and safety skills consistently predict outcome variables associated with accident risk (e.g., Elander et al., 1993; Sümer, 2003).

Näätänen and Summala (1976), Evans (1991), and Elander et al., (1993) made a distinction between driving style (i.e., behavior) and skills (i.e., driving performance) indicating that driving skills can be improved by practice and training. However, driver behaviors have a wider spectrum and basically are influenced by attitudes and beliefs related to driving as well as other distal factors such as personality characteristics, needs, and values (Lajunen, 1997; Sümer, 2003). Although driving behaviors and skills are separated in terms of their contents and their relations to accident risk, they are also interrelated in expressing a general way of driving. Drivers seem to incorporate their driving skills into their general driving style after they learn and master how to drive (Parker and Stradling, 2001).

Previous studies have suggested that if safety skills and concerns can be incorporated into driving skills and automatically activated whenever one drives a vehicle, then safety behaviors can be turned into habituated long term behaviors. On the other hand, overestimation of driving skills seems to predispose drivers to an unrealistic and overly optimistic evaluation of hazardous situations in traffic environment (e.g., McKenna, 1993). Biased perception of driving skills seems to cover most of the areas of driving skills and results in an illusory self-assessment of driving skills (McKenna et al., 1991).

Recent studies showed that besides their driving skills, drivers also overestimate their safety skills and tend to demonstrate a very pervasive "self-enhancement bias," especially when they compare themselves with other drivers (Walton, 1999; Walton and Bathurst, 1998). The majority of drivers in Sweden, the United States, and Poland have been found to evaluate their safety skills as superior to other drivers (e.g., Delhomme, 1991). Bias perception or overconfidence in turn results in a biased risk assessment leading to high levels of risk acceptance (Deery, 1999; Groeger and Brown, 1989).

Previous researchers conceptualized driving skills as perceptual motor-skills and found that drivers, especially male drivers,

* Corresponding author. Tel.: +90 312 210 5111; fax: +90 312 210 1288.
E-mail address: nsumer@metu.edu.tr (N. Sümer).

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consistently overestimate their driving skills when using self-report measures (Brown and Groeger, 1988; Lajunen et al., 1998; McKenna et al., 1991). Considering the distinction between driving behaviors and skills, Lajunen and Summala (1995) asserted that safety skills, defined as the anticipatory accident avoidance skill, should be included in the assessment of perceptual-motor skills. These authors suggested that the distinction between driving and safety skills is imperative because the driver's internal balance between these skills reflects the driver's attitude to safety. Thus, Lajunen and Summala (1995) developed the Driver Skill Inventory (DSI) to assess both general perceptual-motor performance and safety concerns.

Studies using the DSI revealed that both driving and safety skills predict the outcome variables directly related to accident risks. However, as compared to driving skills, safety skills seemed to be more strongly associated with the correlates of accident risks (Lajunen and Summala, 1995; Lajunen et al., 1998). Lajunen et al. (1998) demonstrated that although some minor cross-cultural differences were observed on the association between these skills and accident risk, the pattern of relationships is similar in different cultural contexts. However, the association between these two types of skills and accident risk has not been examined in developing countries, such as Turkey, which have worse safety records than more developed Western countries.

Overall, it has been suggested that the overestimation of driving skills may predispose drivers to risky driving behaviors, while safety skills buffer their risk by making them more cautious and able to anticipate possible hazards on the road. Supporting this suggestion, previous studies revealed that there is an asymmetric relationship between driving and safety skills in predicting certain outcome variables. For example, while driving skills were positively associated with the number of accidents, penalties and level of speed, safety skills were negative associated with these variables (Lajunen et al., 1998; Sümer, 2001). To more specifically test the asymmetric link between driving and safety skills, Sümer (2001) categorized Turkish drivers into four groups on the basis of their scores on the two dimensions of the DSI. Supporting the buffering effect of safety skills, results revealed that those who reported a low level of safety skills but a high level of driving skills reported the highest levels of accidents, penalties, overtaking tendencies, and speed as compared to the other groups including those reporting lower levels of both driving and safety skills. However, this study used categorical variables only and did not directly examine the asymmetric effects by using standard moderated regressions. Moreover, Sümer did not examine whether asymmetric relationships between driving and safety skills have an effect on aggressive driving. We assume that overestimation of driving skills may also be associated with aggressive driving if they are not buffered by safety skills.

Given that high levels of driving skills constitute a serious risk factor if they are not accompanied with high levels of safety precaution, we asserted that these two types of skills have an asymmetric relationship on accident risk and other aberrant driver behaviors. Therefore, we assumed that although driving skills do not have a strong predictive power on outcome variables including accidents and other risky behaviors, these skills moderate the relationship between safety skills and accident risk via the interaction with safety skills.

In sum, the purpose of this study is threefold. First, we aim to examine the asymmetric relationship between two types of skills and outcome variables. Second, we will specially test the assumed moderated relationship by testing the interaction between driving and safety skills on the self-reported accidents and other risky driving behaviors. Finally, we aim to test the factor structure and predictive power of this measure on Turkish drivers.

