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Risky and aggressive driving in young adults: Personality matters

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ABSTRACT

Young, novice drivers constitute a disproportionate percentage of fatalities and injuries in road traffic accidents around the world. This study, attempts to identify motivational factors behind risky driving behavior, and examines the role of personality, especially sensation seeking, impulsivity and sensitivity to punishment/reward in predicting negative driving outcomes (accident involvement and traffic offences) among young drivers. Gender and driver's age are additional factors examined in relation to driving outcomes and personality. Adopting the contextual mediated model of traffic accident involvement (Sümer, 2003), the study is based on the theory that personality, age and gender represent distal factors that predict accident involvement indirectly through their relationship with stable tendencies towards aberrant driving behavior. Results from correlations and Structural Equation Modeling using AMOS 6 indicated that direct personality effects on driving outcomes were few, whereas personality had significant correlations with aberrant driving behavior, showing that personality is a distal but important predictor of negative driving outcomes. These high risk traits appear to be at a peak among young male drivers. Thus, personality is important in understanding aggressive and risky driving by young adults and needs to be taken into consideration in designing targeted accident prevention policies.

1. Introduction

Young drivers, particularly males, are at significantly higher risk of being involved in a road traffic accident compared to other age groups, according to research conducted in various nations (e.g. Massie et al., 1995; Panayiotou et al., 2008). In fact, teenagers have the highest crash rate per miles driven (Shope, 2006). This is a significant social problem since road traffic accidents are the main cause of death and disability for young people in various parts of the world including Europe (WHO, 2004; Cvijanovich et al., 2001). Identifying the reasons for the vulnerability of young drivers would contribute significantly to the public policy efforts to ameliorate the tremendous social and economical consequences of crashes.

Traffic accidents are fairly rare events that occur when several etiological factors operate synergistically, such as road conditions, the weather, vehicle adequacy and human factors. Drivers' behavior contributes significantly to 90–95% of crashes (Evans, 1993). Human factors include cognition (e.g. inattention and lapses in memory), fatigue, use of alcohol, failure to utilize protective measures such as seat-belts, and the tendency to drive in an aggressive or risky manner, along with demographic factors such as age and gender. When it comes to young drivers, risky and aggressive driving appears to be the dominant human factor that places them at risk (Reason et al., 1990). Additional variables include the fact that they are inexperienced but tend to over-estimate their driving skills while underestimating danger (Fisher et al., 2002), and that they tend to drive lower quality vehicles (Williams et al., 2006). It has been found that young drivers believe they are at lower risk to become involved in an accident compared to older adults and age-mates, when in fact their chances are much higher compared to older drivers. At the same time, they overestimate their driving ability compared to what is actually found to be the case in laboratory driving simulations (e.g. McKenna and Crick, 1991; Finn and Bragg, 1986; Brown, 1982).

Why do youngsters drive dangerously? In some respects their behavior is paradoxical: From a rational perspective, young people are in their physical and cognitive prime and may be more educated than older generations, so they should be better able to consider the risks. Current neurophysiological evidence, however, suggests that the brain, and particularly the prefrontal cortex regions associated with executive functions such as inhibition, reasoning and decision making, do not fully develop until the age of 25 (Paus, 2005). Therefore, young drivers may not be cognitively ready to manage the risks of such a complex task as driving, particularly under sub-optimal conditions, such as under the influence of alcohol or fatigue, to both

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of which youngsters are more susceptible (Shope, 2006). Furthermore, young drivers are also novices and lack driving experience, a factor that predicts a significant amount of variance in accident involvement, independently of age (Michiels and Schneider, 1984; Levy, 1990). This means that the driving task is more effortful and less automatized and makes substantial demands on attentional resources (Gregersen and Bjijrulf, 1996). In conditions that deviate from the well-learned and expected, youngsters may find it difficult to make the right decisions quickly (Deery, 1999).

However, with experience controlled for, young age is still very predictive of accident involvement, indicating that there is something about being young that explains the accident propensity of young people, especially of males. Developmental perspectives stress the significant milestones that a late adolescent/young adult must meet. Independence from the family, the development of personal identity and acceptance by peers are important goals for this age-group (Arnett, 2002). Owning a car and driving without the parents is almost a right of passage into adulthood in many western societies (Arnett, 2002). To the contrary, close parental supervision and gradual expansion of driving rights are protective factors against accident involvement (Hartos et al., 2000). Thus, driving for young drivers functions not only as a means of transportation but also as a way to mark their independence. They tend to drive in more risky and aggressive ways when they are around other male peers, perhaps as a way to demonstrate their manhood, fearlessness and competence (Jonah, 1986). Other theoretical perspectives suggest that the behavior of young drivers (particularly males) on the road should not be considered deviant, but expected, on the basis of evolutionary theory. According to Nell (2002) young males in all species operate in ways to attract females. They act fearlessly to demonstrate their ability to offer protection, and compete with other males to gain access to mates. Driving may be one of the few socially sanctioned ways to demonstrate masculinity and aggression in contemporary societies. This may partially explain the higher fatal accident rates when young males drive with male peers as companions (Chen et al., 2000). The social context may also promote this evolutionarily based behavior. Movies and the mass media glamorize fast cars and dangerous driving manoeuvres and associate them with masculinity, as in most contemporary action films (Shope, 2006; Arnett, 2002).

