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Original article

Association of Traffic Behavior with Personality and Platelet Monoamine Oxidase Activity in Schoolchildren

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Abstract

Purpose: Estimations, attitudes and behavioral decisions in everyday life, including traffic-related situations, are influenced by personality traits. It is known that that there is a strong link between certain personality traits, particularly impulsivity, and central serotonergic functioning. This study examined associations between traffic behavior, personality and platelet monoamine oxidase activity, a marker of central nervous system serotonergic neurotransmission, in schoolchildren.

Methods: Participants were 483 schoolchildren (aged 15.3 ± .5 years) who filled in questionnaires on traffic behavior and personality. Platelet monoamine oxidase activity was measured radioenzymatically.

Results: Simple logistic regression analysis revealed that subjects with riskier traffic behavior had higher impulsivity (both adaptive as maladaptive facets) as well as lower Openness, Agreeableness, and Conscientiousness. In multiple logistic regression analysis, many of these associations became nonsignificant, but the high traffic risk group was more likely to have lower Agreeableness and lower platelet MAO activity. Low platelet MAO activity was a significant predictor of risky traffic behavior only in girls who were also influenced by higher Excitement Seeking. Smoking was an independent predictor of all groups with high traffic risks.

Conclusion: Risky traffic behavior in schoolchildren is associated with basic personality dimensions, most consistently with Agreeableness, and with different aspects of impulsivity. Some of these traits, particularly in girls, may be related to central serotonergic neuronal activity. © 2007 Society for Adolescent Medicine. All rights reserved.

Road traffic accidents are judged to be a public health issue worldwide. In a prediction for the year 2020, road traffic accidents ranked third worldwide after ischemic heart disease and unipolar major depression among the diseases and injuries influencing disability-adjusted life years [1]. Traffic fatalities are most often related to alcohol use by drivers, nonuse of safety belts, child occupant restraints [2] or reflectors on road in the dark [3], speeding [4,5], reckless riding on bicycles [6] or motorbikes [7,8], and unsafe crossing of roads [9]. Although drunk driving has decreased in many countries during the past 20 years, alcohol consumption is still one of the main factors in road traffic accidents [10]. In the United States, approximately 390 children died annually in alcohol-related crashes during 1997–2002. About 68% of them were riding with a drunk driver, and the majority of the children who died while riding with a drunk driver were not restrained at the time of the crash [11]. It has been reported that the overall safety belt use has risen over the past 2 decades [12]. Nevertheless, certain groups (e.g., teenagers, drunk drivers) consistently report lower than average usage rates [13]. Children drive a bicycle or a motorbike both for recreation and for transportation [14,15], and the risk that the use of motorbikes presents to their health is increasing [8]. Of behaviors reported on routine health risk

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assessments, the strongest predictor of subsequent fatal accidents was motorcycle use [16].

Estimations, attitudes and behavioral decisions in everyday life, including traffic-related situations, are influenced by personality traits. For example, risk-taking in driving habits among male college students showed positive correlation with Aggression-Hostility trait according to the Zuckerman-Kuhlman Personality Questionnaire [17]. Among the personality traits, risky behavior is most consistently associated with impulsivity. The relationship between impulsivity and traffic behavior has been studied since the late 1980s [18], but not all of the accumulated evidence is consistent. However, it has not always been considered that impulsivity is a multifactorial construct and includes facets such as Novelty Seeking, Excitement Seeking, Sensation Seeking, Venturesomeness, Hyperactivity, Self-control, and Disinhibition [19]. Dickman [20] has differentiated Dysfunctional Impulsivity (tendency to act with less forethought than most people, which leads the subject to difficulties) and Functional Impulsivity (tendency to act with little forethought when such a style is optimal). Although impulsive behavior in car drivers has received quite a bit of attention, the contribution of impulsivity to traffic accidents and law violations in bicycle drivers and pedestrians has remained less studied [21–23], particularly in adolescents. Rosenbloom and Wolf [23] studied the association between road-crossing practices of 7-, 13- and 22-year-old subjects and facets of Sensation Seeking, and found that, among males, the association between Thrill and Adventure Seeking and risky road-crossing was significant in all age groups. The strength of correlations increased with the increase in age. In females, strong association with Thrill and Adventure Seeking was found in 7- and 22-year-old subjects, but not in the teenager group. Another study compared children and adults in road-crossing ability: children made decisions in road-crossing in the same way as adults, but children were less good in judgment and there were large individual differences [22]. The authors suggested that some children were more at risk than others, with possible risk factors being both Impulsivity and fine motor coordination. It has also been found that children injured as bicyclists and pedestrians have higher scores in Impulsivity and Hyperactivity than controls [21].

