New Trends in Psychology

The Relationship between Traffic-Related Causal Attributions and Human Factors in Driving

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Abstract: Attributional theories investigate the psychological consequences of causal attributions; that is, perceived causes of events. Since causal attributions are related to behaviors in a wide range or domains, it is possible that they are also influential in driving context. This study aims to conduct a preliminary investigation of the relationship between causal explanations and subsequent behavior in traffic context. A total of 397 participants (145 female, 252 male) completed a survey battery composed of demographic information form, the Causal Dimension Scale-II, the Driver Skill Inventory, and the Driver Behavior Questionnaire. Results showed that as opposed to the original use of the CDSII, causal explanations in driving were grouped around 3 dimensions, namely personal control, external control, and stability. Stability of weaknesses was negatively associated with positive behaviors and safety skills; whereas the relationships were reversed for stability of strengths. Stability of strengths was also associated with decreased ordinary violations and errors. This study was an initial research investigating the relationship between causal attributions and human factors in driving. Results of it open new windows for those researchers who are interested in the topic.

Keywords: causal attributions; causal dimensions; driver behavior; driving skill

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1. The Relationship between Traffic-Related Causal Attributions and Human Factors in Driving

Unacceptably high numbers of road traffic injuries and fatalities has been a major problem across the world (World Health Organization, 2018). Although the global rank of road injuries among leading causes of death decreased from 10 in 2000 to 12 in 2019, rank of burden of these injuries -represented by disability-adjusted life years- increased from 8 in 2000 to 6 in 2019 (World Health Organization, 2022). The extent of this problem encouraged researchers to produce a growing body of knowledge regarding the causes of road traffic accidents. As a result of large scale studies, these causes were divided into 3 categories; namely human (road user), vehicle, and environment (Oppenheim & Shinar, 2011). Perhaps due to its disproportionate proportion of contribution in accident causation (Oppenheim & Shinar, 2011), human factors have generated a vast amount of interest among road safety researchers.

It is now widely recognized that human factors in accident causation are investigated under 2 main dimensions: driving skills/performance and driver behavior/style (Elander, West, & French, 1993). Skill or performance corresponds to competence in driving-related tasks such as control, maneuvering, and planning, as well as general information processing and motor abilities; while behavior or style mostly refers to drivers' personal characteristics and attitudes towards themselves, traffic environment, and other road users, which are shaped by their exposure to driving (Lajunen, 2002). Put another way, skill represents the level of mastery of driving task. Behavior represents the ways in which drivers choose to drive, either risky or safe. Therefore; mastery, risk, and safety appear as the core concepts of human factors in driving. Previous studies show that accident involvement is closely related with these two dimensions (Özkan, Lajunen, Chliaoutakis, Parker & Summala, 2006a; Özkan, Lajunen, Chliaoutakis, Parker & Summala, 2006b). Therefore, research attempts focused on explaining the variables that are related with them.

A wide range of variables have been found to relate to the human factors in driving. These interrelated variables were grouped under 4 main levels by Özkan and Lajunen (2011): individual/micro level, group/meso level, national/macro level, and ecocultural sociopolitical/magna level. Micro-level variables refer to the individual characteristics of the road users such as personality, cognitive functioning and motivations; while meso-level variables reflect the influence of the membership of or belongingness to various groups such as organizations, place of residence, and social identities. Macro-level variables are composed of the variables that reflect characteristics of the countries such as legal rules and regulations. Finally, magna-level variables, such as economic, societal, and cultural factors, reflect the usual ecological components of the traffic environment. They also claim that some of the individual level variables such as age, sex, and cognitive processes and/or biases (i.e. causal attributions) are universally and directly related with drivers' skill and behavior, which are in turn directly linked to accident involvement. This could be a reason why factors in the micro-level attract particular interest in traffic safety research as in the current study.