2. Method

2.1. Participants

The data reported in this study were initially consisted of 864 drivers from different parts of Turkey (the three biggest cities of Turkey: Ankara, Istanbul and Izmir) and across different age groups (range 19–72 years). Drivers were approached by a group of university students who were trained in data collection and interview techniques and only those who agreed to fill out the questionnaire and had a driving license were included in the study. The participants were assured about anonymity and confidentiality of their identity. Considering the recommendations of Elander et al., (1993), questions on accident involvement were limited to the last 3 years and thus 72 drivers with less than 3 years of driving experience were excluded from the sample. Seven drivers were also excluded because they were either multivariate outliers on the major variables ($p < 0.001$) or left some of the scales in the questionnaire uncompleted, leaving 785 drivers (580 males and 205 females) for the major analyses.

Participants had a mean age of 37.87 years (S.D. = 11.33) and had held a driver's license for a mean period of 14.36 years (S.D. = 9.06). The majority of the drivers were university graduates (52%) or high school graduates (28%), while the remaining drivers (20%) were primary and secondary (middle) school graduates. The mean kilometer driven per year was 19,797 km (S.D. = 22.130). In this study, an accident was defined as any type of crash in the last 3 years caused by the person or the other drivers in the traffic. Those who had any accidents were directed to another section in the questionnaire and asked to give a detailed description of the accident(s). Participants also responded to a series of questions regarding their driving experience and filled out the scales described below.

2.2. Instruments

2.2.1. Demographic variables

Participants were asked to indicate their age, sex, frequency of driving, number and types of accidents (active and passive) and offences during last 3 years, the number of years a full driving license was held, and annual kilometers. Participants were also asked to complete single item measures of overtaking tendency, average speed both within cities and on intercity roads. To measure overtaking tendency, drivers were asked to choose one of the three options best describing their overtaking behavior, "(1)

Table 1
Descriptive statistics and correlations among the major variables of the study

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Education[a]	–													
2	Age	−0.19***	–												
3	Annual kilometers	−0.13***	−0.01	–											
4	Gender[a]	0.14***	−0.06	−0.21***	–										
5	Driving skills	−0.18***	0.09*	0.25***	−0.24***	(0.89)									
6	Safety skills	−0.09*	0.26***	−0.01	0.14***	0.35***	(0.80)								
7	Number of accidents	0.04	−0.16***	0.11**	−0.03	−0.07	−0.16***	–							
8	Number of total offences	0.06	−0.12***	0.20***	−0.14***	0.07	−0.27***	0.30***	–						
9	Overtaking tendencies	0.10**	−0.18***	0.15***	−0.18***	0.19***	−0.29***	0.10**	0.27***	–					
10	Speed intercity roads	0.13***	−0.16***	0.13***	−0.01	0.12***	−0.28***	0.14***	0.26***	0.34***	–				
11	Speed within city roads	0.07	−0.21***	0.07	−0.03	0.05	−0.25***	0.12***	0.16***	0.22***	0.48***	–			
12	Loosing patience with other drivers	0.10**	−0.14***	−0.01	−0.04	−0.08	−0.33***	0.16***	0.20***	0.12***	0.18***	0.13***	–		
13	Hostile aggression and revenge	−0.01	−0.13***	0.07	−0.11**	−0.12***	−0.42***	0.14***	0.19***	0.14***	0.13***	0.21***	0.24***	(0.88)	
14	Aggressive warnings	0.07*	−0.18**	0.03	−0.11**	0.04	−0.38***	0.16***	0.18***	0.22***	0.19***	0.15***	0.42***	0.53***	(0.78)
	Means	3.54	37.87	19.797		3.05	3.02	0.87	1.56	1.58	105.18	61.76	1.77	0.36	1.31
	Standard deviations	0.90	11.33	22.130		0.59	0.60	1.25	2.60	0.77	20.22	17.27	0.55	0.54	0.86
	Range	1–5	19–72	100 –150.000		0–4	0–4	0–5	0–25	1–3	45–225	25–160	1–3	0–4	0–4

Values in parenthesis indicate reliability coefficients.
[a] Level of education was measured as 1, elementary school; 2, secondary school; 3, high school; 4, university; 5, master and doctoral education. Gender: 1, male; 2, female.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

I tend to overtake less often than other drivers, (2) the frequency of my overtaking and others overtaking me is almost equal, (3) I tend to overtake more often than other drivers." Participants were also asked their average speed within cities and on intercity roads when the weather and road conditions were "normal" (see Table 1).

2.2.2. *Driver Skill Inventory (DSI)*

The DSI is a 20 item self-reported measure of perceptual motor and safety skills developed by Lajunen and Summala (1995). DSI was previously translated into English and had been shown to have good reliability and predictive validity in different Western cultures (Lajunen et al., 1998). The DSI was translated into Turkish by authors in previous studies and shown to have high reliability and validity coefficients (e.g., Sümer and Özkan, 2002). This instrument asked drivers to rate how weak or strong they were on the given skills by using five-point scales (0 = very weak and 4 = very strong).

