

The Mediating Role of Cognitive Flexibility in Relation with Personality Traits and Driving Behavior

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Abstract

Introduction: Driving behavior is a multifactor and high-risk behavior that was affected by several factors such as, individual, social and situational. Therefore, the present research aimed to study the mediating role of cognitive flexibility on the relationship between personality traits and driving behavior.

Method: Method was descriptive- correlation SEM. The statistical population comprised of all the male drivers of intercity buses in Tehran terminals. 210 participants were selected by multi cluster sampling and completed the questionnaires of Manchester Driving Behavior (MDBQ), NEO Five-Factor (NEO-FFI) and Cognitive Flexibility (CFI). Data analyzed using structural equation modeling (SEM) and the soft wares of Amos-21 and SPSS-19.

Result: The results showed that the personality traits of neuroticism, agreeableness and conscientiousness have a direct effect on high-risk driving behaviors. Also, personality traits of neuroticism, extroversion, and conscientiousness have an indirect effect on high-risk driving behaviors through cognitive flexibility ($p < .05$).

Conclusion: Cognitive flexibility mediates on the relationship of personality traits of neuroticism, extroversion and conscientiousness with high-risk driving behaviors. Therefore, according to the effect of human factors in high-risk driving behaviors was suggested to develop a psycho-educational package for promoting safe driving behaviors in drivers.

Declaration of Interest: None

Keywords: Cognitive flexibility, Driving behavior, Personality.

Introduction

According to the World Health Organization, more than 3,700 people are killed on the world's roads everyday (one person per 24 seconds) and 10 million get either injured or disabled each year (1). In other words, the annual death on the roads has reached one million and 350 thousand people (1). Injuries and deaths due to road accidents account for an average of 3% of government spending (2). In Iran, after cardiovascular diseases, cancers and respiratory diseases, unintentional accidents and mainly traffic accidents were reported as one of the main causes of death in 2017 (3). Research has shown that human factors play an important role in 90% of accidents, one of the most important of which is high-risk and reckless driving behaviors (4, 5).

Driving behavior is the driving style chosen by the driver, such as speed and safe distance (6). In general, driving is the behavior that is chosen as a practical model by the individual and is implemented in relation to the vehicle (7). In other words, driving is an activity that the driver chooses as a model for his/her driving, such as maintaining a standard distance, concentration, driving speed, etc. Driving behavior is considered a part of human cultural behavior in societies and values, habits, attitudes, and other cultural factors play an important role in its formation (8). Parker, Reason, Manstead, Stradling classified high-risk behaviors into three categories of lapses, errors and violations that are among the human factors and lead to accidents (9, 10).

Driving errors occur due to a lack of attention to precautions such as not looking at the side and rear mirrors when moving left and right or a sudden change of direction. Errors occur

unintentionally and can increase the number of accidents. Lapses are unwanted deviations from what one intends to do and behaviors that result from poor attention, concentration, and accuracy (11). Driving with carelessness and inattention is positively related to the occurrence of dangerous incidents (12). Moreover, people with cognitive impairments are more likely to make a variety of driving errors (13).

Violations refer to the deliberate disregard for traffic rules, such as not paying attention to speed limits on the road, not following safe distances, crossing red lights, and chasing other drivers when angry with the intention of harming them (14). Aggressive drivers are more likely to make driving errors and increase the number of accidents (15). Based on the above-mentioned text, it can be asserted that cognitive dimensions and information processing play a more important role in making errors. However, motivational, social, cultural and contextual factors play a more crucial role in committing violations. Totally, high-risk driving behaviors increase the likelihood of an accident (16). Therefore, it can be concluded that violations and errors are more likely to lead to accidents (17).

One of the factors influencing high-risk driving behavior is the driver's personality traits and it can predispose drivers to higher driving hazards (18, 19, 20). Character refers to the relatively stable styles of thinking, feeling, and acting that describe a person (21). According to the personality trait theory, personality can be thought of as a set of traits that are very individual and relatively stable throughout a person's life and affects a person's behaviors and reactions in a situation (22).

The five-factor model of personality trait is the result of decades of research, and its applicability is known for predicting the consequences of behavior because of its capacity to explain many characteristics. The five-factor model describes the personality based on five factors. Extroversion is described with high loquacity, boldness, and high energy; agreeableness is described with optimism, trust, cooperation, responsibility, conscientiousness, discipline and reliability; neuroticism is indicated with agitation and emotional instability; and openness is characterized with being logical, independent and flawless thinking (23).