One of the gripping micro-level variables is attributions, which is the individuals' naïve attempt to explain the causes of behavior (Försterling, 2001, p. 4). Attributions in the traffic context gain their fascination from the interactional structure of this system. Put differently, a safe traffic environment cannot be achieved solely by the safe behavior of the person, it also requires the person to anticipate other road users' behaviors. Perhaps for this reason, there is a wealth of literature regarding the attributional biases in human factors and accidents in driving (Fındık, Uslu, Öz, Lajunen, & Özkan, 2016; Stewart, 2005). However, there is more to explore attributions in traffic than biases. Attributional theories investigate the psychological consequences of causal attributions; that is, perceived causes of events (Försterling, 2001, p. 9). According to the earlier version of the model proposed by Weiner, cause of an event is evaluated on 2 dimensions: locus of causality and stability (Försterling, 2001, p. 111). Specifically, individuals assess whether the cause of an event resides within the individual or the environment, and whether it is changing or unchanging over time, respectively. Locating the perceived cause on these dimensions results in affective (i.e. emotions) and cognitive (i.e. expectancy regarding future performance) consequences, which then determine subsequent behavior (Weiner, 1990, p. 9). Causal dimensions have been found to relate with psychological and behavioral outcomes such as academic procrastination (Gargari, Sabouri, & Norzad, 2011; Kandemir, 2014), performance on foreign language learning test (Hashemi & Zabihi, 2011), and self-efficacy in sports (Bond, Biddle, & Ntoumanis, 2001). Since causal attributions are related to behaviors in a wide range or domains, it is possible that they are also influential in driving context.

Despite being an influential model in different fields of psychology, especially educational and sport psychology, the relationship between causal attributions and human factors in driving has remained widely unexplored. Of the few studies conducted, Britt and Garrity (2006) report that attributing anger-evoking events to stable causes is associated with anger and aggressive behavior. Another study found that controllability and locus of causality -internal causal attributions- are negatively associated with positive emotions and locus of causality partially mediated the relationship between hypocrisy dissonance (i.e. inconsistent cognitions induced by the awareness that the person, besides other people, have done wrong deeds) and intention to forgive road rage (Takaku, 2006). To specify, hypocrisy dissonance was negatively associated with internal causal explanations; which, in turn, was also negatively associated with intention to forgive road rage exposed. These findings imply that causal attributions are related both to both behavioral and psychological outcomes in traffic. Locus of control or internality/externality has been an exclusively popular concept in relation to traffic-related outcomes. Özkan and Lajunen's (2005a) finding that internal locus of control (as measured by the "self" sub-scale) being positively associated with accidents, offences, and risky driving can shed some light on the relationship between causal attributions and traffic-related outcomes. This finding indicates that those individuals who perceive events in the traffic as under their control engage in more aberrant behavior and negative outcomes in driving, potentially due to over-confidence and optimism. In her thesis, Arslan (2018) found that locus of control's relationship with other outcomes in traffic, such as coping styles, is moderated by negative affect. Specifically, she reported that the relationship between internal locus of control in traffic and task-focused coping (i.e. focus on planning effective actions to achieve safe driving in cases of stress) was stronger among drivers with low negative affect (i.e. having a relaxed, calm, serene mood). Also, she found that the relationship between external -as measured by fate and luck subscale- locus of control in traffic and emotion-focused coping (i.e. focus on managing emotions in cases of stress) was stronger among drivers with low negative affect. These findings highlight the crucial role of affect in the relationship between attributional processes and behavioral outcomes. Finally, Montag and Comrey (1987) reported that driving internality was negatively and driving externality was positively associated with involvement in fatal accidents, which is contrary to Özkan and Lajunen's (2005a) findings. They explain the positive relationship between externality and accident involvement in terms of individuals' lack of caution due to the belief that events cannot be controlled by themselves.

As mentioned above, previous research on attributions in traffic context has mainly focused on illustrating the biased perceptions of drivers. How attributions, on the other hand, can influence the behavior has remained vague. The handful of studies exploring this relationship solely focused on locus of control, not considering the other causal dimensions. Taking the limited literature into consideration, this study aims to conduct a preliminary investigation of the relationship between causal explanations and subsequent behavior in traffic context. In other words, the full set of causal dimensions and their association with human factors in driving was examined in the current study. In sought of this aim, a measure of context-specific (i.e. traffic-related) causal attribution was formed. Then, its relation to driving skills and driver behaviors was investigated.

2. Method

2.1. Participants

Data was collected from 597 individuals in total; however only the complete data were used, resulting in a sample of 397 participants. Of these 397 participants, 145 (36.5%) were females and 252 (63.5%) were males. Ages of the participants varied between 18 and 63, while mean age was 26.36 (SD = 9.72). Most of the participants were university graduates (73%), yet primary school (2%), high school (13.1%), associate degree (7.1%), and masters (3.8%) graduates also took part in the study. More information regarding the sample characteristics can be found on Table 1.

Table 1. Descriptive Characteristics of the Sample

	Mean	**Standard Deviation**
Age	26.36	9.72
Annual mileage (in kilometers)	6485.84	11533.593
Lifetime mileage (in kilometers)	60033.55	288489.618
3-year accident involvement	1.38	1.83

2.2. Instruments

Background information. A demographic information form was given to the participants in order to obtain the background information. This form included questions regarding age, gender, mileage (annual and lifetime), level of education, current city of residence, and number of accidents in the past 3 years.