Thus, underestimation of risk, fearlessness, aggression and lack of consideration of negative consequences are among the factors that make young people dangerous drivers. These are inherent developmental characteristics associated with being young, but they are also personality traits that are normally distributed in the general population. People of all age groups who possess these characteristics to an elevated degree may be more risky drivers compared to age-mates with lower levels of these traits. Among young male drivers, although as a group they are considered the most risky, those who possess elevated degrees of certain personality characteristics are at even higher risk (Tsuang et al., 1985). Such traits include aggression, impulsivity and sensation-seeking (Rimmö and Åberg, 1999). As expected, these are at their prime in adolescence and young adulthood and decline with age (Wilson and Daly, 1985). Evidence from personality psychology supports the notion that certain traits decrease while others increase in intensity developmentally (Vaidya et al., 2002). Specifically, "negative" traits such as Neuroticism and impulsivity decrease with age, while prosocial characteristics, such as Agreeableness and Conscientiousness become more pronounced.

Personality does not predict traffic accidents directly (e.g. Furnham and Saipe, 1993; Ulleberg and Rundmo, 2003), but rather it influences accident involvement indirectly through driving behavior (Elander et al., 1993). Personality may be viewed as a disposition that fuels the driver's motivation for consistent risky or aggressive driving, which in turn leads to negative driving outcomes. Ample evidence exists linking personality characteristics to accident involvement and aberrant driving. Sensation seeking, defined as the "the seeking of varied, novel, complex, and intense sensations and experiences and the willingness to take physical, social, legal and financial risks. . ." (Zuckerman, 1994) has been associated with risky, drunk and aggressive driving (Jonah et al., 2001; Dahlen et al., 2005). Impulsivity, "the propensity to engage in behaviors without proper regard for consequences. . ." (Whiteside and Lynam, 2003) has been found to correlate with risky and aggressive driving, reduced ability to perceive traffic signs and proneness to crashes (Dahlen et al., 2005; Renner and Anderle, 2000).

When looking at broader, temperamental aspects of personality, both impulsivity and sensation seeking are related to two basic motivational systems proposed by Gray, the Behavioral Inhibition System (BIS) and the Behavioral Approach System (BAS – Torrubia et al., 2001). BIS is responsible for avoidance in response to punishment, frustrative non-reward and novel stimuli, whereas BAS controls approach behavior in response to reward or non-punishment. Individuals with hypoactive BIS are less likely to detect unpleasant stimuli and evaluate them as less threatening. People with an overactive BAS have difficulty in inhibitory learning due to their strong motivation towards rewards (Avila, 2001). An overactive BIS is expressed behaviorally as high sensitivity to punishment, whereas an overactive BAS as high sensitivity to reward. Sensitivity to reward is related to traffic violations, while sensitivity to punishment may be related to compliance (Castellà and Pèrez, 2004).

Several models have been proposed to explain the role of personality in driving outcomes. According to Norris et al. (2000), the potent effect of gender on accident proneness can be partly attributed to differences in personality between men and women. Men are higher in impulsivity and sensation seeking compared to women (Arnett, 1994), especially in younger age groups. Sümer (2003) proposed the contextual mediated model which considers personality to be a distal factor influencing accident proneness indirectly, though driving behavior (e.g. speed choice, tendency for violations, drunk driving), which is considered a proximal factor, directly related to accident risk. The distal context additionally includes cultural and socio-demographic factors (age, gender) and attitudes. In this model, the proximal factors mediate the effects of distal factors on accident risk. Sümer (2003) found that aggression, sensation seeking and psychological symptoms (anxiety, depression, hostility and psychoticism) predicted proximal factors like speeding, drunk and aberrant driving, which in turn predicted accident proneness.

The present study examines the association between personality, driving behavior and driving outcomes in a sample of young drivers. The goal is two-fold: (a) To examine the extent to which personality in relation to age, driving experience and gender plays a role in predicting driving outcomes, including accident involvement, and traffic offences. (b) To replicate and extend evidence in support of the theoretical perspective which supports that personality is a distal factor that relates to driving outcomes through driving behavior. Testing the model on young or otherwise "high-risk" drivers is theoretically important as different structural relations may emerge for this group since risky personality traits may be accentuated among youngsters. Specifically, we adopt Sümer's (2003, 2005) view that personality is a distal factor, along with gender and age that affect accident proneness indirectly, but also allowed for previous findings that age (and in our case driving experience) is related to negative driving accidents directly by including age and driving experience as both direct and indirect predictors. For purposes of this study we conceptualized BIS/BAS, which are behaviorally measured as sensitivity to punishment and sensitivity to reward, as overarching, temperamental

Table 1
Means, S.D.s and reliabilities for measures used in the study.