Principle component analysis with varimax rotation on the 20 items of the DSI was run to reassess its factor structure. Consistent with the previous work, analysis yielded two clearly interpretable components, representing the two subscales of the DSI and explaining 46% of the total variance. Using 0.35 cutoff points for item loadings, the first component included 12 items tapping driving (perceptual-motor) skills loaded on the first component, explaining 31% of the variance. These items are (1) "Fluent driving", (2) "Perceiving hazards in traffic", (3) "Managing the car through a skid", (4) "Predicting traffic situation ahead", (5) "Knowing how to act in particular traffic situations", (6) "Making firm decisions", (7) "Controlling the vehicle", (8) "Adjusting your speed to the conditions", (9) "Make a hill start on a steep incline", (10) "Overtaking", (11) "Tolerating other drivers errors calmly", and (12) "Reverse parking into a narrow gap". The second component consisted of seven items tapping safety skills and explained 15% of the total variance. These items are (1) "Driving behind a slow car without getting impatient", (2) "Staying calm in irritating situations", (3) "Keeping a sufficient following distance", (4) "Relinquishing legitimate rights when necessary", (5) "Conforming to the speed limits", (6) "Avoiding unnecessary risks", and (7) Obeying the traffic lights carefully". One of the items stating "Fluent lane-changing in heavy traffic" was loaded on both components with a reverse sign and appeared to be misunderstood by some drivers as safe driving. Therefore, this item was excluded from the scale. Although the subscales

of the DSI had relatively few items, internal consistency coefficients were satisfactory for both driving ($\alpha = 0.89$) and safety skills ($\alpha = 0.80$).

2.2.3. Driver Aggression Indicators Scale (DAIS)

The DAIS is a newly developed scale by Lajunen and Parker and used in Rämet (2003) study. Since this measure was employed first time on a Turkish sample, initially the scales were translated into Turkish and then reverse translated to English by two individuals who are fluent in both languages. The DAIS consists of 13 items and assesses drivers' aggressive behaviors on roads. Initially the DAIS asks drivers to evaluate both self and other drivers' possible aggressive behaviors on the road. In this study, drivers' ratings of their own behaviors only were used. Participants were asked to indicate how often they commit each of the given behaviors/episodes on the list (e.g., "verbally threatening other drivers", "showing the anger by honking") using a five-point scales from "Never" to "Nearly all the time".

A principle component analysis with Promax rotation on the 13 items of the DAIS yielded two interpretable and correlated components explaining 57% of the total variance (first component: 44% and second component: 13%). Using 0.35 cutoff points for item loadings, first component included nine items characterizing drivers' hostile and direct aggressive actions to other drivers. Thus, this component was labeled as "hostile aggression and revenge" (e.g., "intentionally hitting the other car"). The second component consisted of four items reflecting mostly aggressive warning on the road, and thus, labeled "aggressive warnings" (e.g., "showing the reaction by honking"). Although these components had relatively few items, reliability coefficients were acceptable ($\alpha = 0.88$ and 0.78, respectively).

In addition to the DAIS items, a single item was used to measure driver's tolerance to other drivers and the frequency of loosing their patience with others' behaviors by asking them to endorse one of the three statements (1) "other drivers or pedestrians never make me inpatient and loose my nerves with their behaviors", (2) "other drivers or pedestrians sometimes make me inpatient and loose my nerves with their behaviors"; (3) "other drivers or pedestrians often make me inpatient and loose my nerves with their behaviors". The rating on this item was used a continuous measure of frequency of loosing patience with other drives as an indicator of more emotional driving response.

3. Results

3.1. Descriptive statistics and correlations

Descriptive statistics for major variables and correlations among these variables are presented in Table 1. Of the 785 drivers 54% did not report any accident, 23% reported only one accident, and 23% reported two or more accidents in last 3 years. Drivers had an average of 1.56 penalties, mainly for speeding tickets. Overall, participants reported relatively lower levels of hostile aggression and aggressive warnings while they reported higher levels of both driving and safety skills. As illustrated in Table 1, driving skills were positively and moderately correlated with safety skills ($r = 0.35, p < 0.001$). As expected, driving skills were positively correlated with age, exposure to driving, overtaking tendency, and weakly but significantly correlated with hostile aggression. As expected, while safety skills were positively correlated with age, they were, however, negatively and relatively strongly correlated with number of accidents, penalties, overtaking tendencies, speed variables, and all of the dispositional variables (losing patience with other drivers, hostile aggression and revenge, and aggressive warning).

3.2. Testing the asymmetric moderated relationships

We ran a series of hierarchical regression analyses on all of the outcome variables in order to directly examine the hypothesized asymmetric effect between driving and safety skills. Specifically, we tested if driving skills moderate the effects of safety skills on outcome variables above and beyond the main effects of both types of skills and demographic characteristics. Thus, separate hierarchical regression analyses were performed on each of the outcome variables (number of accidents, penalties, overtaking tendency, speed in intercity and within city road, losing patience with other drivers, hostile aggression, and aggressive warning). In each of these regressions, the four demographic and exposure variables (i.e., level of education, age, gender, and annual kilometers driven) were entered in the first step to control for their effect, and driver skills, safety skills and their interaction were entered in the second step. Following the procedure outlined by Aiken and West (1991), moderator (driving skills) and independent variables (safety skills) were first centered and then the interaction term was created before the analyses. Significant interactions were plotted by generating simple regression equations of a given outcome (dependent) variable at low (i.e., 1 standard deviation below the mean) versus high (i.e., 1 standard deviation above the mean) levels of driving and safety skills (cf. Aiken and West, 1991).