Causal dimensions. In measuring the attributional dimensions, Causal Dimension Scale-II (CDSII) was used. The original scale was developed by Russell in 1982 in an attempt to assess how individuals perceive the causes of events. Later on, McAuley, Duncan, and Russell (1992) revised the Causal Dimension Scale and proposed the improved CDSII. In this improved version of the scale, participants are asked to provide a cause for an event, think of this cause and evaluate the features of it along 12 items. These 12 items compose of 4 dimensions, namely locus of causality (i.e. whether the cause is something about the person or outside the person; 3 items), external control (i.e. the extent to which the cause can be changed by other people; 3 items), personal control (i.e. the extent to which the cause can be changed by the person; 3 items), and stability (i.e. whether the cause is constant or variable over time; 3 items). Each item is rated on a 9-point scale, higher points indicating internal locus of causality, increased control over causes by others, increased control over causes by the self, and increased constancy of causes, respectively. Koçyiğit's (2011) Turkish translation of the CDSII was used in this study. The scale was adjusted to the traffic setting in order to understand how individuals perceive the causes of traffic-related events. Specifically, the participants were asked to define and evaluate the causes of 6 different situations. These were situations, in which the highest and lowest levels of mastery, risk, and safety were experienced while driving by each subject. As mentioned in the introduction section, human factors in driving has 2 main components: skill and behavior. Mastery was chosen to represent the skill component, which is about the expertise in handling the vehicle and various situations in traffic. Risk and safety were chosen to represent the behavior component, which refers to driving style, which can be in a risky or safe manner. All 6 evaluations were separately analyzed for their factor structure and internal consistency.

Driving skills. Driving skills were measured with the Driver Skill Inventory (DSI). DSI is developed by Lajunen and Summala (1995) in order to measure drivers' self-assessed skill and safety motive levels. The 29 items of the DSI are rated on a 5-point Likert-type scale (0=Very weak, 4=Very strong) and compose of 2 dimensions, namely perceptual-motor skills and safety skills. Turkish adaptation of the DSI was conducted by Lajunen and Özkan (2004). Their version of the scale consisted of 20 items. In the current study, a 10-item version of the DSI (5 items per subscale with the highest loadings in Lajunen and Özkan's version) was used. Adequate internal consistency values were observed for the scale in this study (Cronbach's alpha = .83 and .72 for perceptual-motor skills and safety skills, respectively).

Driver behaviors. Aberrant driver behaviors were evaluated using the Driver Behavior Questionnaire (DBQ). DBQ is developed by Reason, Manstead, Stradling, Baxter, and Campbell (1990) in an attempt to reveal the frequency of different types of deviant traffic behaviors that drivers display. An addition to the DBQ was suggested by Özkan and Lajunen (2005b) with the idea that drivers also engage in positive behaviors from time to time. With this rationale in mind, they developed the Positive Driver Behavior Questionnaire as an extension for the original one. Turkish adaptation of the DBQ was conducted by Lajunen and Özkan (2004). Their version of the scale is consisted of 28 items rated on a 6-point Likert-type scale (1 = Never, 6 = Almost always). Moreover, Turkish DBQ is composed of 4 dimensions: errors (8 items), lapses (8 items), ordinary violations (9 items), and aggressive violations (3 items). Positive DBQ is composed of 9 items and rating is identical to that of the DBQ. Adequate internal consistency values were observed for the scale in this study (Cronbach's alpha = .73, .83, .65, and .86 for errors, ordinary violations, aggressive violations, and positive behaviors, respectively).

2.3. Procedure

Upon retrieving ethical permission from the Middle East Technical University Applied Ethics Research Center, all the questionnaires were prepared on an internet-based survey site. Specifically, Qualtrics (www.qualtrics.com) was used in data collection. The study link generated by Qualtrics was shared via social media (Facebook, etc.). In addition, Sona System, which is a participant pool allowing students to participate in studies in exchange for bonus points in their courses, was used. Hence, part of the sample was composed of students enrolled in one of the several different psychology classes in Middle East Technical University.