	M females	M males	M all	S.D. all	α^c
Barratt Impulsiveness Scale[a]	2.29	2.30	2.30	.30	.75
Motor Impulsiveness	2.36	2.28	2.31	.53	.67
Attentional impulsiveness	2.30	2.33	2.32	.55	.60
Nonplanning	2.13	2.22	2.20	.53	.61
Sensation Seeking Scale[a]	4.27	5.02	4.79	.93	.81
Thrill and Adventure Seeking	4.94	5.72	5.48	1.62	.82
Disinhibition	4.27	5.71	5.27	1.58	.74
Sensitivity to Punishment/Reward	–	–	–	–	
Sensitivity to Punishment[b]	0.24	−0.88	.01	.97	
Sensitivity to Reward[b]	−.09	.09	.03	.92	
DBQ[a]	2.16	2.43	2.35	.74	.93
Ordinary Violations	2.24	2.70	2.56	.91	.91
Aggressive Violations	2.46	2.83	2.72	1.16	.69
Mistakes	1.78	1.76	1.77	.59	.86

[a] Statistics based on all items.
[b] For SP and SR means were converted to *z* scores.
[c] Reliabilities are based on larger standardization sample ($N = 434$).

characteristics to which the other traits examined are secondary manifestations. We expected to replicate findings that young age and male gender are related to elevated rates of accidents and traffic code violations, and to verify that driving behavior acts as a mediating factor between personality traits and driving outcomes. As a secondary goal we wanted to examine the association of gender and age with the personality traits that have previously been found to affect driving behavior. The study adds to the relevant literature by exploring the contextual mediating model in a sample of young drivers, and by expanding Sümer's model to include additional personality traits that have not been examined previously, such as sensitivity to punishment and reward. The study helps to address the question of why young age and male gender are such significant predictors of road traffic accidents, and the reason young males are so significantly over-represented as casualties and fatalities of driving accidents around the world. The study also stresses the role of individual differences in accident risk, suggesting that prevention and intervention efforts may be more effective if targeted to specific high-risk profiles.

2. Method

2.1. Participants

All participants ($N = 352$) were white, Greek-Cypriots of which 241 were male, 109 were female, and two did not declare their gender. The majority resided in the city (61.1%) and were single (88.1%). This was a convenience sample aggregated from three sources: college students, primarily female, in two public higher education institutions (24.8% of the sample, $N = 87$), males serving their compulsory term in the National Guard (50.3% of the sample, $N = 177$), and young drivers in the general community (19.6% of the sample, $N = 69$). The selection criterion for inclusion in the study was that participants should be active drivers for at least a year and up to 25 years old. The mean age of the participants was 20.29 years (S.D. = 1.59) with a mean driving experience of 2.43 years (S.D. = 2.05).

2.2. Procedure

Military camps were selected randomly from a list provided by the National Guard, which functioned as a research partner for this study. All servicemen who were on duty on the day of the data collection and willing to participate in the study were administered the questionnaires. Participation of college students in the study was voluntary after the study was announced in their classes. Community participants were recruited using the snowball method with students advertising the study among their acquaintances. Participants completed a set of questionnaires anonymously, which were administered in a group format either on the college campus or at the military camps. Questionnaire packages were administered to a larger sample totalling 434 individuals. The total sample was used for standardization of the measures that were used for the first time in Greek, while of the larger group only participants <25 years of age took part in the present examination.

2.3. Measures

Instruments that were used with Greek-Cypriot participants for the first time were modified or translated into Greek by two bilingual psychologists using the front and back translation method. Before use in the present study, psychometric analyses of the questionnaires were carried out in a larger community sample ($N = 434$) of which the current participants are a sub-sample. Using the larger sample for validation was judged necessary in order to carry out factor analyses of the questionnaire structure. Validation was carried out using Exploratory Factor Analysis (EFA) with the Principal Components extraction method and a varimax rotation, and subscale reliability analyses with Chronbach's α coefficient. Results are briefly reported below (details of the factor analyses can be obtained from the authors upon request). Table 1 presents the means and S.D.s for the participants of the present study (broken down by gender) and Cronbach α reliabilities for the measures used in analyses.

2.3.1. Driving behavior

The Driving Behavior Quesionnaire (DBQ) was used, which typically breaks down driving behavior into 4 factors. *Errors* are actions that fail to achieve the intended results (Reason et al. 1990) and pose some risk for driver's safety. *Lapses* are failures in attention and memory, which are less likely to result in serious accidents, while *Violations* are "deliberate deviations from the practices believed necessary to maintain the safe operation of a potentially hazardous system" and correlate strongly with traffic accidents (Reason et al., 1990, p. 1316). Violations have been further divided into "aggressive", which have an emotional/interpersonal component (e.g. sound the horn to indicate annoyance) and "ordinary" with no aggressive motive but still intentional (Kontoyiannis et al., 2002). Men typically report significantly more violations than women (Reason et al., 1990), while young people also engage in more risky driving in all categories (Blockley and Hartley, 1995). For purposes of this study, we combined sections of previously

published versions of the DBQ. The first part of this modified DBQ (Loutsiou-Ladd et al., 2009) included the corresponding first section of the Greek DBQ (Kontoyiannis et al., 2002), which assesses demographics (e.g. age and gender) and contains open ended questions about daily driving, driving experience, number of prior traffic accidents in which the respondent was involved, and self-reported traffic offences (i.e. how many times they were stopped by the police for dangerous driving, speeding, drunk driving etc.). The second part of the modified DBQ consisted of 45 items anchored on a 6-point Likert scale (1 = never to 6 = very often) measuring how often the respondent engages in certain driving behaviors. Twenty-seven of the 45 items were a translation of the Manchester Driver Behavior Questionnaire (MDBQ) (Lajunen et al., 2004). The other 18 items were adopted from its predecessor, the Driver Behavior Questionnaire (DBQ) (Reason et al., 1990) and from the Greek DBQ (Kontoyiannis et al., 2002). These measured mostly driving violations or mistakes that are sensitive to traffic accident risk and are particularly relevant to young drivers (Blockley and Hartley, 1995). Based on the EFA conducted on the standardization sample, the modified DBQ was reduced to 3 factors explaining 42.1% of the variance, rather than the 4 found in studies in other countries. Some items did not load in their expected factors and were thus excluded. Factors were namely Aggressive Violations (4 items), Ordinary Violations (19 items), and Mistakes (19 items). The latter factor included items from the Errors and Lapses components found in previous studies and is thus meaningful, grouping together the unintended driving violations. Mean factor scores, based on the EFA, were computed as well as a mean of all DBQ items (N of items = 45). Data for the total number of self-reported traffic offences (e.g. dangerous driving, speeding, driving under the influence of alcohol and other) were converted into z scores because slightly different Likert scales were used in the administration of the questionnaire to some of the participants.