There is a relationship between personality traits and their high-risk behaviors (24). the personality traits of extroversion, agreeableness and conscientiousness in ordinary drivers were more than violating ones. Also, a higher level of neuroticism is observed in violating drivers as to normal drivers (25). Guo, Wei, Liao and Chu in a study on Chinese Drivers showed that drivers with high conscientiousness and extroversion do less accident. high conscientiousness and low agreeableness are associated with less high-risk driving behaviors (26).

The study hypothesized that cognitive flexibility could mediate the relationship between personality traits and high-risk driving behaviors. Previous research has shown that there is a significant relationship between cognitive flexibility and personality traits (27). On the other hand, personality traits can predict cognitive development (28). the cognitive flexibility as the ability to change cognitive functions to adapt to the changing environmental stimuli (29). Individuals with high levels cognitive flexibility are flexible, confident to self, aware of their choices in difficult situations and resistant in conflicts and

uncertainty (30). Also, they have less stress and efficient perception and effective thinking (31). Individuals with high score on neuroticism and low score on conscientiousness have more problems in cognitive flexibility as an executive function (27). According to the above, investigations carried out in Iran and abroad have further investigated the relationship between the two variables studied in this study. However, none of these studies examined the mediating role of cognitive flexibility in the relationship between personality traits and driving behavior and the effect of cognitive flexibility on either increasing or decreasing the relationship between these variables. Therefore, the researcher sought to examine this and the following conceptual model and answer the question that whether cognitive flexibility plays a mediating role in the relationship between personality traits and drivers' driving behavior?

Methods

Research Method was descriptive- correlation and structural equation modeling (SEM). In present research, the statistical population comprised of all the men drivers of intercity buses in Tehran terminals in 2019. According to Hooman optimal sample size for structural equation modeling is 30 participants for each observed variable (31). Whereas in present research 7 variables were studied, 210 participants were selected using multi-stage cluster sampling in West, Beyhaqi and Punak terminals. Therefore, 2 terminals (West and Beyhaqi Terminals) were first selected from among Tehran's intercity terminals and then, 8 cooperative companies were randomly selected from each terminal.

After selecting cooperative companies and describing research aims for participants, questionnaires were distributed to be filled out. data were collected in the period from July to

November of 2019. The inclusive criteria were literacy, driving intercity, masculinity, and employment in Tehran's cooperatives. In order to observe the ethical principles of the research, the purpose of the research, confidentiality, and the right to withdraw from the research were explained to the drivers.

Materials

Manchester Driving Behavior Questionnaire (MDBQ): This questionnaire was developed in 1990 at the Psychology Department of Manchester's University by Reisen et al. This 50-item questionnaire is scored on a 5-point Likert scale. The questions differ from each other in two aspects, one, in the type of behavior and the other, in the degree of danger that behavior has for other drivers. Parker et al. (9) have obtained the correlation coefficients of 0.81 for errors and 0.75 for violations in the test-retest reliability on 80 drivers and within a seven-week interval (9). The results of exploratory and confirmatory factor analyses showed that all four factors of MDBQ have high internal coefficients: lapses 0.77, errors 0.91, aggressive violations 0.86 and ordinary violations 0.65 (33).

NEO Five-Factor Inventory (NEO-FFI): This inventory has 60-items and assess big five factors. This inventory developed by Costa and McCrae (34). The five factors of personality are neuroticism (N), extroversion (E), openness to experience (O), agreeableness (A), and conscientiousness (C). the answers are scored on a five-point Likert scale, from 1 totally disagree (1) to strongly agree (5). the validity of this questionnaire based on the correlation of its scores with the scores of spouses and peers was obtained to be in the range of 0.44 and 0.36 (for

conscientiousness) to 0.65 and 0.48 (for openness to experience) (35). The results of this The reliability of

Panayiotou et al. used SCL25 short form of the Symptom Checklist-90-Revised (SCL-90-R) to examine the validity of NEO-FFI. The results of this Inventory on 208 American students in 3 months showed that reliability is from 0.75 to 0.83 (23).

In Iran, Roshan Chelsi & et al reported simultaneous validity using the relationship of this Inventory with SCL-90-R. The results showed that there is a significant relationship between neuroticism and all the dimensions of SCL-90-R, which indicates the validity of this questionnaire (36). Elhaghi reported the Cronbach's alpha for each of the factors of neuroticism, extroversion, openness to experience, agreeableness and conscientiousness to be 0.70, 0.72, 0.71, .41 and 0.75, respectively (37).