2.4. Analyses

In order to examine the factor structure of the CDSII, principal axis factoring was conducted with promax rotation for each of the 6 situations. Resulting factor structures were then compared to capture any convergence or divergence across situations. Additionally, mean scores of the factors were examined across situations. In these comparisons, paired samples t-tests were used. The final structure and use of the subscales of the CDSII was determined based on these t-tests. Based on the subscale formation of the traffic-related CDSII in the previous step, the relationship between causal attributions and human factors in traffic were examined via Pearson correlations and hierarchical regression analyses. As an additional analysis, differences between accident-free and accident-involved drivers were compared via independent-samples t-test. All analyses were conducted using IBM SPSS (Statistical Package for the Social Sciences) v.28 software.

3. Results

3.1. Factor Structure of the Traffic-Related CDSII

Principal axis factoring with promax rotation was conducted in order to examine the factor structure of the traffic-related causal attributions. The analysis was conducted separately 6 times for each situation, that is the situations in which the highest and lowest levels of mastery, risk, and safety were experienced while driving. According to the results of the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO), KMO values varied between .85 and .90. In addition, Bartlett's Test of Sphericity was significant at $p<.001$ at all 6 analyses. These findings indicate that the items were suitable for factoring. Upon rotation, eigenvalues suggested 3 factors in all 6 analyses. Screeplots supported the 3-factor solution as well. Hence, the 3-factor solution presented the most suitable structure in all 6 analyses. Detailed information regarding the results of the factor analyses and internal consistency tests were presented in Table 2.

Table 2. Results of the Traffic-Related CDSII Factor Analyses and Internal Consistency Coefficients

	Factor 1-Personal Control			Factor 2-External Control			Factor 3-Stability		
Item 1	.65	.82	.75						
	.77	.82	.80						
Item 2	.96	.96	.94						
	.88	.99	.93						
Item 3	.37						.50	.73	.79
							.82	.73	.74
Item 4	.91	.92	.94						
	.87	.90	.94						
Item 5				.73	.78	.78			
				.77	.77	.83			
Item 6	.65	.81	.87						
	.77	.79	.86						
Item 7							.64	.79	.84
							.82	.83	.73
Item 8				.65	.87	.86			
				.85	.92	.87			

Item 9	.49 .59	.63 .77	.69 .71						
Item 10	.78 .76	.85 .89	.87 .87						
Item 11							.77 .67	.61 .66	.66 .68
Item 12				.70 .69	.76 .65	.69 .69			
Eigenvalue	5.33 4.71	5.44 6.23	5.87 5.58	1.53 2.35	2.13 1.55	1.83 2.21	1.19 1.55	1.44 1.38	1.35 1.32
%Variance explained	44.41 39.28	45.35 51.91	48.95 46.48	12.72 19.56	17.71 12.91	15.21 18.45	9.94 12.98	12.00 11.50	11.25 11.02
Cronbach's alpha	.89 .90	.94 .95	.94 .95	.75 .81	.84 .83	.82 .85	.71 .81	.75 .79	.80 .76

Note. At each row, coefficients in the upper three cells correspond to the highest levels of mastery, risk, and safety; and the coefficients in the lower three cells correspond to the lowest levels of mastery, risk, and safety situations. For ease of interpretation, pattern matrix coefficients lower than .30 were omitted.

As can be seen in Table 2, items were neatly loaded to their corresponding factors and no cross-loading was observed with only one exception. Item 3 cross-loaded to Factor 1 and 3 in the highest level of mastery situation, however the large difference in the coefficients and absence of this pattern in other 5 situations allowed for locating the item to Factor 3. Factor 1 composed of 6 items which correspond to the Personal control and Locus of causality items in the original CDSII. In other words, 3 Personal control and 3 Locus of causality items merged in the traffic-related version of the CDSII to form a new 6-item factor, eliminating the difference between them. Since the factor loadings of the original Personal control items were higher than the original Locus of causality items in the newly merged factor, the name in the original CDSII, "Personal control", was retained instead of Locus of causality. Factor 2 composed of the same 3 items in the External control dimension of the original CDSII, hence called "External control". Finally, Factor 3 comprised of the same 3 items in the Stability dimension of the original CDSII, hence called "Stability" in this solution as well.

4. Similarities and Differences between Causal Attributions across Situations

In an attempt to discover whether causal attributions change across situations, 3 paired samples t-tests were conducted. First, highest mastery, lowest risk, and highest safety situations on one hand; and lowest mastery, highest risk, and lowest safety situations on the other hand were pooled together to form a main distinction between causal explanations of strengths and weaknesses in traffic-related events, respectively. In the t-tests, personal control, external control, and stability scores of strength and weakness conditions were compared. In doing so, potential differences in individuals' causal attributions of their strengths and weaknesses were examined. According to the results, the difference between strengths and weaknesses were significant for personal control ($t(396)=9.16$, $p<.001$), external control ($t(396)=-6.34$, $p<.001$), and stability ($t(396)=15.86$, $p<.001$) dimensions. To specify, personal control was higher, external control was lower, and stability was higher for strengths ($M=6.17$, $SD=1.65$; $M=4.34$, $SD=1.55$; $M=5.97$, $SD=1.67$; respectively) as compared to weaknesses ($M=5.33$, $SD=1.64$; $M=4.85$, $SD=1.57$; $M=4.48$, $SD=1.61$; respectively). Taking these consistent differences into account, subscale scores in strength and weakness conditions were included in further analyses separately instead of in aggregated manner.