2.3.2. Sensitivity to Punishment/Sensitivity to Reward (SP/SR)

The 48-item Sensitivity to Punishment/Sensitivity to Reward Questionnaire (SPSRQ – Torrubia et al., 2001) was converted from a YES/NO format to a 6-point Likert type scale, where 1 = not at all and 6 = very much in order to make the format compatible with the remaining scales. This instrument measures the behavioral manifestations of Gray's BIS/BAS by assessing a tendency to avoid punishment and frustrative non-reward and the tendency to approach or prefer rewarding situations. However, this change took place after part of the sample (N = 150) had already been administered the questionnaire with the dichotomous format. For this reason, and in order to combine the data, mean scores were computed for SP and SR, means were converted into z-scores for each data set separately to account for the use of the two different scoring formats, and all data were combined. Scales were accepted a priori for this instrument.

2.3.3. Sensation Seeking

Zuckerman's 40 item Sensation Seeking Scale-V Form (SSS-V) was used (Zuckerman, 1994). It includes four subscales: thrill and adventure seeking (TAS), experience seeking (ES), disinhibition (DIS) and boredom susceptibility (BS) that measure respectively the seeking of unusual and risky experiences, of novel sensory, mental experiences, of intense social activities, and the intolerance of repetitiveness. The answering format was modified from a forced choice into a 9-point Likert type scale, since forced choice has been considered a drawback of this tool (Haynes et al., 2000). The original four-factor structure of SSS-V was verified via the EFA conducted on the standardization sample, and explained 33.5% of the variance. Not all items loaded on their expected factors, and eight items were excluded from the final analyses. ES and BS were left out from subsequent analyses because the Cronbach's alpha procedure revealed unacceptably low internal consistency, $\alpha = 0.42$ and $\alpha = 0.55$ respectively, and because these two subscales have been shown to have weak correlations with driving behavior (Rimmö and Åberg, 1999). Thus, the mean scores of TAS (11 items) and DIS (8 items) were computed and used in the subsequent analyses.

2.3.4. Impulsivity

The 30 item, 4-point Likert type scale format Barratt Impulsiveness Scale-11 (BIS11) (Patton et al., 1995) was used, which includes three subscales: Attentional Impulsiveness, Motor Impulsiveness and Non-Planning that measure cognitive, motor and executive aspects of impulsivity respectively. The EFA conducted on the standardization sample supported the 3-factor structure, which explained 32.5% of the variance. However, 11 out of the 30 items did not load on their expected factors and were excluded. The reliability coefficients of the scales, although low, are similar to those reported from other cultural adaptations of the BIS-11 in other languages (e.g. Fossati et al., 2001; Someya et al., 2001).

3. Results

3.1. Driving behavior and effects of gender and age

The majority of the sample (61.1%) reported that they drive daily and spend an average of 3.7 hours per day driving (mode = 2 h, S.D. = 2.45). The range of life-time self-reported traffic accidents ranged from 0 to 6 (M = 0.74, S.D. = 1.09), with 56.3% of the sample reporting zero accidents. Only a small minority (13.4%) of the sample had an accident for which they were held responsible according to self-report, while the majority (56.8%) reported at least one traffic offence for which they were stopped by the police. A Pearson's bivariate correlation analysis showed that traffic accidents correlated positively with traffic offences ($r = 0.35$, $p < .001$). The five DBQ items with the highest mean scores in this sample all referred to self-reported speeding or aggressive driving towards others.

The three groups of participants (national guard servicemen, students, and community sample) differed significantly both in age, $F(2, 328) = 19.31$, $p < .01$, and driving experience, $F(2, 330) = 132.50$, $p < .01$. Specifically, service men (who constituted the majority of the men in the sample) were significantly younger and had the least driving experience. Thus, univariate analyses of covariance (ANCOVAs) with both age and driving experience as covariates were conducted separately in order to compare differences in driving outcomes across gender. With age controlled for, there was a marginally significant difference in total self-reported accidents, $F(1, 347) = 3.77$, $p = .05$, with men reporting more accidents and significantly more traffic offences, $F(1, 349) = 21.35$, $p < .001$, than women. Also, men scored significantly higher on Ordinary Violations, $F(1, 349) = 16.48$, $p < .001$, and on Aggressive Violations, $F(1, 349) = 5.11$, $p < .05$, but did not differ significantly from women in terms of self-reported Mistakes. Separate ANCOVA's with driving years as a covariate instead of age, were also carried out to examine possible driving experience effects independent of age. When controlling for driving experience, the gender effect on number of self-reported accidents became non-significant ($p = .47$), although men still scored significantly higher in offences, $F(1,346) = 9.27$, $p < .01$, Ordinary Violations, $F(1,347) = 22.07$, $p < .001$, and aggressive violations, $F(1,347) = 7.87$, $p = .005$.

