

Risky behavior, personality traits and road accidents among university students

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The personality traits that mediate risky driving and accidents among university students drivers were investigated. Study 1 (N=132) tested for the relation between risky behaviors and personality (16PF-5 second order dimensions). Three factors were extracted concerning risky driving: driving errors of commission, distraction, and driving errors of omission. Individuals with low self-control and high levels of anxiety were more prone to commit distractive behavior and driving errors of omission. Low self-control and high independence levels were associated with driving errors of commission. In study 2 (N=540), we tested if the number of road accidents for which an individual has been responsible was related to risky driving behavior. Drivers who committed more accidents presented higher scores in three new risky driving factors obtained: reckless driving, impaired concentration and division of attention.

Key words: Risky driving, personality, accidents, behavior.

Comportamiento de riesgo, rasgos de personalidad y accidentes de carretera en estudiantes universitarios. En este estudio se investigaron los rasgos de personalidad relacionados con la conducción de riesgo y los accidentes en estudiantes universitarios. El primer estudio (N=132) evaluó la relación entre los comportamientos de riesgo y la personalidad (16PF-5 dimensiones de segundo orden). Tres factores fueron extraídos en relación con la conducción de riesgo: cometer errores de conducción, distracción, errores de omisión en la conducción. Los individuos con bajo autocontrol y altos niveles de ansiedad eran más propensos a tener comportamientos distractores y cometer errores de omisión en la conducción. Mientras que sujetos con bajo autocontrol y altos niveles de independencia se asociaron con el factor cometer errores de conducción. En el segundo estudio (N=540) evaluamos si el número de accidentes de tráfico, de los que una persona ha sido responsable, está relacionado con el comportamiento de riesgo en la conducción. Los resultados muestran que los conductores que cometen más accidentes presentan puntuaciones superiores en tres nuevos factores de riesgo en la conducción: conducción temeraria, concentración afectada y división de la atención.

Palabras clave: Conducción, personalidad, accidentes, comportamiento.

The role of personality in risk research remains unclear despite a plethora of related research (Iversen & Rundmo, 2002). Although a great deal of research has considered the problem of traffic psychology (Arthur, Barrett & Alexander, 1991; Elander, West & French, 1993; Evans, 1991; Golding, 1983; Hansen, 1988; Hilakivi, Veilanti, Asplund, Sinivuo, Lattinen & Koskenuvo, 1989; Lester, 1991; McGuire, 1976, Peck, 1993; Signori & Bowman, 1974), the contribution of psychology to the traffic policies has been repeatedly neglected in some European countries such as Portugal (Santos, Correia, Gomes, Caldeira & Cunha, 1995). According to Manstead (1993), in the analysis of rule infringement, socio-cognitive variables such as attention (Theeuwes, 1993), perception (Manstead, 1993; Owsley, Ball, Sloane, Roenker & Bruni, 1991) and judgment processes (Cavallo & Laurent, 1988) should be considered. Additionally, a study with a sample of 1000 drivers revealed that 11 variables (3 perceptive and 8 psycho-motor) were valid predictors of car accidents since they explained 85% of total variance of road accidents (Alves & Silva, 1993). A set of researches developed by Özkan, Lajunen, Chliaoutakis, Parker and Summala (2006) revealed that safety skills (e.g., “conforming to the speed limits”) and perceptual-motor skills (e.g., “fluent driving”) are important predictors of the number of road accidents across different countries.

According to Santos (1995), psychological variables (such as personality) are associated with high levels of inter-individual variability, which can have a significant impact on the driving behavior. Social context has also a very important role as it contributes to aggressive behavior emergence (DeRidder, Schrujjer & Rijsman, 1999). Recent studies emerged (Dahlen & White, 2006; Horta, 2005), revealing that accidents among teenagers and young adults are related to high trait anxiety levels and suicidal tendencies. Moreover, these drivers present a self-destructive psychopathology as well as a poor familiar structure. In this sense, the vehicle is seen as a Self prolongation (Arnett, 1990) and individuals are compelled to test new “personal potentialities” closer to the infringement of the law (Sousa, 2005). Overall, those studies did not account for the question of responsibility. Also, drivers who regard their vehicles as a way of expressing emotions have higher extroversion levels. As Arnett (1990) puts it, the statement “Me and my car” is transformed in “Me in my car” and the road is understood as a “social scene” where there is information exchange with other drivers (Sousa, 2005).