The personality traits associated with risk-taking behavior are claimed to be relatively high in heritability [17]. One biological correlate of personality traits such as Impulsivity, Sensation Seeking and Monotony Avoidance is the activity of the platelet enzyme monoamine oxidase (MAO), which is a peripheral marker of serotonergic activity in the central nervous system [24]. It has been shown that low platelet MAO activity is associated with several behavioral and psychiatric problems, including tendencies of impulsive behavior, alcohol dependence, and antisocial behavior [24]. One concern with the studies on platelet MAO activity and risk-taking behavior has, however, emerged from the fact that cigarette smokers have lower platelet MAO activity because of a direct dose-related inhibitory effect of the smoke on the enzyme. However, recent studies excluding the smoking effect have confirmed that platelet MAO is a marker of deviant behavior and central serotonergic activity [25]. We have previously found that police-referred nonsmoking drunk drivers had lower platelet MAO activity [26]. Drunk drivers also had higher Dysfunctional Impulsivity compared with controls. In further studies, we have found that police-referred speed-limit exceeders, although also showing higher Dysfunctional Impulsivity compared with controls, additionally had higher Functional Impulsivity and higher Excitement Seeking [27].

The purpose of the present study was to examine the association of personality, with particular attention to impulsivity, and platelet MAO activity with risky traffic behavior in adolescents. The hypothesis was that high traffic risk subjects were more likely to have higher scores in impulsivity-related personality traits and lower platelet MAO activity than low traffic risk subjects. The uniqueness of this investigation is in the use of comprehensive personality assessment and a biological marker, platelet MAO activity, in a relatively large representative sample of adolescents.

Methods

Study sample

The sample was originally used in the European Youth Heart Study (in the 1998/1999 school year), and incorporated into the longitudinal Estonian Children Personality Behavior and Health Study. The selection of the original sample and procedure of data collection has been described in detail previously [28]. The present analysis concerns only the second study wave in the 2004/2005 school year because no data on traffic behavior were collected during the first. Of the 583 children who participated in the first study wave, 47 could not be contacted because they had changed schools or their addresses. Thus, 536 adolescents were invited to participate and, of them, 90.1% agreed. Altogether, 483 children (222 boys and 261 girls) with the mean age of $15.3 \pm .5$ (SD) years participated. Parents and children gave their written consent. The Ethics Committee at the Faculty of Medicine of the University of Tartu approved this study.

Traffic behavior

Subjects reported their traffic behavior during the past year in a self-administered questionnaire. The questions asked were selected to enable a comparison with previous epidemiological health studies in Estonia and neighboring countries. To the following five items: (1) “Frequency of using a seat belt in the front seat,” (2) “Frequency of using a seat belt in the back seat,” (3) “Frequency of using a reflector while moving on streets and roads in darkness,” (4)

"Frequency of using crosswalks on their way to school," and (5) "Frequency of bicycle racing or motorbike racing with cars in traffic," participants responded on a five-point scale ranging from "1" – "Always" to "5" – "Never." In addition, a question about "Riding with a drunk driver" was included, and subjects responded "1" – "No," "2" – "Do not know for sure whether they had" or "3" – "Yes." We also asked about motorbike driving (respondents "1" – "No" or "2" – "Yes"). Traffic risk-taking behaviors have been viewed as a separate health behavior cluster [29], therefore, to reduce the number of comparisons, all seven items were included in a traffic risk score. Responses to the question on racing were flipped over. A few children (n = 9) had left one or more question unanswered. If there was one missing item, the subject was included in data analysis, the missing item being replaced with the median value of the sample. If more than one item was missing, the subject was excluded from the analyses based on the traffic risk score. All items were standardized into z-scores ([Y – mean (Y)]/SD [Y]) and these were summed. In case some activity did not occur during the past year (e.g., a considerable number of children had no need to cross a road on their way to school), the subject obtained zero for that item. Cronbach alpha of the traffic risk questionnaire thus formed was .59. On the basis of the 75th percentile value of the traffic risks score (separately for boys and girls), we divided the subjects into low and high traffic risk groups.

Personality measures

Subjects filled in the Estonian Personality Item Pool NEO (EPIP-NEO; [30]), which is a 240-item measure of the five major personality domains: Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness. Russian-speaking students filled in the 240-item Russian version of the Revised NEO Personality Inventory [31]. These two inventories measure the same domains very similarly [30,32], and the personality data were unified by means of z-scores computed separately by gender. Adaptive and Maladaptive Impulsivity Scale (AMIS) was used to measure different facets of impulsivity (Fast Decision-Making, Thoughtlessness, Disinhibition and Excitement Seeking) as previously described [26,27]. AMIS is based on the concept of functional and dysfunctional impulsivity as described by Dickman [20], and measures these two aspects as well as the aspects of impulsivity that are represented in the NEO Personality Inventory five-factor model (Impulsiveness sub-scale under Neuroticism and Excitement Seeking subscale under Extraversion) (e.g., [31]). AMIS was found to distinguish four separate factors in a sample of 1000 adult men [26,27]. Each of the four scales consisted of six items.