Age was related positively and significantly ($r = .46$, $p < .01$) to years of driving experience (defined as years of driving after securing a driver's license), suggesting that in the age range examined age and driving years are strongly related but not entirely overlapping constructs. A series of bivariate correlations explored the role of age in aberrant driving. Results indicated that age correlated positively with self-reported traffic offences ($r = .17$, $p < .01$)

Table 2
Pearson's *r* correlations among personality traits and between personality traits and age.

Personality factors	1.	2.	3.	4.	5.	6.	7.
1. Sensitivity to Punishment							
2. Sensitivity to Reward	0.24**						
3. Thrill and Adventure Seeking	−0.21**	0.10**					
4. Disinhibition	−0.11*	0.30**	0.35**				
5. Motor Impulsiveness	0.01	0.26**	0.03	0.16**			
6. Attentional Impulsiveness	0.04	−0.08	−0.14*	0.03	0.12*		
7. Nonplanning	−0.04	−0.04	0.03	0.10	0.10	0.45**	
8. Age	−0.01	−0.04	−0.04	−0.18**	0.02	−0.05	−0.05

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

and accidents ($r = .15$, $p < .01$) suggesting that the longer one drives the more likely one is to encounter negative driving outcomes. On the other hand, age correlated negatively with the Ordinary Violations factor of DBQ ($r = -.13$, $p < .05$), indicating that even within a young sample, younger participants tend to report more dangerous driving behavior. These correlations remained significant even when driving experience was controlled for, indicating that the relation of age with driving behavior and negative driving outcomes cannot be explained merely by the level of experience or driving exposure. To the contrary, the association between driving experience and driving behavior was not significant.

3.2. Relationship between driving behavior and driving outcomes

The DBQ factors correlated positively with each other ($r = 0.42$ to $r = 0.59$, $p < .01$). The total DBQ score ($r = .15$, $p < .01$) and Ordinary Violations ($r = .25$, $p < .01$) correlated significantly with self-reported traffic offences. Regarding the number of self-reported traffic accidents, total DBQ score ($r = .17$, $p < .01$), Ordinary Violations ($r = .21$, $p < .001$) and Mistakes ($r = .13$, $p < .05$) were significant correlates. The correlational analyses were repeated for the number of subjects who reported at least one accident. Results for this sub-sample showed again substantial and significant correlations of total DBQ score ($r = .20$, $p < .05$) and Ordinary Violations ($r = .24$, $p < .05$) with self-reported traffic accidents, although Mistakes were no longer significantly related to traffic accident involvement, pointing to the primacy of the intentional violations in predicting negative driving outcomes.

3.3. Effects of personality

Table 2 shows Pearson correlations among the personality traits examined, and the correlations between these traits and age. The factors of BIS-11 and SSS-V correlated weakly among themselves and with each other. An unexpected weak correlation was also found between SP and SR, which are usually believed to be orthogonal. Sensation Seeking correlated negatively with Sensitivity to Punishment and positively with Sensitivity to Reward which in turn correlated positively with Motor Impulsivity. Possibly due to the narrow age range of the sample, no significant correlations were found between age and any of the personality factors, with the exception of disinhibition, which is weakened with increased age. This association remained significant even with driving experience controlled for in a partial correlation. There were no significant associations between personality and driving experience.

To examine gender differences in personality, univariate ANCOVAs were conducted for all traits, controlling for age. The SSS factors (DIS and TAS) showed significant gender difference with male drivers scoring higher, $F(1, 346) = 62.99$, $p < .001$, and $F(1, 346) = 18.26$, $p < .001$ respectively. Women were also significantly higher on Sensitivity to Punishment, $F(1, 348) = 10.35$, $p = .001$, but no significant differences were found for Sensitivity to Reward, or any of the Impulsivity factors.

Somewhat unexpectedly, based on the contextual mediated model, personality correlated with self-reported accidents, and specifically the factors of Disinhibition ($r = .16$, $p < .01$), Thrill and Adventure Seeking ($r = .12$, $p < .05$) and Motor Impulsivity ($r = .14$, $p < .01$), although correlations were of a small magnitude. Similarly, Thrill and Adventure Seeking ($r = .18$, $p < .01$) and Disinhibition ($r = .22$, $p < .01$) showed small positive correlations with self-reported traffic offences, while there was additionally a small negative correlation with Sensitivity to Punishment ($r = -.16$ $p < .01$) and a positive one with Sensitivity to Reward ($r = .11$ $p = .05$). As expected on the basis of the contextual mediated model stronger positive correlations were observed between personality and driving behavior, as seen in Table 3.

3.4. Model

In order to examine the role and contribution of personality to the prediction of driving outcomes and to explore the application of Sümer's contextual mediated model in a community sample of young adult drivers, a structural equation model was tested using AMOS 6.0 (Arbuckle, 2005). Self-reported traffic offences were used as the dependent variable, rather than traffic accidents, given the infrequency of accidents in the sample and in accordance with prior recommendations that personality be examined as a predictor of aggregate driving behaviors rather than accident frequency (Epstein, 1979).