In this sense, driving is associated with feelings of power that bring to mind individual fantasies of competition, in order to obtain gratification, credit and denial of reality (Girão & Oliveira, 2005; Schreer, 2002). Among different traits of personality, it seems that sensation-seeking personality factor emerges as good predictor of self-reported driving violations. Personality traits such as sensation-seeking, impulsiveness, and boredom-proneness seem to be good predictors of crash-related conditions,

aggressive driving, risky driving, driving anger expression and self-reported driving violations (Dahlen, Martin, Ragan & Kuhlman, 2005; Iversen & Rundmo, 2002; Schwebel, Severson, Ball, Karlene & Rizzo, 2006). In fact, personality factors such as sensation seeking, trait driving anger, and narcissistic personality traits have received considerable attention in the area of risky driving behavior (Arnett, Offer & Fine, 1997; Dahlen & White, 2006; Deffenbacher, Oetting & Lynch, 1994; Jonah, 1997; Schreer, 2002).

A study developed by Miles and Johnson (2003) showed that aggressive drivers showed no significant differences regarding the following dimensions of personality: agreeableness, conscientiousness, and neuroticism. Certain emotional states such as irritation, sadness, immaturity, aggressiveness, search for intense sensations, low tolerance to frustration, insecurity and low self-esteem are personality characteristics associated with risky driving behavior (Lajunen & Parker, 2001; Miles & Johnson, 2003; Schreer, 2002; Sousa, 2005). These individuals suffer from lack of control and follow their impulses in an unrepressed manner (Deffenbacher, Fletti, Richards, Lynch & Oetting, 2003). Higher anger drivers seem to engage in a series of riskier types of behavior. A study by Özkan and Lajunen (2006) revealed that being male is significantly associated with more Highway Code violations. Moreover, men report more aggressive driving behavior (Deffenbacher *et al.*, 2003). By using a sample of 21 studies, a meta-analysis undertaken by Bogg and Roberts (2004) revealed that conscientiousness traits were negatively related to all risky health-related behaviors.

Self-control was usually associated with conscientiousness-related traits and was negatively associated ($r = -.25$) to risky driving. This meta-analysis also revealed that self-control was negatively associated with specific behaviors of drunk driving ($r = -.28$) and speeding ($r = -.25$).

According to Barros and Loureiro (1997), infringements of road traffic laws are usually committed by male individuals who have had a driving license for more than 2 years or less than 6 months, drive an average of 200 km a week and who have not been fined for road traffic offenses in the last 5 years. Males behave in a riskier manner than females and these risky types of behavior tend to decrease with age (Peck, 1993). Moreover, the meta-analysis developed by Bogg and Roberts (2004) showed that drivers under 30 years of age exhibited lower self-control levels ($r = -.27$) than older drivers ($r = -.13$). It seems that deviant driving styles are associated with being male and young (Elander *et al.*, 1993).

To summarize, it is clear that social, cognitive and personality variables influence the driving process and, consequently, the absence or existence of accidents. In line with previous studies (Arthur & Graziano, 1996; Blanchard, Barton & Malta, 2000; Dahlen & White, 2006; Jonah, 1997; Lajunen & Parker, 2001; Schwebel *et al.*, 2006) driver's personality is a good predictor of dangerous driving behavior.

Similarly, links between risky driving and motor vehicle accidents have previously been established (e.g., Dula & Ballard, 2003; Miles & Johnson, 2003). The two studies reported below sought to extend the findings in this area by investigating the following questions, concerning samples of university student drivers:

Study 1: Are risky driving behaviors related to personality variables? If so, which risky driving behaviors are associated with which aspects of personality?

Study 2: Is the number of road accidents for which an individual has been responsible related to risky driving behavior? If so, which are the relevant risky driving behaviors?

METHOD: STUDY 1

Participants

Study 1 sample consisted of 132 adults (91 female, 41 male) with an average age of 27.2 years (SD=8.2, range =18 to 51 years). Participants were undergraduate students at a private university in Lisbon (Portugal), the majority of which (87.1%) were adults under 39 years, and all had a valid driving license. On average, participants had a driving experience of 7.7 years (SD=7.1, range 1 to 34 years) and had a mean of 180 thousand kilometers covered. All subjects participated voluntarily and anonymously in this study.

Instrument and Procedure

In order to assess participants' personality, we used the fifth version of the Sixteen Personality Factors (16PF-5) developed by Cattell, Cattell and Cattell (1993) and translated and adapted by a Portuguese institution (CEGOC-TEA, 1998). This questionnaire consisted of 16 primary factors which can be combined into five global scales: Extroversion (Ex), Anxiety (An), Tough-mindedness (Tm), Independence (In) and Self-control (Sc). The Portuguese version was used which has the same number of items as the original English version. Internal consistencies for the 16 factors range from .47 to .85 which, are equivalent to those reported by Conn and Rieke (1994). The questionnaire was administrated and supervised in small groups of about 15 participants per session. Previously, relevant instructions were provided to participants. For each of the 170 items self-report questionnaire, participants had to choose between three answers: "yes", "no" and "?".