As presented in Table 2, demographic variables in the first steps consistently predicted outcome variables. Level of education weakly but significantly predicted the number of penalties taken in last 3 years, overtaking tendencies, speed in intercity roads, and loosing patience with other drivers. Higher levels of education were associated with more risky driving for this sample and it seems that the highly educated participants were mostly young drivers. Consistent with the previous work in this area, the age of the drivers was negatively associated with all of the criterion variables, suggesting that younger drivers reported more risky driving than older ones. As would be expected, annual kilometers significantly predicted the number of accidents, penalties, and overtaking tendencies. Finally, gender of the drivers predicted overtaking tendencies, indicating that female drivers overtake less often than males, and outcome variables representing aggressive drivers. On these variables, female drivers reported lower levels of both hostile aggression and aggressive warnings than male drivers.

After controlling the effects of the four demographic variables, the results of the regression analyses in the second steps generally supported the assumed asymmetric interplay between the two types of skills and criterion variables. As presented in

Table 2
Moderated hierarchical regression analyses on the outcome variables

	Beta	R	R^2 change	F
Number of accidents				
1. Step		0.19	0.04	7.59***
Education	0.03			
Age	−0.15***			
Annual mileage	0.10**			
Gender (1, male; 2, female)	−0.03			
2. Step		0.25	0.03	7.28***
Driving skills	−0.07			
Safety skills	−0.10*			
Interaction	−0.10**			
Number of penalties				
1. Step		0.27	0.07	15.10***
Education	0.09*			
Age	−0.11**			
Annual mileage	0.19***			
Gender (1, male; 2, female)	−0.12***			
2. Step		0.38	0.08	19.12***
Driving skills	0.13***			
Safety skills	−0.30***			
Interaction	−0.10**			
Overtaking				
1. Step		0.30	0.09	19.20***
Education	0.10**			
Age	−0.17***			
Annual mileage	0.12***			
Gender (1, male; 2, female)	−0.18***			
2. Step		0.47	0.13	31.67***
Driving skills	0.30***			
Safety skills	−0.35***			
Interaction	−0.11**			
Speed intercity roads				
1. Step		0.24	0.06	11.38***
Education	0.13***			
Age	−0.13***			
Annual mileage	0.14***			
Gender (1, male; 2, female)	−0.01			
2. Step		0.42	0.12	24.07***
Driving skills	0.26***			
Safety skills	−0.37***			
Interaction	−0.07*			
Speed within city roads				
1. Step		0.23	0.05	10.62***
Education	0.04			
Age	−0.21***			
Annual mileage	0.07			
Gender (1, male; 2, female)	−0.03			
2. Step		0.34	0.06	14.07***
Driving skills	0.16***			
Safety skills	−0.27***			
Interaction	−0.04			
Loosing patience with other drivers				
1. Step		0.16	0.03	5.37***
Education	0.08*			
Age	−0.13***			
Annual mileage	−0.01			
Gender (1, male; 2, female)	−0.06			
2. Step		0.34	0.09	14.83***
Driving skills	0.04			
Safety skills	−0.32***			
Interaction	−0.09**			
Hostile aggression and revenge				
1. Step		0.17	0.03	5.85**
Education	−0.02			
Age	−0.13***			
Annual mileage	0.04			
Gender (1, male; 2, female)	−0.10**			
2. Step		0.42	0.15	24.25***
Driving skills	0.02			
Safety skills	−0.40***			
Interaction	0.11**			
Aggressive warning				
1. Step		0.22	0.05	9.50***
Education	0.06			
Age	−0.17***			
Annual mileage	0.01			
Gender (1, male; 2, female)	−0.12***			
2. Step		0.42	0.13	24.16***
Driving skills	0.19***			
Safety skills	−0.41***			
Interaction	−0.05			

* $p<0.05$.
** $p<0.01$.
*** $p<0.001$.

Table 2, safety skills significantly predicted the number of accidents in last 3 years ($\beta=-0.10$, $p<0.01$). Although, driving skills did not have a significant main effect on accidents, as predicted, its interaction with safety skills had a significant effect on accidents ($\beta=-0.10$, $p<0.01$).