According to Sümer's model (2003) age and personality were hypothesized to be distal factors that predict traffic violations indirectly through stable tendencies in driving behaviors. Driving experience was also included as a distal factor along with age given that the correlations reported above show that these are related but not overlapping constructs in the current sample. Thus in the initial model, Sensitivity to Punishment and Sensitivity to Reward, Disinhibition, Thrill and Adventure Seeking, Attentional and Motor Impulsivity and Non-planning were entered as distal variables along with age and driving experience. All of these were set to predict driving behavior as measured by the three DBQ factors, i.e. Aggressive and Ordinary Violations and Mistakes, which in turn were assumed to predict traffic offences. Age and driving experience were set to predict involvement in violations both directly (Norris et al., 2000) and indirectly through driving behavior. Measurement errors for each variable were introduced as unobserved variables and inter-correlations between variables were entered as covariates based on their known correlations from Table 2. Thus the resulting model expands upon that proposed by Sümer (2003) by introducing age and driving experience as both distal and direct factors. At the first stage, the model was tested on the entire sample ignoring the effects of gender.

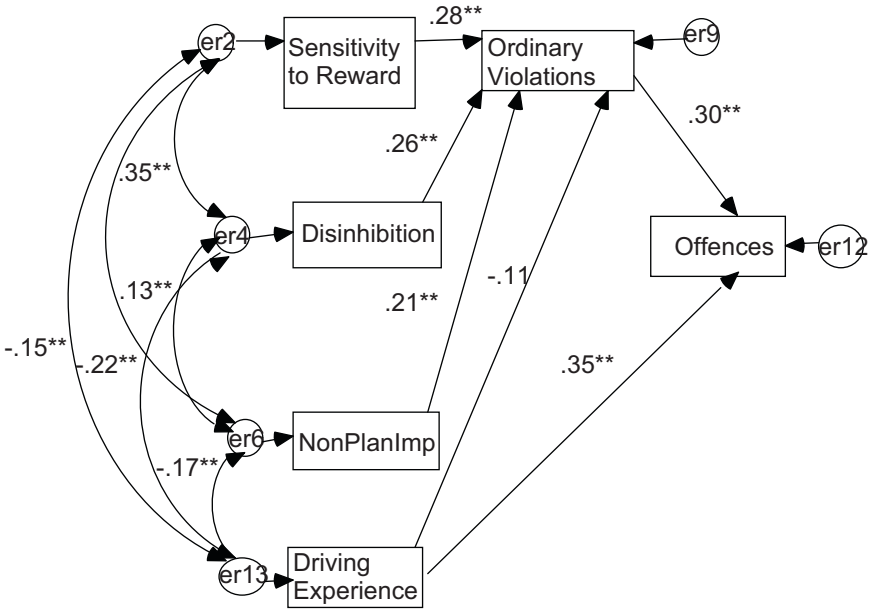
Several indices were used to assess model fit. The chi-square goodness-of-fit is a generally recognized index, which tests the

Table 3
Pearson's *r* correlations between personality and DBQ factors.

Personality factors	DBQ factors		
	Ordinary Violations	Aggressive Violations	Mistakes
Barratt Impulsiveness Scale			
Motor Impulsiveness	0.27**	0.17**	0.24**
Attentional impulsiveness	0.06	0.09	0.14**
Nonplanning	0.22**	0.09	0.21**
Sensation Seeking Scale			
Thrill and Adventure Seeking	0.16**	0.04	0.02
Disinhibition	0.39**	0.24**	0.13*
Sensitivity to Punishment/Reward Questionnaire			
Sensitivity to Punishment	0.02	0.06	0.14**
Sensitivity to Reward	0.36**	0.34**	0.26**
Age	−0.13*	−0.10	−0.08

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

null hypothesis that there is no difference between the hypothesized model and the data. The higher the probability associated with the chi-square, the closer the fit (Bollen, 1989). For small samples in particular, the chi-square needs to be non-significant. Another recommended index is the ratio of chi-square to degrees of freedom (Tanaka, 1993), which needs to be less than 3 and close to 1 (Carmines and McIver, 1981). These two indices along with the CFI (which is recommended to be >0.90; Mueller, 1996) and the RMSEA (recommended to be <0.08, and ideally <05; Hu and Bentler, 1999) indices showed that the initial hypothesized model fit the data poorly. This was because several personality variables had very small associations with driving behavior and traffic offences. Age and driving experience had a very high covariation index ($r = .90$). Based on this and the fact that driving experience showed stronger associations with driving offences, age was removed from the model. The model was further modified by gradually removing misfit variables and very low associations until an acceptable fit was achieved, without affecting the theoretical structure. The final model, as presented in Fig. 1, fits the data well, with the chi-square statistic satisfying the criterion for goodness of fit ($x^2 = 5.9$, df = 4, $p = .20$, CMIN/df = 1.48). CFI was 0.99 and the Normed Fit Index (NFI) = 0.98 both exceeded the target value of 0.90 which indicates good fit. Root Mean Square Error of Approximation (RMSEA = 0.03) also satisfied the specified criterion. The model as depicted in Fig. 1 fits the contextual mediated theory. However, contrary to previous findings that Aggressive Violations are important for young drivers, only Ordinary Violations from the DBQ predicted driving outcomes, probably because speeding is the most common violation among youngsters in Cyprus. Driving experience appeared to explain a larger percent of the variance as a direct predictor of outcome rather than as a distal predictor, through driving behavior. Beta weights indicated that the direct association between driving experience and traffic offences was positive, i.e. it predicted increased involvement in offences. However, its association with ordinary violations was negative (but very small, $r = -.11$). This suggests that it exerts its direct effects mostly because of its high covariation with age, so that, the longer one drives, the more likely one is to become involved in an offence. However, experience does