Risky driving variables

As well as stating personal data, subjects had to answer a short questionnaire concerning their driving behavior, rated on a 4-point frequency scale ranging from 0 (never) to 3 (frequently). This instrument was used to assess risky driving behavior and

considered the following seven variables: driving after drinking alcohol, breaking speed limits, driving during bad weather conditions, driving while using a mobile phone, overtaking in dangerous situations, distractive behavior, and little or no signaling light use. Despite the existence of similar instruments (Duda & Ballard, 2003; Lajunen & Parker, 2001), the authors developed a specific one to account for the Portuguese population.

RESULTS

Gender differences in demographical variables

Significant gender differences were found -using 't' tests- for the following variables: age, number of years with a valid driving license and total distance driven since obtaining a driving license (number of kilometers). Details of these results are shown in table 1.

Table 1. Means and standard deviations for biographical variables analyzed by gender

		Mean	Std. Deviation	t-test	Sig. (2-tailed)
Age	Female	26.0	7.9	-2.39	.018
	Male	29.7	8.4		
Nr of years with driving licence	Female	6.8	7.3	-2.23	.027
	Male	9.7	6.3		
Total nr of kilometers driven	Female	127,015	228,764	-2.02	.045
	Male	284,800	630,620		

Results show that, on average, men were significantly older, had been in possession of a driving license for significantly longer and had driven a significantly greater distance than women.

Factor analysis of types of risky driving behaviors

A maximum likelihood factor analysis was applied to the seven risky driving variables and this showed a Kaiser-Meyer-Olkin (KMO measure) value of .810, which indicated an adequate amount of common factor variance to be analyzed. After finding that two factors -using Kaiser's criterion ($\lambda > 1.00$)- were insufficient to give a good fit, we forced the extraction of three factors, which explained 57.4% of total variable variance. The goodness of fit test was not significant, which indicated that three factors offered a good fitting solution. Moreover, there were no residuals with values in excess of 0.05. The initial solution was rotated in various ways and the form of rotation giving the best approximation to simple structure was achieved by means of an oblique rotation (Promax with K=4). This yielded an interpretable Pattern matrix shown in table 2.

Table 2. Pattern matrix for risky driving dimensions

Risky Driving Dimensions	Factor 1	Factor 2	Factor 3
Driving after drinking alcohol	.648	.008	.016
Breaking speed limits	.773	-.076	-.077
Driving during bad weather conditions	.450	-.083	.154
Driving while using a mobile phone	.472	.201	-.017
Overtaking in dangerous situations	.677	.035	.018
Distractive behavior	-.010	1.002	.006
Little or no signaling light use	.011	.009	.994

As shown in table 2, the first factor has loadings on the first five aspects of risky driving behavior. Situations such as driving after drinking alcohol, breaking speed limits, driving during bad weather conditions, driving while using a mobile phone and overtaking in dangerous situations are clearly risky types of behavior that a driver does but should not do. Thus, Factor (1) was labeled “driving errors of commission”. Factor (2) is associated with two aspects of risky driving: distractive behavior and use of mobile phone and was labeled “distraction” (errors of attention). Finally, Factor (3) is also associated with only one dimension -little or no signaling light use- that represents something that the driver fails to do but should do. This dimension was named “driving errors of omission”, and more specifically means lack of appropriate signaling during driving.

In order to test if risky driving behaviors were related to personality, a set of regression analyses (enter method) was also conducted. The three risky driving factors obtained in the previous exploratory factorial analysis were used as dependent variables and the five second order personality domains from the 16PF-5 (Independence, Anxiety, Self-control, Extroversion and Tough-Mindedness) were the predictor variables.

In the first regression analysis -factor “errors of commission”- we examined the impact of the five first order personality dimensions on the factor “driving errors of commission”. Only two of the predictor variables (Independence and Self-control) were significant: Independence ($\beta=.199$, $p<.05$) and Self-control ($\beta=-.426$, $p<.001$). In this case, Independence predicts positively and self-control correlates negatively with the factor “driving errors of commission”. Overall, the five personality factors accounted for 16.4% of the variance of the factor “driving errors commission” (adjusted $R^2=.164$).

Secondly, we analyzed the effect of personality traits on the factor “distraction”. Once again, two of the predictor variables (Anxiety and Self-control) were significant: Anxiety ($\beta=.222$, $p<.05$) and Self-control ($\beta=-.467$, $p<.001$). Thus, Anxiety was positively related with distraction and, in contrast, Self-control was negatively associated to distractive behaviors. Overall, personality traces accounted for 13.2% of the model’s explained variance (adjusted $R^2=.132$).