4.1. Relationship between Causal Attributions in Driving and Human Factors in Driving

An initial examination of the relationship between causal attributions, and driver behaviors and driving skills was conducted via Pearson correlation analysis. Results showed that as age increased, attribution of personal control for strength also increase ($r=.12$, $p<.05$). On the other hand, age and attribution of external control for weaknesses were negatively correlated ($r=-.14$, $p<.05$). A similar relationship pattern was observed between exposure as measured by licensed years and causal attributions. Positive driver behaviors and perceptual-motor skills showed a higher number of correlations with attributional dimensions as compared to aberrant driver behaviors and safety skills. In addition, most of the relationships were observed between human factors and causal attribution for strengths as compared to weaknesses. Correlation coefficients between the variables are presented in Table 3.

Table 3. Pearson correlation coefficients between the study variables

	Str - PEC	Str - EXC	Str - STA	Wea - PEC	Wea - EXC	Wea - STA
Age	**.12* (397)**	.03 (397)	.02 (397)	-.03 (397)	**-.14* (397)**	-.05 (397)
Gender	.03 (397)	**-.12* (397)**	.03 (397)	.01 (397)	-.07 (397)	**.14** (397)**
Licensed years	**.11* (384)**	**-.20** (384)**	.00 (384)	-.06 (384)	**-.16** (384)**	-.06 (384)
3-year accidents	.06 (378)	**-.13* (378)**	-.01 (378)	.06 (378)	**-.18** (378)**	-.02 (378)
AV	.05 (397)	-.02 (397)	-.01 (397)	.08 (397)	.04 (397)	.06 (397)
OV	.06 (397)	-.06 (397)	-.01 (397)	.07 (397)	.04 (397)	.08 (397)
ER	-.09 (397)	**.17** (397)**	**-.15** (397)**	.08 (397)	.07 (397)	.07 (397)
PO	**.14** (397)**	**-.17** (397)**	**.13* (397)**	-.01 (397)	-.04 (397)	**-.12* (397)**
PM	**.23** (397)**	**-.31** (397)**	**.17** (397)**	-.01 (397)	-.10 (397)	.00 (397)
SS	.04 (397)	-.04 (397)	.08 (397)	-.01 (397)	-.02 (397)	**-.15** (397)**

Note. Numbers in parentheses show the sample sizes for the corresponding Pearson correlation coefficient. Str: Strength, Wea: Weakness, PEC: Personal control, EXC: External control, STA: Stability, AV: Aggressive violations, OV: Ordinary violations, ER: Errors, PO: Positive driver behaviors, PM: Perceptual-motor skills, SS: Safety skills. *$p<.05$, **$p<.01$.

In order to further examine the relationship between driving-related causal attributions and human factors in driving, a number of hierarchical regression analyses were performed. Specifically, 6 hierarchical regression analyses were conducted for the 6 outcome variables (i.e. aggressive violations, ordinary violations, errors, positive driver behaviors, perceptual-motor skills, and safety skills). In all 6 analyses, age, gender, and education were entered in the first step in order to control their effects. In the second step of the analyses, personal control, external control, and stability scores in strength and weakness conditions were entered. Results of the hierarchical regression analyses are summarized in Table 4.

As shown in Table 4, first steps of the models were significant for ordinary violations (F(3, 393)=10.01, p<.01, *Adj.* R^2=.06), errors (F(3, 393)=4.83, p<.01, *Adj.* R^2=.03), positive driver behaviors (F(3, 393)=7.03, p<.01, *Adj.* R^2=.04), perceptual-motor skills (F(3, 393)=21.68, p<.01, *Adj.* R^2=.14), and safety skills (F(3, 393)=6.71, *p*<.01, *Adj.* R^2=.04), but not aggressive violations. Among the step 1 variables, age was negatively associated with ordinary violations (*β*=-.21, *p*<.01) and errors (*β*=-.19, *p*<.01), and positively associated with positive driver behaviors (*β*=.23, *p*<.01), perceptual-motor skills (*β*=.16, *p*<.01), and safety skills (*β*=.22, *p*<.01). In addition, being male was associated increased ordinary violations (*β*=.18, *p*<.01), increased perceptual motor skills (*β*=.31, *p*<.01), and decreased safety skills (*β*=-.11, *p*<.05).