Model fit indices: Chi-square = 5.94; df = 4; P = .20; CMIN/df = 1.48; NFI = .98; CFI = .99; RMSEA = .03

Fig. 1. Final model predicting self-reported traffic offences for entire sample of young drivers. df = degree of freedom. CMIN/df = chi-square/degrees of freedom, NFI = Normed Fit Index. CFI = Comparative Fit Index. RMSEA = Root-Mean Square Error of Approximation. **$p < 01$.

tend to lower deliberate violations somewhat, so that indirectly it may act as a moderator of traffic offences. Because the direct associations of driving experience with offences were substantially larger than the indirect (as is predicted by the contextual model) it may be the case that this factor is a proximal predictor when it comes to young drivers. In terms of personality, only Sensitivity to Reward, Non-planning and Disinhibition were retained in the model, showing that in young age groups these traits are particularly significant in predicting negative driving outcomes.

The model was re-tested on male and female drivers separately given the omnipotence of gender in predicting traffic accidents and aberrant driving, even though this attempt is somewhat hindered by the significantly smaller resulting sample sizes. The same procedures were used to test the fit of the initial hypothesized model to the data, by removing variables that did not show significant associations with their outcome factors. For both male and female drivers, the model was almost identical to the model for the overall sample as shown in Fig. 1, with the exception in both cases that driving experience was only a direct predictor (and not indirect) of traffic offences (i.e. a proximal factor). However, for men, the fit was slightly better (though the original model satisfied all criteria) if both age and driving experience were kept, and therefore this latter model was maintained. Both exerted only direct positive effects on offences. The respective fit indices for men and women were as follows: Male participants, $x^2 = 6.4$, df = 13, $p = .93$, CMIN/df = .49, CFI = 1.00, NFI = 0.96, RMSEA = 0.001; female participants $x^2 = 3.7$, df = 7, $p = .8$, CMIN/df = .53, CFI = 1.00, NFI = 0.97, RMSEA = 0.001. For women drivers the model fit was somewhat poorer, mostly with regards to the probability of the x^2, but this was probably an effect of the small sample size. In general, however, the fit is satisfactory for both genders reflecting the same pattern of associations, and supporting the overall hypothesized model.

4. Discussion

This study aimed to contribute to the literature by exploring the role of personality in risky and aggressive driving and accident proneness of *young* drivers (<25 years old), while taking into consideration the role of age and gender, within a contextual mediated model. The distal factors in this model were age, driving experience and personality (sensation seeking, sensitivity to punishment and reward and impulsivity), whereas proximal factors were driving behaviors as measured by DBQ factors. A particular strength of the study is the ecological validity of the sample, which was drawn from the community and was thus composed of the average young driver rather than selected high-risk groups. This has the advantage of highlighting the characteristics of the typical driver who has negative driving outcomes. In some respects, the convenience of the sampling procedure may however, also be construed as a limitation of the study: Results can best generalize to women college students (i.e. with some higher education and perhaps of a certain socioeconomic status) and men who are currently serving in the military, whose driving behavior may be somewhat influenced by the social expectations of that particular context or the "macho" stereotype that such an environment fosters.

Findings overall add to the literature by exemplifying and clarifying the role of personality in negative driving outcomes while at the same time replicating previous evidence regarding chronic driving behavior tendencies as the proximal causes of negative driving outcomes. The perspective taken in this study is that young drivers are vulnerable to traffic accidents for many reasons, including their developmental needs, motivation (which is related to evolutionary needs), cognitive maturity, inexperience and the social context (Shope, 2006). In addition to these factors, youngsters are also at risk because they have heightened levels of personality traits that are associated with risky and aggressive behaviors. This conceptualization is for the most part supported by the findings of this study.

Gender was found to be related to driving outcomes and behaviors in accordance with past research (e.g. Reason et al., 1990), even when controlling for age and driving experience. Men reported more accidents and traffic offences as compared to women, and more deliberate violations on the DBQ (aggressive and ordinary violations but not mistakes, e.g. Elander et al., 1993). These results verify that males are indeed the high risk group for road traffic accidents, mostly due to the aggressive and self-serving way in which they drive. As previous research also supports, male drivers may be more prone to accidents precisely because they have certain personality characteristics that make them under-estimate danger and take more risks (higher sensation seeking, lower sensitivity to punishment in this study), rather than because they make mistakes, in which the two genders did not differ. The later finding points to a potential protective factor of sensitivity to punishment for women against risky driving, even though this was not apparent in the model where the sensitivity to punishment variable was removed.

Age correlated positively both with the number of accidents and traffic offences, which is probably due to the confounding effects of driving exposure. In this young sample, an increase in age indicates a substantial increase in total amount of driving exposure thus increasing the probability of an accident (e.g. Janke, 1991; Cooper et al., 1994). The vast majority of youngsters in this country earn their driving license upon reaching legal age, meaning that being older also usually means having more experience (in the model also the covariation between the two variables was very high). Driving experience was operationalized as years since earning the driving license rather than miles driven, which increases the association between age and this variable. Age had a negative correlation with Ordinary Violations, confirming previous evidence that driving improves with maturity and experience (Reason et al. 1990; Kontoyiannis et al., 2002).