Plotting of this interaction (see Fig. 1) reveals that the relationship between safety skills and number of accident varied for

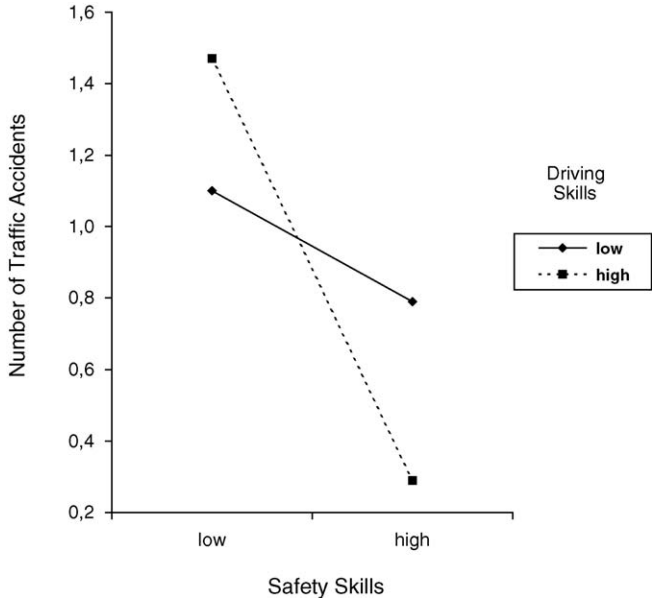

Fig. 1. The interaction between safety skills and driving skills on total traffic accidents.

drivers with high and low levels of driving skills. Specifically, among drivers with low levels of driving skills, safety skills were not related to the number of accidents; the simple slope for low driving skills group was not significant ($t(775) = 1.24$). Overall, these drivers had lower levels of accidents. In contrast, among drivers with high levels of driving skills, as their safety skills decreases their number of accidents increased. The simple slope was significant for those with high levels of driving skills ($t(775) = 4.86$, $p < 0.001$). Briefly, as seen in Fig. 1, those with high levels of driving skills but low levels of safety skills reported the highest levels of accidents and those with high levels of both safety and driving skills reported the lowest levels of accidents. These findings underscore the moderating role of driving skills and indicated that high levels of driving skills may be hazardous if they were not buffered by safety skills.

Regression on the number of penalties yielded a pattern similar to one explained above for accidents. Driving skills had weak but positive effect on penalties ($\beta = 0.13$, $p < 0.001$), while safety skills had a moderately strong negative effect ($\beta = -0.30$, $p < 0.001$). The interaction between the two types of skills on penalties was also significant ($\beta = -0.10$, $p < 0.001$). As illustrated in Fig. 2, plotting of the interaction demonstrated that drivers with self-reported high driving skill and high safety, do not differ significantly from drivers with self-reported low skill and high safety. However, drivers with self-reported high skill and low safety, have significantly more penalties than drivers with self-reported low skill and low safety. Furthermore, the simple slope was significant for both driving skills groups suggesting that, in addition to this documented difference, as safety skills decreases the number of penalties increases for both groups ($t(775) = 9.14$, $p < 0.001$ and $t(775) = 5.14$, $p < 0.001$, for high and low driving skills groups, respectively).

The regression on overtaking tendencies replicated the typical asymmetric relationship. After controlling the demographic variables, driving skills positively and safety skills negatively predicted overtaking tendency ($\beta = 0.30$, $p < 0.001$ and $\beta = -0.35$, $p < 0.001$, respectively). Moreover, as seen in Fig. 3, the plotting of the significant interaction on overtaking tendencies revealed a very similar pattern the one described above for penalties. The drivers with high driving skills reported the highest level of overtaking at the low levels of safety skills. The simple slopes were significant for both groups signifying the role high safety skills in balancing the negative effects of high levels of driving skills ($t(775) = 11.35$, $p < 0.001$ and $t(775) = 6.72$, $p < 0.001$, for high and low driving skills groups, respectively).

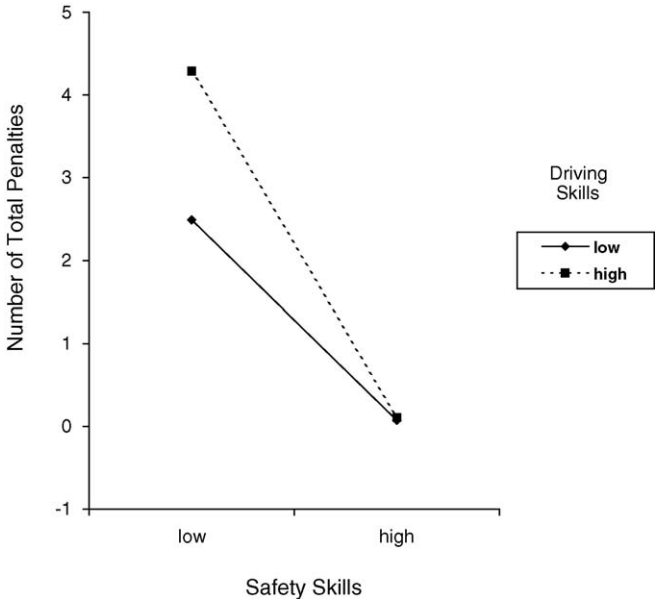

Fig. 2. The interaction between safety skills and driving skills on total penalties.