Cognitive Flexibility Inventory (CFI): The Cognitive Flexibility Inventory was developed by Dennis and Vander Wal in 2010 and is used to measure cognitive flexibility. CFI consists of 20 items that are scored on a 7-point degree from strongly disagree (1) to strongly agree (7). Dennis and Vander Wal used the simultaneous validity method to examine the validity of this tool and obtained the correlation of this questionnaire with Beck Depression Inventory and Martin Cognitive Flexibility Scale to be 0.39 and 0.75, respectively. They also reported the reliability of CFI using the Cronbach's alpha method, 0.91 and test-retest reliability, 0.81(29).

In Iran, factor analysis method show that the items of CFI are two factors of problem-solving processing (13 items) and controllability

perception (6 items). The reliability of CFI using Cronbach's alpha method for the whole questionnaire and two factors of problem solving and controllability perceptions was obtained to be 0.89, 0.77 and 0.81 respectively. Also, they assessed the validity of the questionnaire using simultaneous validity method and reported the correlation between the total score of the questionnaire and the two factors of problem solving and perception of controllability with the score of Beck Depression Inventory to be -0.66, -0.57 and -0.59, which indicates the good validity of CFI for measuring cognitive flexibility (38).

Results

All participants in present research were men with age mean of 47.18 and as an intercity driver is working at terminals in Tehran. Financially, 29% drivers less 2 million toman, 42.4% 2 to 3 million toman, 25.7% 4 to 5 and 2.9% more 5 million toman per month. 27.6% participants under diploma, 51% diploma, 6.7% up diploma and 14.8% B.A. 7.1% participants 1 to 3 years, 20% participants 4 to 6 years, 21.9% participants 7 to 9 years and 51% more 10 years have job experience. 11.9% participants were single and 87% participants were married.

Table 1. Descriptive indices of the variables

	Variables	Min	Max	M	SD
Cognitive flexibility	Cognitive flexibility	31	134	96.92	17.49
	Problem solving	24	91	64.89	11.17
	controllability	6	42	27.15	8.57
Driving behavior	Driving behavior	52	188	87.58	22.15
	Lapses	21	72	36.77	9.94
	Errors	9	44	14.42	4.60
	Violations	17	66	30.71	8.71
Personality traits	Neuroticism	18	50	34.05	6.87
	Extroversion	28	55	40.56	5.23
	Openness	26	51	35.56	3.84
	Agreeableness	29	55	41.18	5.12
	Conscientiousness	28	54	41.68	4.75

Table 2. Values of K-S, Skewness, Kurtosis

Variables	K-S	Skewness	Kurtosis
Cognitive flexibility	.166	-.410	-.057
Problem solving	1.035	-0.515	0.343
Controllability	1.071	-0.396	-0.790
Driving behavior	.0680	1.143	0.395
Lapses	1.04	0.784	0.578
Errors	.921	.527	.426
Violations	0.345	1.024	1.349
Neuroticism	.142	.088	-.736
Extroversion	.204	.063	-.501
Openness	.152	.208	.724
Agreeableness	.368	-.015	-.090
Conscientiousness	.191	-.195	-.451

Table 3. Collinearity test of independent variables

Independent variables	Tolerance	VIF
Neuroticism	.822	1.22
Extroversion	.657	1.52
Openness	.980	1.02
Agreeableness	.733	1.36
Conscientiousness	.529	1.89

The mean of cognitive flexibility ($m=96.92$), Problem solving ($m=64.89$), controllability ($m=27.15$), high risk driving behavior ($m=87.58$), lapses ($m=36.77$), errors ($m=14.42$), violations ($m=30.71$), neuroticism ($m=34.05$), extroversion ($m=40.56$), openness to experience ($m=35.56$), agreeableness ($m=41.18$) and conscientiousness ($m=41.68$). As be observed, the mean of personality traits of agreeableness and conscientiousness were higher than other personality traits. Also, the mean of cognitive flexibility and components were low. The results of the Kolmogorov-Smirnov test showed that all the research variables have a normal distribution. The significance level of K-S test for all the research variables was higher than .05 ($p < .05$), which indicates that the distribution of variables is normal. An examination of kurtosis and skewness showed that values have been obtained in the range of +2 to -2. Thus, all the variables have a normal or near normal distribution. In sum, distribution of all the variables can be considered normal or almost normal.

Therefore, parametric tests such as Pearson correlation and structural equation modeling can be used.

The tolerance values and the variance inflation factor are presented in Tables 4. As it can be

observed, all the values of tolerance are greater than .5 and all the values of variance inflation are less than 2. It indicates that there is no severe or problematic correlation between the independent variables, and the independent variables are not highly correlated. Therefore, the assumption of non-linearity of independent variables is confirmed.