Lastly, we examined the relations between personality and the factor “driving errors of omission”. The same predictor variables (Anxiety and Self-control) were significant: Anxiety ($\beta=.312$, $p<.01$) and Self-control ($\beta=-.435$, $p<.001$). In this case, the driving errors of omission factor were positively influenced by anxiety. On the contrary, this factor was negatively related with self-control. Overall, those variables accounted for 16.4% of the explained variance (adjusted $R^2=.164$).

DISCUSSION

Previous research in the field of risky driving behavior has focused primarily on factors such as socio-cognitive variables (Manstead, 1993), though stress and aggressiveness issues are becoming increasingly popular (Arthur *et al.*, 2001; Dahlen & White, 2006; Lajunen & Parker, 2001; Lester, 1991). More recently, emotional status, self-esteem (Schreer, 2002; Sousa, 2005) and anxiety (Horta, 2005) have become prominent in the literature. However, in a Portuguese context, little research has explored how personality traits may be related to risky driving variables. Our research data -using broad personality dimensions- suggests that multiple dimensions of personality may be important in understanding why some individuals engage in various risky driving types of behavior.

In order to facilitate the interpretation of the model, the seven risky driving behaviors were initially submitted to an exploratory factor analysis (maximum likelihood method, Promax rotation, $K=4$). Three factors were extracted: “driving errors of commission”, “distraction” and “driving errors of omission”. The first of these factors includes types of behavior such as breaking speed limits, which is one of the most consistently powerful predictors of accident involvement (Elander *et al.*, 1993; Jonah, 1997; McKenna & Horswill, 2006). Another dimension included in “driving errors of commission” deals with the fact of driving after drinking alcohol, which is also a crucial risky driving dimension (Curry, Ludman, Grothaus, Donovan & Kim, 2003; Jonah, 1997). Other equally important variables were included in the first factor: driving during bad weather conditions, driving while using mobile phone and overtaking in dangerous situations. Secondly, the factor “distraction” is associated to the distractive behavior. A study conducted by Deffenbacher *et al.* (2003) lead to the conclusion that lapses of concentration are associated with risky driving behavior. Finally, a third dimension -labeled “driving errors of omission”- is associated to little or no signaling light use.

Considering these risky types of behavior, we ought to understand which personality factors predicted the risky behavior related factors obtained in the exploratory factor analysis. Each type of risky driving factor was significantly predicted by low Self-control. This personality trait appears to be negatively associated

with the three types of risk behavior, suggesting that self-controlled personalities avoid risky driving errors of commission, distraction and driving errors of omission.

These results are consistent with the meta-analysis developed by Bogg and Roberts (2004), in which risky driving behaviors and self-control exhibited negative correlations of $-.25$. These authors suggest that stable cognitive processes are necessary to provide a safer kind of driving behavior. Also, self-controlled personalities are less prone to cause driving accidents. This fact is in line with other work by Hansen (1988) and Sousa (2005), since individuals who do not repress impulses are more prone to have accidents. Drivers with more self-control are more likely to avoid risky situations such as driving after drinking alcohol, breaking speed limits, and driving while using mobile phone.

Self-control is also negatively associated to the “distraction” factor, given the fact that distraction is clearly a risk factor for loss of control or lack of control. We have found a negative relation between self-control and “driving errors of omission”. Arguably, self-controlled personalities are more likely to be alert, thus not forgetting important driving actions. Moreover, Dahlen and White (2006) argue that personality dimensions of agreeableness and openness to experience are important predictors of risky driving behaviors.

Our results also revealed that anxiety was significantly related to two of the three types of risky driving behavior factors. It seems that individuals with high anxiety levels drive in a riskier way. Other research conducted by Horta (2005) also relates risky driving behavior with this personality trait. Anxiety can lead to a series of uncontrolled and disturbed reactions usually associated with strong levels of emotional instability. As Horta (2005) puts it, individuals who exhibit greater anxiety seem to be more disturbed and therefore develop a riskier type of behavior associated with accidents. Moreover, the extroversion and euphoria associated with drivers’ participative environment can lead to the violation of traffic rules, therefore having more accidents. As is shown in our results, anxiety is associated with distraction and one reasonable explanation might be the fact that anxious people are more concerned with their instability and problems and this reflects in higher levels of distraction. On the other side, individuals with high anxiety levels are associated to “driving errors of omission”, since deranged minds are more likely to forget important actions.

Finally, independence was significantly related to “driving errors of commission” factor. These findings suggest that the individuals with critic behavior and low levels of submission have a greater tendency to drink alcohol, which reveals a libertine behavior that disregards society values and norms. What Cattell and cols. (1993) first referred to as a critic behavior characterizes independent people and emphasizes risky behavior.