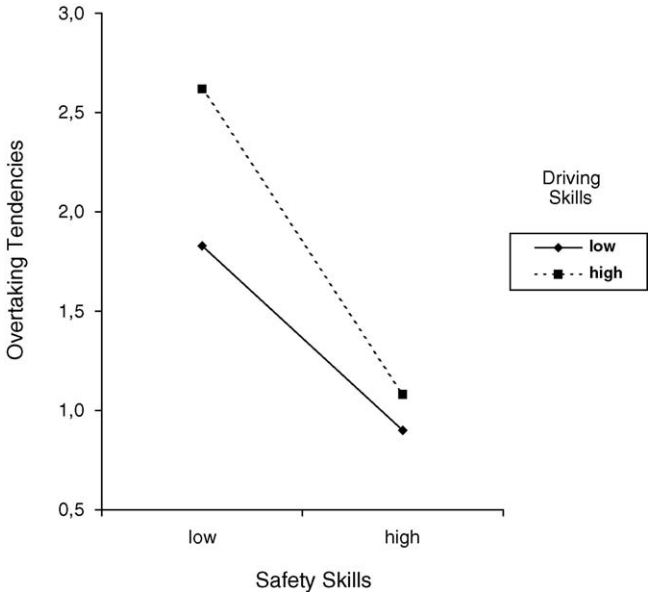

Fig. 3. The interaction between safety skills and driving skills on overtaking tendencies.

Regression of the average speed on intercity roads demonstrated the same pattern explained above for overtaking tendencies. Drivers reported higher levels of speed as their driving skills increased ($\beta = 0.26$, $p < 0.001$) and safety skills decreased ($\beta = -0.37$, $p < 0.001$). The plotting of the significant interaction effect showed that at the low levels of safety skills, drivers with high driving skills reported more speed than those with low driving skills (see Fig. 4). However, while the regression on the average speed within city roads yielded main effects for both driving skills ($\beta = 0.16$, $p < 0.001$) and safety skills ($\beta = -0.27$, $p < 0.001$) the interaction effect was not statistically significant.

As shown in Figs. 5 and 6, regression on the outcome variables defining aggressive driving also revealed patterns consistent with the obtained asymmetric relationship between safety and driving skills on other outcome variables. The regression on the single item variable measuring loosing patience with other drivers showed that safety skills had a moderately strong effect on the drivers' feeling about other road users' intentions ($\beta = -0.40$, $p < 0.001$), indicating that drivers with less safety concerns also experienced more negative affect and frequently felt annoyed by other road users. Although driving skills did not have a significant main effect, the interaction term on loosing patience with other drivers was significant ($\beta = 0.11$, $p < 0.001$). Plotting of the interaction demonstrated that both high and low

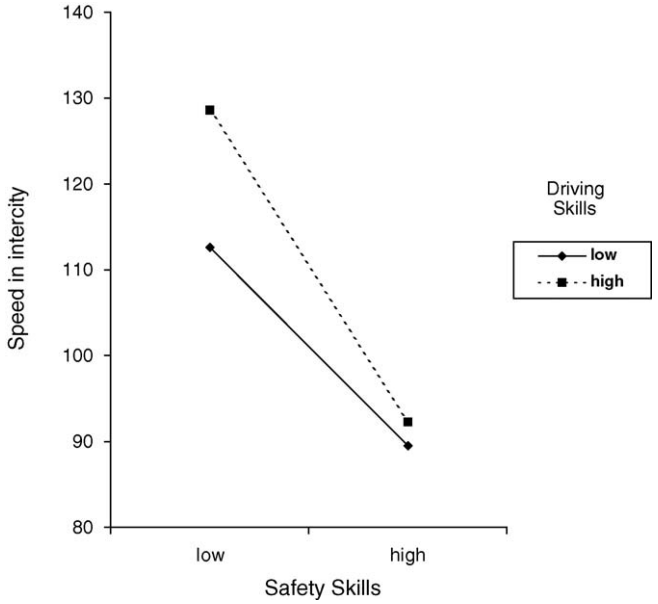

Fig. 4. The interaction between safety skills and driving skills on speed in intercity.

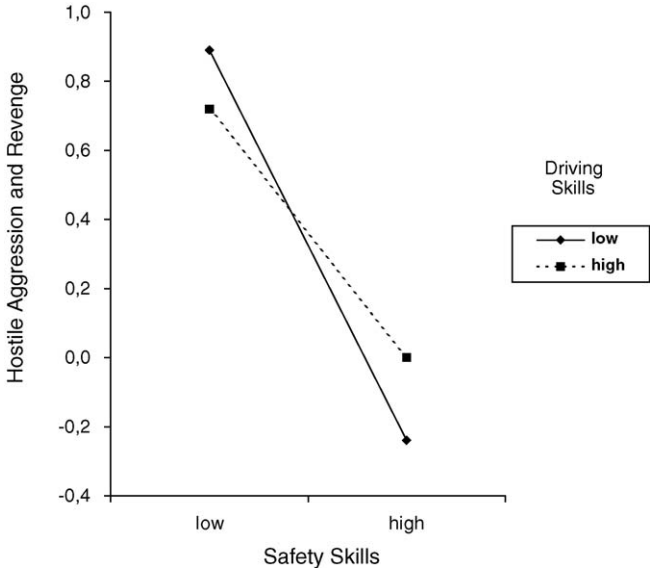

Fig. 6. The interaction between safety skills and driving skills on hostile aggression and revenge.

driving skills groups reported lower levels of loosing patience with other drivers at the high levels of safety skills than the low levels of safety skills. However, those with high driving skills reported the highest levels of loosing patience with other drivers when they had low levels of safety skills, and in contrast, they reported the lowest level of negative feeling when they had higher levels of safety skills. Documenting the important role of safety skills in predicting the feeling of loosing patience with other drivers, the simple slopes for both driving skills groups were significant.