Similarly, Table 4 shows that the second step variables explained a significant amount of variance in ordinary violations (*F*(9, 387)=4.92, *p*<.01, *Adj.* R^2=.08), errors (*F*(9, 387)=4.19, *p*<.01, *Adj.* R^2=.07), positive driver behaviors (*F*(9, 387)=4.70, *p*<.01, *Adj.* R^2=.08), perceptual-motor skills (*F*(9, 387)=12.68, *p*<.01, *Adj.* R^2=.21), and safety skills (*F*(9, 387)=4.09, *p*<.01, *Adj.* R^2=.07), but not aggressive violations. Among these variables, external control of strengths was negatively associated with ordinary violations (*β*=-.15, *p*<.05) and perceptual-motor skills (*β*=-.23, *p*<.01). Stability of strengths was negatively associated with ordinary violations (*β*=-.16, *p*<.05) and errors (*β*=-.19, *p*<.01), and positively associated with positive driver behaviors (*β*=.13, *p*<.05) and safety skills (*β*=.21, *p*<.01). Stability of weaknesses, on the other hand, showed a negative relationship with positive driver behaviors (*β*=-.15, *p*<.01) and safety skills (*β*=-.20, *p*<.01).

Table 4. Results of the Hierarchical Regression Analyses

	Adjusted R^2						***F* value**					
Step 1. Control variables	AV	OV	ER	PO	PM	SS	AV	OV	ER	PO	PM	SS
	-.00	.06**	.03**	.04**	.14**	.04**	0.66	10.01**	4.83**	7.03**	21.68**	6.71**
	Beta											
	AV	OV	ER	PO	PM	SS						
Age	-.06	-.21**	-.19**	.23**	.16**	.22**						
Gender	.04	.18**	.05	-.08	.31**	-.11*						
Education	.01	.03	-.02	.03	-.05	.05						
	Adjusted R^2						***F* value**					
Step 2. Main variables	AV	OV	ER	PO	PM	SS	AV	OV	ER	PO	PM	SS
	.00	.08*	.07**	.08**	.21**	.07*	1.13	4.92**	4.19**	4.70**	12.68**	4.09**

	Beta					
	AV	OV	ER	PO	PM	SS
Str-PEC	.05	.09	.03	.02	.13	-.07
Str-EXC	-.09	-.15*	.09	-.11	-.23**	.05
Str-STA	-.11	-.16*	-.19**	.13*	.04	.21**
Wea-PEC	.10	.07	.12	-.01	-.07	.01
Wea-EXC	.11	.10	.03	.06	.05	.01
Wea-STA	.07	.09	.10	-.15**	-.03	-.20**

*Note. Str: Strength, Wea: Weakness, PEC: Personal control, EXC: External control, STA: Stability, AV: Aggressive violations, OV: Ordinary violations, ER: Errors, PO: Positive driver behaviors, PM: Perceptual-motor skills, SS: Safety skills. *p<.05, **p<.01.*

4.3. Comparison of Accident-Free and Accident-Involved Drivers

An additional independent-samples t-test analysis was conducted in order to examine the differences between accident-free and accident-involved drivers. Test variables were the human factors variables included in previous analyses (i.e. aggressive violations, ordinary violations, errors, positive driver behaviors, perceptual-motor skills, and safety skills). Grouping variable was formed based on the responses to the question "How many accidents were you involved in while driving in the last 3 years?". In order to obtain groups with roughly similar amount of participants, the variable was dummy-coded as accident-free (n=150) and accident-involved (n=247) drivers. Levene's test of equality of variances was violated for positive driver behaviors; hence, test statistics with equal variances not assumed were considered for this variable.

According to the results of the analysis, accident-free and accident-involved drivers differed in terms of their scores on aggressive violations ($t(395)=-2.55$, $p<.01$), ordinary violations ($t(395)=-3.92$, $p<.001$), safety skills ($t(395)=3.18$, $p<.01$), and external control of weaknesses ($t(395)=2.35$, $p<.05$). Specifically, aggressive violations and ordinary violations were lower among accident-free drivers (M=2.16, SD=.85; M=1.96, SD=.67, respectively) as compared to accident-involved drivers (M=2.39, SD=.87; M=2.25, SD=.74, respectively). On the other hand, safety skills and external control of weaknesses were higher among accident-free drivers (*M*=3.92, *SD*=.70; *M*=5.08, *SD*=1.54, respectively) as compared to accident-involved (*M*=3.71, *SD*=.61; *M*=4.70, *SD*=1.57, respectively) drivers.