It is important to notice some limitations of the present study. First, we tried to establish relationships between variables. As such, it is impossible to determine the causal pathway -if there is one- between personality and risky driving behavior. Moreover, a large percentage of variance in risky driving factors remained unexplained. We acknowledge that other constructs such as cognition, affection and psycho-motor variables may also play an important role, as described by Manstead (1993).

As mentioned above, risky driving behavior variance is only partially explained by personality factors. Thus, this investigation would be incomplete if we did not account for other variables such as the number of accidents involved and its responsibility. We take that into account in the next study.

METHOD: STUDY 2

Participants

Study 2 sample consisted of 540 adults (297 female, 243 male) with a mean age of 32.9 years (SD=11.4, range =18 to 76 years). Participants were undergraduate students at a private university in Lisbon (Portugal), the majority of whom (65.9%) were young adults (aged from 18 to 35 years) and all had a valid driving license. On average, participants had a driving experience of 11.9 years (SD=9.5, range 1 to 51 years) and had a mean of 239,947 kilometers covered (about 149,966 miles). In this second study, we included the number and type of accidents the participants were involved in since obtained a valid driving license. These were arranged into five categories: no accidents (45.4%), one or more accident for which the participant was not responsible (19.6%), one accident for which the participant was responsible (23.1%), two accidents for which he/she was responsible (8.3%) and, lastly, three or more accidents for which the participant was responsible (3.5%). All subjects participated voluntarily and anonymously in this study.

Risky driving variables

As in study 1, subjects had to answer a short questionnaire concerning their driving behavior, rated on a 4-point scale ranging from 0 (never) to 3 (frequently). This instrument was again used to assess risky driving behavior, but now considering the following nine variables: driving after drinking alcohol, breaking speed limits, driving during bad weather conditions, driving while using a mobile phone, overtaking in dangerous situations, distractive behavior, little or no signaling light use, somnolence and reading while driving. Similarly to study 1, the authors adopted a specific questionnaire designed for the Portuguese population.

RESULTS

First, we tested for significant gender differences concerning the nine risky driving behaviors. Thus, an independent samples t-student test was conducted. Significant differences were found in six of the nine risky driving behaviors, with male drivers scoring higher on these traffic violations: driving after drinking alcohol ($p < .001$), breaking speed limits ($p < .001$), driving during bad weather conditions ($p < .001$), driving while using mobile phone ($p < .05$), overtaking in dangerous situations ($p < .001$) and, finally, somnolence ($p < .001$). To understand specific differences concerning the number and type of accidents, we conducted a χ^2 analysis. As is shown in table 3, significant differences were found between those variables ($p < .001$).

Table 3. Distribution of gender differences and number/ type of accident

Gender	Number and type of accident					χ^2	Sig. (2-sided)
	Nr accidents	1 or more accidents (not responsible)	1 accident (responsible)	2 accidents (responsible)	3 or more accidents (responsible)		
F	165	52	64	12	4	40.776	.000*
M	80	54	61	33	15		

* $p < .001$

In this sample, more men than women have accidents of all kinds (i.e., accidents for which they were responsible as well, as those for which they were not responsible). In fact, 48.8% of men had at least one accident for which they were responsible compared to 29.2% of women. In terms of accidents for which participants were not responsible, the difference between the percentage of men (23.3%) and women (18.9%) is much smaller. These results are consistent with the view that men are more reckless drivers than women, though it must also be remembered that men in the sample had significantly more driving experience (longer possession of a license, more miles driven) than women. It is also important to report that more men than women have single and also multiple accidents (more than two).

As in study 1, we developed an exploratory factorial analysis in order to simplify the risky driving variables structure. A maximum likelihood exploratory factor analysis was applied to the nine risky driving variables and this showed a KMO value of .805 which indicated an adequate amount of common factor variance to be analyzed. Using Kaiser's criterion, three factors were extracted which explained 39.40% of total variable variance. For those three factors we obtained a Goodness of Fit using χ^2 which is highly significant ($p < .001$) which indicates a poor fit. However, there are 8% of residuals greater than .05. The initial solution was rotated in various ways and the form of rotation giving the best approximation to simple structure was achieved by means of

an oblique rotation (Promax with K=4). Although the lower fit, we used this pattern matrix since it yielded an interpretable result.