Regression on the hostile aggression and revenge factor of the DAIS showed that safety skills had a moderately strong effect on the drivers' feeling of hostile aggression and revenge ($\beta = -0.40$, $p < 0.001$), indicating that drivers with less safety concerns also experience negative feelings while driving. Although driving skills did not have a significant effect, the interaction term on hostile aggression was significant ($\beta = 0.11$, $p < 0.001$). Although both driving skills groups reported higher hostile aggression to other road users when they have low levels of safety skills than they have high levels of safety skills, drivers with lower levels of driving skills (rather than higher levels) reported the highest hostile aggression at the low levels of safety skills, and the this pattern reversed at the high levels of safety skills.

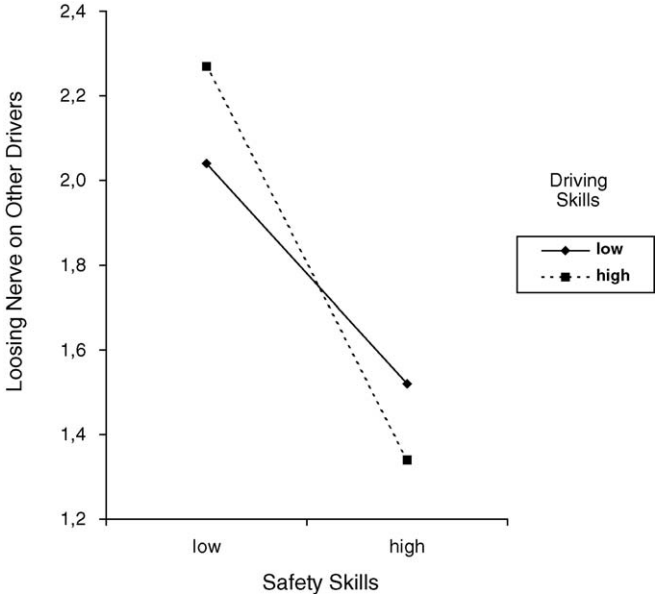

Fig. 5. The interaction between safety skills and driving skills on loosing patience with other drivers.

Finally, regression on the aggressive warning factor indicated that as expected, driving skills positively ($\beta = 0.19$, $p < 0.001$) and safety skills negatively predicted ($\beta = -0.41$, $p < 0.001$) the frequency of aggressive warnings drivers make. However, the interaction between these skills was not significant.

After controlling demographic variables, driving and safety skills, and their interaction accounted for significant portions for variances on criterion variables. The contribution of these variables in the second step varied between 3% (for accidents) to 15% (for hostile aggression and revenge), suggesting a weak to moderate effects in explaining the accident risk.

4. Discussion

The results of this study revealed that self-assessment of driving and safety skills should be taken into account in relation to each other in examining their effects on accidents and risky driving. Our findings suggest that if the extreme reliance on one's driving skills is accompanied with low levels of safety skills, this may create an overconfidence effect leading to the underestimation of possible hazards or risks on the road (e.g., Gregersen, 1996). First of all, confirming our expectation on asymmetric effect, while driving skill was positively correlated

with the majority of outcome variables, safety skill was negatively correlated with these variables.

Considering that safety skills are strongly correlated with the outcome variables, it can also be argued that this is similar to the well-known association between driving violations and accidents. Given that safety skills are strongly and negatively correlated with aberrant driving behaviors (e.g., Sümer and Özkan, 2002) low levels of safety skills imply a tendency for the violations, and thus, for risky driving.

The interaction between driving and safety skills yielded a significant effect on six of the eight outcome variables suggesting a strong moderating effect of driving skills. As expected, plotting of these interactions revealed that the relationship between safety skills and outcome variables varied for drivers with high and low levels of driving skills. Specifically, those with high levels of driving skills but low levels of safety skills seemed to have the highest risk on the majority of outcome variables with the exception of hostile aggression and revenge. In other words, high levels (or overestimated) driving skills may be hazardous if they were not buffered and balanced by safety skills.

These findings were consistent with past research which has demonstrated that exaggerated self-assessment of driving ability was associated with risky driving and/or risk taking on the road which results in an overconfidence, optimism bias or self-bias (see Deery, 1999, for a review). However, the majority of past studies investigating the effect of self-reported driving skills on risky driving have assessed the differences between the perception of self and other drivers and found that drivers either exaggerate their own driving ability (e.g., Delhomme, 1991; Groeger and Brown, 1989) or evaluate average drivers' ability more negatively than their own ability, indicating a self-enhancement bias (McKenna et al., 1991; Walton and Bathurst, 1998; Walton, 1999). The findings of this study suggest that in addition to the well-documented self and other perception bias, the discrepancy between driving and safety skills within the self-driving perception can be a robust predictor of driving and/or accident risk. Therefore, our findings suggested that self-perception bias should be examined not only in relation to other or average drives but also in relation to the intra-individual evaluative discrepancies.