Table 4. Structural Model Fit indices

Fit indices	Acceptable domain	Statistics
χ^2		95/32
χ^2/df	Less than 5	2/58
CFI	Greater than 0.90	0/92
IFI	Greater than 0.90	0/94
GFI	Greater than 0.90	0/91
AGFI	Greater than 0.90	0/92
RMSEA	Less than 0.08	0.07

According to the findings of Table 4, experimental model indicates with the conceptual model. the values of the two indices of GFI =0.91 and AGFI =0.91 are close to one. Also, the RMSEA index indicates the suitability of the model's fit. The results of the structural equation modeling (Table 5) showed that all the model relationships are significant and all the seven relationships in the model were confirmed ($p < .05$).

Table 5. Paths and their standard coefficients in the research's final model

Type of effect	Standardized coefficient	t value	P value	Result
Neuroticism→ problem solving	-.32	7.24	<.001	Confirmed
Neuroticism→ Controllability	-.71	13.37	<.001	Confirmed
Extroversion→ problem solving	.67	11.20	<.001	Confirmed
Extroversion→ Controllability	.39	7.85	<.001	Confirmed
Conscientiousness→ problem solving	.55	10.17	<.001	Confirmed
Conscientiousness→ Controllability	.47	9.13	<.001	Confirmed
Neuroticism→ Lapses	.34	6.94	<.001	Confirmed
Extroversion→ Errors	-.37	7.63	<.001	Confirmed
Conscientiousness→ Violations	-.45	8.97	<.001	Confirmed
problem solving → Lapses	-.04	1.14	.257	Refuse
problem solving → Errors	-.47	9.20	<.001	Confirmed
problem solving → Violations	-.23	4.16	<.001	Confirmed
Controllability → Lapses	-.14	2.13	<.001	Confirmed
Controllability → Errors	-.08	1.62	.102	Refuse
Controllability → Violations	-.41	7.43	<.001	Confirmed

According to the findings of Table 5, the effect of Neuroticism on problem solving and Controllability is negative and the effect of extroversion and Conscientiousness on problem solving, and Controllability is positive. the effect of Neuroticism on high risk driving behaviors is positive and the effect of

extroversion and Conscientiousness is negative. Thus, it could conclude the personality traits of Neuroticism, extroversion and Conscientiousness directly effect on cognitive flexibility and high-risk driving behaviors ($p<.01$).

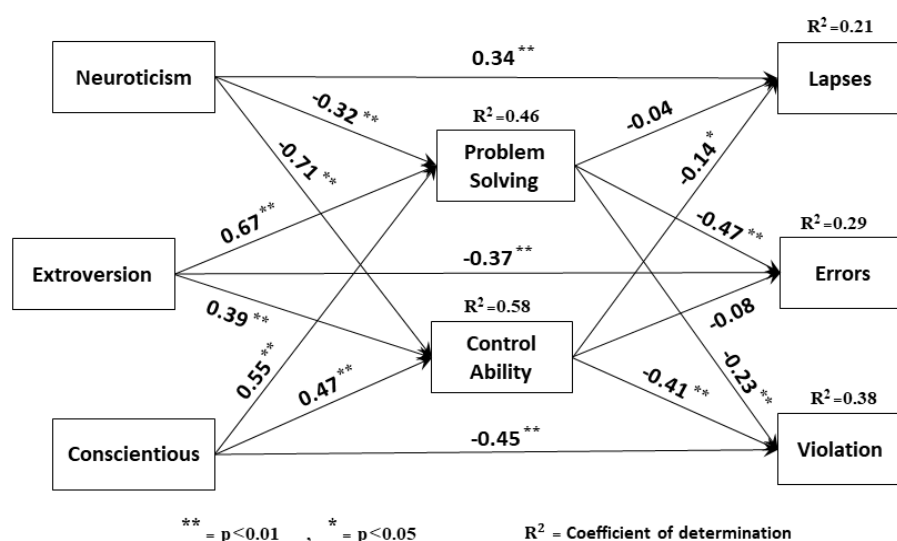


Figure 1: The final model of research

Figure 1 shows the modified model in the standardized coefficients. As it can be seen in the figure above, the standard coefficients of the direct paths are significant ($p < .01$), but the

paths of problem solving to Lapses and Controllability to Errors aren't significant.