Table 4. Pattern matrix for risky driving dimensions

Risky Driving Dimensions	Factor 1	Factor 2	Factor 3
Overtaking in dangerous situations	.743	.052	-.228
Breaking speed limits	.654	-.100	.090
Driving after drinking alcohol	.536	-.009	-.066
Driving during bad weather conditions	.409	-.067	.141
Little or no signaling light use	.363	.156	-.040
Distractive behavior	-.024	1.006	.007
Somnolence	.203	.250	.213
Reading while driving	-.194	.026	.668
Driving while using mobile phone	.238	-.031	.472

According to the results of the exploratory factor analysis, three interpretable factors underlie the initial nine risky variables originated. The first factor had high loadings on five variables of risky driving behavior. These variables clearly represent Law infringements and are easily avoidable, at least from a cognitive point of view. As in study 1, we labeled Factor (1) as “reckless driving” which is very similar to Factor (1) in the first study but it includes lack of use of signaling (which appeared as a separate factor in Study 1). Factor (2) is also associated to distractive behavior. However, this factor has an additional two more variables that may reflect errors of attention: little or no signaling light use and somnolence. This second factor may be interpreted as distractive behavior and was labeled as “impaired concentration”. Finally, Factor (3) concerns two risky behaviors: reading while driving and driving while using mobile phone. These two dimensions reflect a deliberate action that affects proper handling of the vehicle, thus engaging in a risky behavior. According to this, this factor may be named “division of attention through secondary task performance”. In what concerns this last factor, we will state “division of attention” in order to facilitate reading.

To understand how these factors concerning risky driving behavior affect the number and type of accidents, we used a factorial MANOVA in order to test simultaneously two factors (i.e. independent variables) and three dependent variables. The factors were Gender (Female/Male) and Type and number of accident (None/ One or more accident not responsible/ One accident responsible/ Two accidents responsible/ Three or more accidents responsible). The three dependent variables were the risky driving factors (reckless driving, impaired concentration and division of attention through secondary task performance). The Box 'M' test is not significant ($p=.221$), which indicates adequate homogeneity of covariance matrices across all 10 cells of the design matrix. The Multivariate 'F' values were significant for the variable gender ($p<.001$, Power =.959) and Type and number of accidents ($p<.001$, Power>.999). The

‘F’ value for the interaction term was not significant ($p > .05$, Power = .305). The “Between subjects” results showed that, for all drivers included in the sample, male drivers had a significantly greater mean (.485) than females (.111) on the Reckless driving ($p < .001$, Power = .911). Male and female drivers did not differ significantly in their mean scores on the risky driving factor of Impaired concentration (female .371; male .246) or Division of attention (female .123; male .313). As regards differences among Type and number of accidents, the “Between Subjects” term in the MANOVA showed significant differences for each of the three Types of risky driving factors: reckless driving ($p < .001$, Power > .999), impaired concentration ($p < .001$, Power > .999) and division of attention ($p < .001$, Power > .999).

Figure 1. All risky driving factors scores

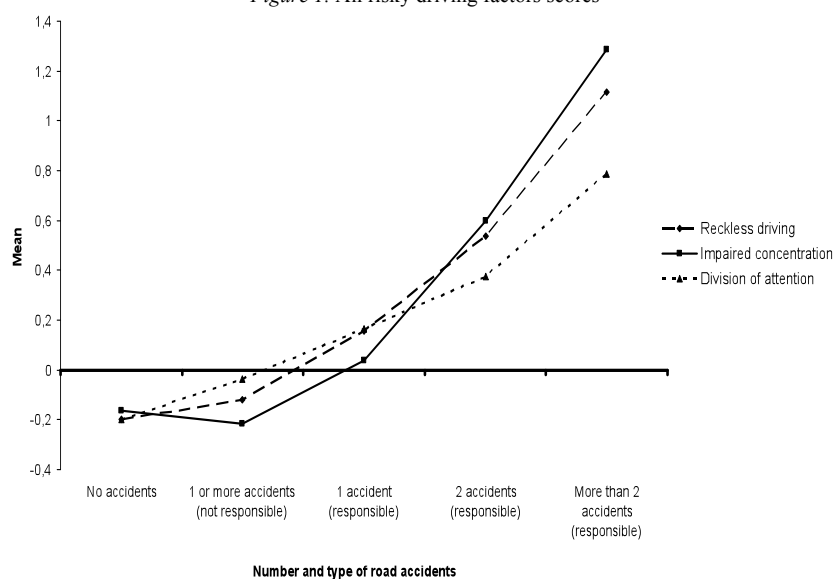
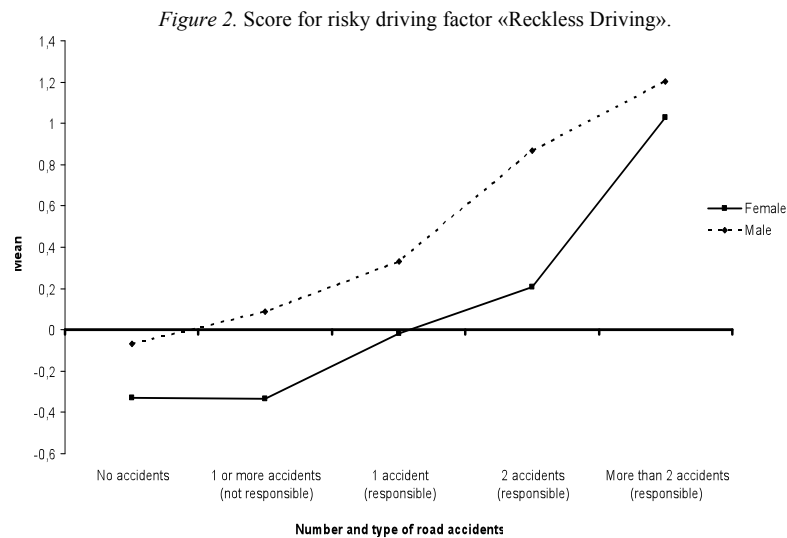