5. Discussion

5.1. Structure and Use of the Traffic-Related CDSII

The current study sought to conduct a preliminary research for exploring the relationship between context-specific (i.e. traffic-related) causal attributions and human factors in driving. As a first step in reaching this purpose, CDSII was adapted to the traffic context and its factor structure was examined. Results showed that as opposed to the original use of the CDSII (McAuley et al., 1992), causal explanations in driving were grouped around 3 dimensions, namely personal control, external control, and stability. Put differently, locus of causality and personal control dimensions were merged into a single dimension. Though McAuley and his colleagues (1992) reported a high (i.e. *r*=.71) correlation between these two dimensions, their comparative analysis showed that the proposed 4-factor model fit their data better than the alternative model combining locus of causality and personal control. In the current study, on the other hand, the 3-factor structure was maintained in all 6 conditions tested (i.e. highest mastery, highest risk, highest safety, lowest mastery, lowest risk, lowest safety). Why did locus of causality dimension merge in the same direction with personal control, instead of merging in the opposing direction with external control? In other words, why has internal locus of causality been interpreted as equivalent to high personal control; rather than external locus of control being interpreted as equivalent to high external control? The answer could be that internally caused events in driving were simultaneously considered as controllable; yet, externally caused events in driving were considered as either controllable or non-controllable by the participants. It could also be that externally controllable events can be caused by both internal and external reasons. Also, individuals explained positive (i.e. referred in this study as strengths) and negative (i.e. referred in this study as weaknesses) aspects of their driving differently. Consistent with previously reported cognitive biases in traffic setting (Baxter, Macrae, Manstead, Stradling, & Parker, 1990; Fındık et al., 2016), strengths were rated as more personally controlled and stable, and less externally controlled as compared to weaknesses. This means that individuals interpret positive and negative events differently, which is why the subsequent analyses included 6 causal dimensions (i.e. personal control of strengths, external control of strengths, stability of strengths, personal control of weaknesses, external control of weaknesses, and stability of weaknesses) instead of 3 (i.e. personal control, external control, and stability).

5.2. Points to Consider Regarding the Previous Research on Attributions in Traffic Context

In the second step in sought of reaching the purposes of the study, the associations between the traffic-related causal dimensions and human factor in driving was explored. Before moving on to this step, several points should be discussed so that the current findings can be properly linked to previous ones. As mentioned in the preceding sections, previous studies examining the relationship between attributions and behavioral outcomes in traffic concentrate on locus of control as the sole causal dimension. As Pettersen (1987) pointed out, there are different formulations regarding the concept of locus of control in the literature, which are used interchangeably in a wrong manner. According to him, one group of researchers define locus of control in terms of the ability/inability to control what happens to the individuals (i.e. behavioral outcome contingency explanation); whereas others define the concept in terms of the perception of themselves/external forces as the source of what happens to them (i.e. causal attribution explanation). In other words, researchers examining the concept from the behavioral outcome contingency approach seem to refer to controllability, while those examining it from the causal attribution approach seem to refer to locus of causality. Literature on locus of control and human factors in driving present inconsistent results and these inconsistencies may be the reflection of the conceptual differences (Bıçaksız, 2021; Töre, Kaçan-Bibican, & Özkan, 2019). Our finding that internal locus of causality being interpreted as equivalent to personal controllability, yet external locus of causality not being interpreted equivalent to external controllability offers an additional explanation to the inconsistencies in the literature. Assuming that the previous conceptualizations (Montag & Comrey, 1987; Özkan & Lajunen, 2005a) refer to controllability, our findings are in line with them in terms of taking personal and external controllability as two separate dimensions instead of a unidimensional construct. However, assuming that the previous conceptualizations refer to locus of causality, our findings differ from these studies in terms of omitting locus of causality as a separate construct, either multidimensional or unidimensional.