In a recent study, Ulleberg (2002) classified young drivers into six personality subtypes in terms of their responses to a traffic safety campaign by using cluster analysis. Consistent with our findings, he found that the cluster 2 represented the high-risk group in traffic with post hoc test characterized by higher ratings of their own driving skills as well as lower scores on the safety attitudes and risk perception measures. Ulleberg concluded that in contrast to a high degree of accident involvement of the male dominated members of this cluster, they also had high confidence in their own skills as drivers.

Interestingly, in contrast to the pattern of interactions observed on the majority of outcome variables, those with both low levels of driving and safety skills reported the highest hostile aggression and revenge feelings. It is plausible to suggest that the feeling of frustration and disappointment stemming from drivers' low levels of driving skills result in a direct aggression toward other drivers if it is not buffered by high levels of safety skills. It appears that high safety skills may make drivers more aware of their limitations regarding their driving skills and may make them more focused on their own behaviors rather than other road users which may cause the feeling of revenge and aggression. Future studies should explore more on this issue to clarify if the discrepancy between self and others' perception of driving skills (i.e., self-enhancement bias) plays a role in directing frustration to other road users.

The results of the present study also indicated that the DSI had a clear two-factor structure, high item loadings, and acceptable internal consistency. Factor analysis showed that only the item ("fluent lane-changing in heavy traffic") loaded on both factors because of the misinterpretation of the "heavy" traffic as allowing people to change the lane more often. Driving skills were positively correlated with age and exposure to driving while safety skills were positively and strongly associated with age and sex (being female). It was shown that especially young men overestimate their driving skills and emphasize vehicle handling skills and driving reflexes rather than safety (Lajunen and Summala, 1995).

Overestimation of one's own driving skills may also be associated with the curriculum used in the driver training and culture specific expectations regarding driving proficiency. It is argued that additional training on a specific driving skill may increase confidence especially among novice drivers, and in turn, this may lead to an increase in the accidents (Gregersen, 1996).

If driver-training courses specifically emphasize on the overall driving skills rather that safety skills it may create a sense of self-confidence bias. In Turkey, the most widely applied driver-training curriculum and practices focus on the skill training rather than safety concerns. Therefore, the prototype of "good driver" is commonly characterized with the maneuvering skills in controlling the vehicle. Furthermore, it is a widespread belief in the public that inadequate vehicle handling skills are the major cause of traffic accidents in Turkey. We claim that these faulty beliefs and lack of positive attitudes toward traffic safety create an atmosphere in which drivers perceive their driving abilities as the chief factor in becoming a good driver while they devalue the role of safety skills.

These findings have critical implication for transportation safety, driver training, and safety campaigns. Exaggerated evaluation of driving skills which is not balanced by high levels of safety skills can be seen a simple demonstration of the well know "driver overconfidence effect" and may result in a serious risk factor for involving road accidents especially for young male novice drivers. First, such an asymmetric perception may result in an underestimation of the potential hazards and risks on the road (Deery, 1999). Second, it may reinforce the feeling of "illusion of control" (McKenna, 1993) that increases the vulnerability of drivers in risky situations. Third, this may lead to a disbelief or lack of motivation to take part in safety campaigns (McKenna et al., 1991; Ulleberg, 2002).

Our findings emphasize the fact that not only driving skills, but also safety skills should be taken into account when investigating the relationship between skills, risky driving, and traffic accidents. Rather than having deficiencies in driving skills,

having overconfidence in driving skills seem to lead to risky driving (Lajunen and Summala, 1995; Näätänen and Summala, 1976), especially when they are not buffered by safety skills. Therefore, safety skills should be incorporated into driving skills through driver education and licensing. In addition, these findings have implications for the information about the reactions of drivers with high levels of driving skills toward road safety campaigns. Drivers with high driving skills but low safety skills may tend to ignore the messages of road safety campaigns because they may not perceive themselves as a potential target (Delhomme, 1991). It might be helpful to underline the distinction between safety and driving skills in safety campaigns.

The present study has some methodological limitations. The data were based solely on drivers' self-reports of behavior. It is known that individuals suppose that they behave more frequently in a positive way and less frequently in negative way than others do (false consensus). However, the respondents completed the questionnaires anonymously and could not gain anything by giving biased responses.

Although we controlled for critical demographic variables such as sex and age in regression analyses, given that exaggerated rating of driving skills is common among young males the pattern of the interaction between the two types of skills may vary for the different sexes and age groups. Second, this study has also some limitations stemming from the general methodological deficiencies in the psychological study of driver behavior (see af Wåhlberg, 2003). For instance, given that accidents have a binominal-Poisson distribution, future studies should use more appropriate statistical techniques than the standard multiple regression especially in predicting accident data.

In conclusion, the present study contributed to the current literature by demonstrating that the interaction between driving and safety skills has a unique and independent effect on risky driving above and beyond the main effects of these two fundamental groups of skills.

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