Figure 1 is readily interpretable in terms of generally higher risk (of each type) being associated with more accidents, especially those for which the individual was responsible. As is stated, the main effect for number and type of road accidents is significant for all three risk factors. But there is a significant sex difference only for reckless driving. The interaction terms are not significant.

Figure 2 clearly shows that, for all type and number of accidents, women have a lower mean value for reckless driving. Both graphs show a general tendency for the increase of the number and type of road accident across all three dimensions of risky drive behavior.



The "Between subjects" terms show that there are significant differences for each of the three dependent variables (reckless driving, impaired concentration, and division of attention) and the level of power for each is higher than .999. Only reckless driving shows a significant effect for Sex ($p=.001$, Power =.905). "Between subjects" results reveal that the Interaction term "Gender x Type and number of accidents" was not significant for any of the three risky driving factors.

DISCUSSION

Results suggested that generally men report significantly more accidents than female drivers. Our data is consistent with other research (Barros & Loureiro, 1997; Elander *et al.*, 1993). Those investigations report that men are more likely to infringe law (Barros & Loureiro, 1997; McCarthy, Pedersen, Thompsen & Leuty, 2006; Özkan & Lajunen, 2005; Tränkle, Gelau & Metker, 1990) and to have deviant driving styles such as expressing more aggressive behavior (Deffenbacher *et al.*, 2003; Elander *et al.*, 1993; Özkan & Lajunen, 2005). Our findings show an exception in the case of having one accident and being responsible for it. This fact may be explained because female drivers reported fewer lapses of concentration (Deffenbacher *et al.*, 2003). Those lapses of concentration affect driving, thus explaining the reason females are only represented in the situation in which the driver was involved in one accident and was responsible for it.

In what concerns the risky driving behaviors extracted factors, two dimensions were added: somnolence and reading while driving. The same data reduction procedure was conducted: an exploratory factor analysis, maximum likelihood method (Promax, $K=4$). The new variable somnolence integrates a second factor as well as the dimension distractive behavior. These two variables were named “impaired concentration”. The second new added variable -reading while driving- was also added to the same factor as driving using mobile phone. As these are variables concerning deliberate accessory behavior, the last factor was labeled “division of attention”.

We also studied differences between males and females concerning the three obtained risk factors-male individuals exhibit higher values in all three situations. Once again, results are consistent with other research (e.g., Barros & Loureiro, 1997; Deffenbacher *et al.*, 2003; Elander *et al.*, 1993) that shows males are more prone to risky behaviors. Our research also revealed that individuals who commit more accidents present higher scores in the risk factors. This shows that the variable number of accidents may be associated with the frequency of risky behaviors (Elander *et al.*, 1993; Peck, 1993). Thus, we suggest the implementation of training programs specially focused on drivers who are more likely to commit accidents. This is crucial, since certain types of skills training can influence drivers’ risky-taken behavior (McKenna, Horswill & Alexander, 2006).

It should be noted that the present study is cross-sectional, not longitudinal nor experimental, so we need to be cautious when inferring the directions of causality of the effects. Although our sample consisted of 540 adults, some groups may be not representative. For instance, people who committed 3 or more accidents (responsible) consisted only of 19 drivers (15 male and 4 female). This must be reconsidered in future research.

GENERAL DISCUSSION

Our research suggests that personality variables directly affect accidents and moving violations, even though this relationship has only been assessed indirectly through the intermediary of risky driving behavior. The self-report method was used in this investigation. Several researchers (Arthur *et al.*, 2001; Owsley, *et al.*, 1991; Szlyk, Severing, Fishman, Alexander & Viana, 1993) raised doubts concerning the reliability and validity of self reports for measuring drivers’ behavior. However, this method is appropriate and recommended when dealing with large samples, and may even give rise to good examples of measures with appreciable psychometric properties (e.g., Dula & Ballard, 2003).