In addition to their definitional inconsistencies, previously used traffic-related locus of control measures accept accidents as the basis and subject of interest (Montag & Comrey, 1987; Özkan & Lajunen, 2005a). Measuring locus of control exclusively in relation to accidents can be problematic given the complexity of these events, the negative effects of it on the individuals, and the cognitive biases people are prone to. Accoring to Stewart's (2005) findings, accidents resulting in more severe consequences were attributed more to other drivers as compared to both self and weather/road conditions, reflecting the defensive attributional tendencies. He also reported that the effect of weather/road conditions were more evident for drivers who assigned the accident's responsibility to themselves as compared to other drivers, displaying actor-observer bias. Stewart's (2005) findings demonstrate the potential threats in using accidents as the sole subject in attribution research. Using CDSII for measuring controllability in driving, hence, minimizes this risk by letting the researcher choose the basis or the subject of interest. For the current study, mastery, risk and safe situations were chosen as the basis instead of a severe event such as accidents. Though the behaviors, for which the causal dimensions are evaluated, are defined differently by each participant depending on their own individual features, they are standard in the sense of being "the most" or "the least" mastered/safe/risky situation for each individual. Another critical issue regarding traffic-related locus of control measurements is the wording of items. In Montag and Comrey's (1987) scale, the subject of items is a third person; whereas in Özkan and Lajunen's (2005a) scale the subject of items is self. This, in relation to actor-observer bias, could be another reason for conflicting results.

5.3. Findings of the Current Study and Their Link with Previous Research

Despite the above-mentioned disagreements regarding the concept and conflicting findings, the results of the current study are worth discussing with reference to previous results. In our study, human factors' relationship with causal explanations regarding strengths were more salient, rather than that of weaknesses. Accidents, which form the basis of the current locus of control measurements, are undesirable events and therefore more appropriate to be evaluated in the scope of results of weaknesses. Therefore, our findings are in line with previous studies reporting no relation between locus of control and aberrant driving (Iversen & Rundmo, 2002). On the other hand, increased external control of strengths was associated with decreased ordinary violations and perceptual-motor skills. This means that individuals who evaluate their strengths as being controllable by external forces engage in less ordinary violations and perceive themselves as less skillful. It can be claimed that these drivers interpret their strengths as dependent on situational factors (e.g. traffic flow), hence depend less on their perceptual-motor skills and act more cautiously. This is supported by our additional analyses showing that external control of weaknesses is higher among accident-free as compared to accident-involved drivers. Overall, our results are in line with the results of the review study conducted by Bıçaksız (2021), which states that despite disagreements, literature on locus of control in traffic context present an overall trend linking internality with risky behaviors, externality with safe driving.

Another noteworthy finding of the current study is that stability of weaknesses was negatively associated with positive behaviors and safety skills; whereas the relationships were reversed for stability of strengths. Stability of strengths was also associated with decreased ordinary violations and errors. According to Weiner, Frieze, Kukla, Reed, Rest, and Rosenbaum (1972), stability dimension is particularly related to the future expectations regarding the occurrence of the behavior, in turn with the occurrence or extinction of the behavior. Specifically, when failure is attributed to stable factors (e.g. lack of ability, task difficulty), subjective expectancy of success decreased and performance was ceased; when they are attributed to unstable factors (e.g. lack of effort, bad luck), this decrement was minimized and performance was maintained. Negative relationship between stability of weaknesses on one hand, and positive and safe behaviors on the other could also be through subjective expectancies. As individuals attribute their weaknesses to stable reasons, their expectancy to improve these may decrease and they may lose their motivation to act positively and safely. It is possible that these individuals focus their attention to operating their vehicle and function in the traffic system rather than improving the system. On the other hand, the opposite can be said for those who attribute their strengths to stable causes. Since their expectancy for future success would be high, they may maintain their motivation to act positively and safely. It is possible that these individuals shift their attention from operating the vehicle to improving the traffic system. Potential mediators and moderators in these relationships are yet to be explored. Also, since culture moderates causal attributions of individuals (Higgins & Bhatt, 2001), similar research should be conducted in other countries to explore the interplay between these variables.

6. Conclusions

This study was an initial research investigating the relationship between causal attributions and human factors in driving. Results of it open new windows for those researchers who are interested in the topic. This study contributes to the literature in a number of ways. First novelty of it is to examine the full range of causal dimensions in the traffic context, as opposed to the previous literature on attributions in traffic, which concentrate solely on locus of control. By doing so, this study both contributes to unraveling the conflicting results in the previous studies and draws attention to the stability dimension. Another novelty of this study is to analyze attributions about positive (i.e. strengths) and negative (i.e. weaknesses) aspects of driving separately. Although previous studies mostly explore the attributions regarding extreme negative events, such as accidents, this study explores both the positive and negative events in driving. Finally, whereas the focus was mostly on driver behaviors in the previous literature, this study included both components of human factors in driving, driver behaviors and driving skills.

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