Table 6. Bootstrap results for the indirect effects of cognitive flexibility

variables	Indirect effect		P value
	max	min	
Neuroticism→ problem solving→ Errors	-.43	-.26	$P < .05$
Neuroticism→ problem solving→ Violations	.27	.12	$P < .05$
Neuroticism→ Controllability→ Lapses	.53	.39	$P < .05$
Neuroticism→ Controllability→ Violations	-.67	-.51	$P < .05$
Extroversion→ problem solving→ Errors	.32	.15	$P < .05$
Extroversion→ problem solving→ Violations	.44	.35	$P < .05$
Extroversion→ Controllability→ Lapses	.25	.20	$P < .05$
Extroversion→ Controllability→ Violations	.78	.41	$P < .05$
Conscientiousness → problem solving→ Errors	.33	.22	$P < .05$
Conscientiousness → problem solving→ Violations	-.77	-.58	$P < .05$
Conscientiousness → Controllability→ Lapses	.59	.43	$P < .05$
Conscientiousness → Controllability→ Violations	.45	.31	$P < .05$

The results of bootstrap in table 6, indicated that there is no zero in confidence intervals and all the indirect paths are significant with the mediating of cognitive flexibility. This means that the personality traits of neuroticism, extroversion, and conscientiousness have an indirect effect on the errors and violations of driving behavior through problem solving. Also these personality traits have an indirect effect on the lapses and violations of driving behavior through controllability.

Conclusion

In order to examine the mediating role of cognitive flexibility on the relationship between personality traits and high-risk driving behaviors, a theoretical model was proposed and tested using structural equation modeling. The results showed that the proposed model have a good fit. The findings showed that the personality trait of neuroticism, extroversion,

and conscientiousness have direct and indirect effects on high-risk driving behaviors (lapses, errors, and violations) through the components of cognitive flexibility (problem solving and controllability). Due to the novelty of the research, there is a paucity of research on the subject, and no research has examined the mediating role of cognitive flexibility in the relationship between the personality traits and high-risk driving behaviors, so far. Therefore, we cite studies that deal with the dyadic relationship between these variables.

The findings of this study are in line with the findings of research (18, 19, 20, 25, 39,40, 41). These researchers pointed out that the personality trait of neuroticism related to high-risk driving behavior. Other researchers concluded that the personality traits of extroversion and conscientiousness have a direct and positive relationship with cognitive flexibility; whereas, neuroticism has a direct

and negative relationship with cognitive flexibility (25, 27, 42, 43, 44, 45, 46, 48, 49).

Neuroticism leads to an increase in high-risk driving behaviors by reducing the drivers' cognitive flexibility. But, extroversion and conscientiousness decrease high-risk driving behaviors by increasing the cognitive flexibility in drivers. Neuroticism affects the driver's perception of the environment and driving behaviors and deprives him of the possibility of appropriate and measured reactions. Such drivers are more likely to be involved in accidents due to their low concentration, mental conflict with their worries, a lack of cognitive flexibility, and driving errors, lapses, and violations. Also, these conflicts reduce cognitive abilities and their functions including decision-making, and their judgments, which ultimately lead to, increased errors and high-risk driving behaviors and road accidents. The neurotics' impulsiveness also creates this belief and attitude in a person that the purpose of driving is to gain more excitement and stimulation. Thus, it causes the driver to engage in high-risk driving, high speed, and violation of the rules (13).

high-risk drivers scored lower on extroversion, conscientiousness, and agreeableness (50). When they faced difficult and threatening situations on the road, extroverted and conscientious drivers who have cognitive flexibility can check the situation, organize information and choose the best solution to deal with the situation. As a result, it can be said that extroverted and conscientious drivers have high problem solving and cognitive flexibility. They are less likely violate the traffic rules because they find it easier to control and deal with

difficult situations and engage in high-risk driving behaviors. Based on the above, it is clear that driving is a complex task in which personality traits and cognitive abilities play an important role (51). Abnormal personality traits along with reduced cognitive flexibility in drivers increase high-risk driving behaviors and road accidents' rates (52).

Based on the results of this study, it is suggested that the current research be conducted on various samples of drivers such as taxi drivers, intercity buses, and private vehicle drivers and compare the results obtained from these samples to identify and prevent the factors affecting high-risk driving behaviors and accidents. Also, by identifying the role of human factors in high-risk driving behaviors and its motivating factors, it is possible to develop psycho educational interventions to encourage safe driving behaviors in drivers. The results of this study showed that personality traits and cognitive flexibility affect driving behavior; therefore, it is recommended that personality traits and cognitive flexibility of individuals be evaluated when training driving and granting or renewing a license. Furthermore, neurotic individuals who lack of cognitive flexibility should be referred to counseling centers for education and treatment in order to reduce the risk of road accidents.

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