There is also some criticism concerning the metrical properties of the 16PF instrument (Eysenck, 1986), since the question about the adequate number of factors that this personality inventory should have remains unanswered. However, efforts have been made in order to find an adequate representation of a second order structure with five personality factors. In spite of this, some researchers consider that the 16PF presents an adequate factorial validity (Rolland & Mogenet, 1996). The fifth edition of the 16PF confirmed the factorial hierarchical structure (Aluja & Blanch, 2004; Chernyshenko, Stark & Chan, 2001; Hofer, Horn & Eber, 1997; Noller, Law & Comrey, 1987; Rossier, Stadelhofen & Berthoud, 2004), with internal consistencies varying from .57 to .81 (Rolland & Mogenet, 1996). It also has demonstrated stability in the second order factors, in all English, French and Spanish languages (Aluja & Blanch, 2003). In spite of all the limitations of the 16PF -especially the poor internal consistency of some scales-, we selected this instrument since it is widespread and validated to the Portuguese population. Moreover, other authors (Hilakivi *et al.*, 1989) have adopted the same instrument to measure similar risky driving variables.

Following McIntyre (1993) argument, we argue that the selection and assessment of future drivers must include the existence of psychological variables. This should represent a contribution to the increase of qualifications and the decrease of the number of accidents. Thus, we propose to study the second order 16PF-5 personality dimensions and measure their impact in driving behavior variables. We also suggest the improvement of some traffic policies that often lack psychological studies and intervention programs (Santos *et al.*, 1995). Because certain types of skills trainers can influence drivers risky-taken behavior (McKenna *et al.*, 2006) we will recommend training to improve drivers' skills.

In short, the purpose of the present study is to explore the relationship between risky driving behavior and personality factors assessed on the 16PF-5. Thus, personality domains of the 16PF-5 could account for a significant portion of the variance in the characterization variables and in the risky driving variables. We specifically compared the 16PF personality profiles and those risky types of behavior. According to previous studies (Hilakivi *et al.*, 1989; Horta, 2005; Sousa, 2005) we expected that individuals with higher anxiety, extroversion and lower self-control had more risky driving behavior, thus having caused more accidents. Accident likelihood is related to personality characteristics associated with stress vulnerability, such as personal maladjustment, depression, anxiety, and aggression (Dula & Ballard, 2003; Miles & Johnson, 2003; Schreer, 2002). Moreover, individuals who rate themselves as more self-disciplined, responsible, and dependable are less prone to be involved in driving accidents (Arthur & Graziano, 1996).

This study contributes significantly to the understanding of the personality variables concerning risky driving behavior. As such, it allows a deeper comprehension

about the personality factors that originate the commitment of driving accidents. Thus, we complement previous research that did not account for personality dimensions (Barros & Loureiro, 1997; Horta, 2005; Manstead, 1993; Sousa, 2005; Theeuwes, 1993).

Despite the limitations found in our studies, we think that interesting results were obtained concerning personality aspects and risky driving factors. One main conclusion leads us to understand that self-control traits of personality predict negatively driving errors of commission, distraction and driving errors of omission. Anxiety is positively associated with distraction and driving errors of omission risky driving factors and, finally independence is only associated with driving errors of commission. These results found theoretical support, especially when associating positive anxiety and negative self-control with risky driving behaviors (Bogg & Roberts, 2004; Horta, 2005; Sousa, 2005).

We have to make a careful analysis because adjusted R square to the model (personality traits) seems to be lower and represents 16.4% for driving errors of commission and driving errors of omission. The model reveals even lower values regarding the factor Distraction (13.2%), in what concern the big five personality dimensions. A possible explanation has to do with the absence of other important issues, especially cognitive and psychomotor variables (Manstead, 1993). Study 2 revealed that the higher the number of accidents committed, higher the risky driving factor score. This is important in order to identify risk profiles and manage training processes as a means of reducing the risky types of behavior, which seem associated with accidents. However, this is not an experimental study, and future research could replicate it and also examine some of the potential hypothesis previously described. Moreover, we suggest that certain personality attributes (such as high anxiety or independence or low self-control) should be considered both in driving examinations and in the definition of drivers' risk profile - although we admit getting a driving license after passing the exam is a citizen's right. Furthermore, personality testing may be more appropriated to the selection of professional drivers than to the general public. According to this, specific skills training should be implemented in order to remediate risky-driving proclivities. On the other hand, we consider that these results may help insurance companies to outline drivers' profiles and perform a segmentation of individuals, and take into account the risk of each driver when conceiving a specific insurance plan.

Finally, in consonance with a previous study conducted by Iversen, Rundmo, and Klempe (2005), demonstrating that community-based health promotion in Norway high schools modified attitudes and self-reported risky driving behaviors, we recommend the worldwide implementation of youth training safe traffic programmes.

These programmes could be tailored to fit different personality types, in order to promote more responsible drivers and less risky driving behavior.

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