Correlations between age (as well as driving experience) and personality factors were mostly non significant, contrary to expectations that traits related to poor driving would be exaggerated among young people. The exception was disinhibition (i.e. seeking intense social experiences), which decreased with age, indicating that lack of self-control is a characteristic of young (male) drivers that puts them at risk. This was one of the significant personality variables that predicted poor driving behavior in the model as well. The absence of more significant associations between age and risk-related traits was probably due to the restricted age-range examined.

Correlational findings support prior evidence that driving behavior in terms of total DBQ score, Mistakes and Ordinary Violations, is related to driving outcomes (accidents and offences). Mistakes were no longer a significant correlate however, when examining only drivers who had at least one accident, indicating the supremacy of violations (i.e. deliberate acts) rather than unintended errors in predicting poor driving outcomes. This association also supports the proposal put forth by the contextual mediated model that driving behavior is a proximal factor that *directly* relates to driving outcomes.

For the most part, personality emerged as a distal factor that did not correlate directly with driving outcomes, supporting similar findings from previous applications of the contextual mediated model (Sümer, 2003; Sümer et al., 2005). Noteworthy exceptions were the small positive correlations between Motor Impulsivity, Thrill and Adventure Seeking and Disinhibition with self-reported accidents. This is a potentially important finding, pointing to the necessity of examining models of crashes both in general and more "high-risk" samples, such as this sample of young drivers, since

results may differ. Previous applications of the contextual mediated model (Sümer, 2003; Sümer et al., 2005) used a general driver population of variable age groups. However, when testing the model on young or otherwise "high-risk" drivers, different structural relations may emerge because in such a group risky personality traits may be accentuated and thus relate more directly to accidents. For young people, risky personality traits may be a small but significant factor implicated proximally in their accident risk. For traffic offences there were also small positive correlations with Thrill and Adventure Seeking, and Disinhibition, along with a small negative correlation with Sensitivity to Punishment, pointing to the small but potentially important role of fear of negative consequences as a protective factor in driving outcomes.

As expected on the basis of the contextual model, personality was significantly correlated with proximal factors, i.e. aberrant driving behaviors. Impulsivity and Sensation Seeking correlated positively, as found previously, with DBQ (Jonah et al., 2001; Dahlen et al., 2005) as did Sensitivity to Reward, whereas Sensitivity to Punishment was only associated with increased mistakes. Sensitivity to Reward, Nonplanning and Disinhibition were also shown to be important predictors of driving behavior in the SEM model, pointing to the primacy in this age group of traits associated with acting without thinking, for the sake of the excitement of dangerous driving itself.

The SEM models provided support overall for the contextual mediated model for a young community sample, in a different country than it has been tested previously. Distal factors, personality and driving experience, had indeed indirect effects only on number of offences through the mediation of driving behavior, even though in our case, driving experience was found to have potent direct effects as well, partly perhaps due to the confounding role of age (as stressed by Rimmö and Åberg, 1999). Ordinary rather than Aggressive Violations were shown to be the most important predictors of traffic code violations in this sample, probably because Ordinary Violations (speeding) is by far the most common reason why drivers are pulled over by the police in Cyprus. As shown from the correlation analyses, however, in the >1 accident group Aggressive Violations were also about equally strongly associated with accidents, indicating that aggression may be a more potent behavioral variable for high-risk groups in predicting their accident involvement.

The findings of this study stress the role of individual differences in accident risk. Some researches have avoided focusing on personality, since it is considered a stable variable that is resistant to change and thus not easily the target of interventions. Our results indicate first that some personality variables may be particularly related to the aberrant behavior of young, male drivers, and may be at peak in this age group, i.e. disinhibition. This finding is related to the evidence that higher cortical functions having to do with executive control do not fully develop until after age 25. Secondly, the findings from this study suggest that personal characteristics may affect the motivation and style with which one drives. Such individual differences may explain why accident prevention campaigns often fail to demonstrate effectiveness, particularly among high risk drivers. Results from this study point to the need for developing separate prevention campaigns that target different drivers and take into consideration their personality characteristics and motivational factors that relate to their driving behavior. There needs to be a goodness of fit as others have proposed between the prevention message, and methodology, and the profile of the targeted drivers (Ulleberg and Rundmo, 2003). Prevention programs that rely mainly on punitive consequences, such as penalties, may be effective in the general population, but may have limited impact on those high-risk drivers, typically young male drivers, that are less sensitive to punishment (Dee, 1998). Intensification of penalties and of punitive consequences may be necessary to modify the driving behavior of those high-risk young drivers who are less sensitive to punishment. Alternatively, reward-based programs, such as though earning smaller insurance or license renewal fees, might be pivotal for more efficacious prevention that targets high-risk young drivers who are high on Sensitivity to Reward.

In terms of implications for future research, findings should be further investigated in other age groups in order to take into consideration the role of increased exposure and experience, and to explore the developmental trends in these traits and behaviors for each gender. Future research could explore more thoroughly the additive contribution of these and other personality traits to accident involvement and risky driving, in order to demonstrate their significance in relation to other distal and proximal risk factors.

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