Platelet MAO activity and smoking

Platelet MAO activity was measured in platelet-rich plasma by a radioenzymatic method. After thawing, the samples were sonificated four times for 10 seconds each, and estimation of the enzyme activity performed by incubation at 37°C for four minutes with ^{14}C-labeled β-phenylethylamine as the substrate, as previously described [28]. All samples were blindly analyzed in duplicate and corrected using a reference sample. MAO activity is expressed as nanomoles of substrate oxidized per 10^{10} platelets per minute. The intra- and inter-assay variation coefficients for platelet MAO activity were 6.9% and 4.1%, respectively. For controlling the effect of smoking on MAO activity, the number of smoked cigarettes during the past 7 days was recorded and used. According to the questions describing the frequency of smoking, the subjects were divided into nonsmokers (who had never smoked or who had tried, but did not smoke currently) and smokers.

Statistical analysis

Data were analyzed using SAS software (version 9.1; SAS Institute Inc., Cary, NC). Values of $p < .05$ were considered statistically significant. Descriptive data are expressed as means and standard deviations (SD) and frequencies. Pearson's Chi-square test and *t*-test procedure were used. Simple and multiple logistic regression analysis were used for computing odds ratios to belong to the high traffic risk group. Personality measures and MAO activity were standardized into z-scores for regression analysis.

Results

Traffic behavior

An overview of traffic behavior of the sample is presented in Table 1. There were no differences between boys and girls in the frequency of using seat belts in either seat, in using a reflector while moving on streets and highways in darkness or in using crosswalks on their way to school. However, a significant difference appeared in frequency of racing with cars in traffic on bicycle or motorbike, the boys having more frequently raced in traffic. The proportion of individuals who had been riding with a drunk driver during the past year was similar in boys (28.9%, n = 63) and girls (28.0%, n = 73). Many more boys than girls had driven a motorbike ($\chi^2 = 26.86$, $p < .0001$; 60.3%, n = 132 and 36.5%, n = 95, respectively).

Associations between traffic behavior, personality, and platelet MAO activity

We divided subjects according to the 75th percentile value of the traffic risks score (2.2 for boys and 2.1 for girls) into low-risk (n = 161 in boys, n = 193 in girls) and high-risk (n = 54 in boys, n = 64 in girls) subjects. The high traffic risk group was more likely to have higher Disinhibition, Excitement Seeking, and Thoughtlessness, and lower Openness, Agreeableness, and Conscientiousness compared with the low traffic risk group according to

Table 1
Self-reported traffic behavior in schoolchildren in the total sample and by gender

	Missed activity	1 Always	2 Almost always	3 Occasionally	4 Mostly not	5 Never	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n
Using a seat belt in the front seat							
Boys	8 (3.7)	95 (44.4)	67 (31.3)	30 (14.0)	11 (5.2)	3 (1.4)	214
Girls	9 (3.6)	129 (51.4)	67 (26.7)	38 (15.1)	6 (2.4)	2 (.8)	251
Total	17 (3.7)	224 (48.2)	134 (28.8)	68 (14.6)	17 (3.6)	5 (1.1)	465
Using a seat belt in the back seat							
Boys	20 (9.5)	45 (21.4)	42 (20.0)	36 (17.2)	41 (19.5)	26 (12.4)	210
Girls	12 (4.7)	56 (22.0)	69 (27.0)	43 (16.9)	49 (19.2)	26 (10.2)	255
Total	32 (6.9)	101 (21.7)	111 (23.9)	79 (17.0)	90 (19.3)	52 (11.2)	465
Using a reflector while moving on streets and roads in darkness periods							
Boys	5 (2.4)	37 (17.4)	54 (25.4)	48 (22.5)	41 (19.2)	28 (13.1)	213
Girls	3 (1.2)	50 (19.4)	66 (25.6)	77 (29.8)	46 (17.8)	16 (6.2)	258
Total	8 (1.7)	87 (18.5)	120 (25.5)	125 (26.5)	87 (18.5)	44 (9.3)	471
Using crosswalks on their way to school							
Boys	77 (36.0)	36 (16.8)	37 (17.3)	36 (16.8)	15 (7.0)	13 (6.1)	214
Girls	75 (29.1)	55 (21.3)	58 (22.5)	52 (20.1)	11 (4.3)	7 (2.7)	258
Total	152 (32.2)	91 (19.3)	95 (20.1)	88 (18.6)	26 (5.5)	20 (4.2)	472
	No activity	1 Never	2 Mostly not	3 Occasionally	4 Almost always	5 Always	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n
Bicycle racing or motorbike racing with cars in traffic[a]							
Boys	2 (.8)	85 (39.2)[b]	55 (25.4)	51 (23.5)[b]	8 (3.7)	16 (7.4)[b]	217
Girls	17 (6.6)	160 (62.2)[b]	54 (21.0)	19 (7.4)[b]	4 (1.6)	3 (1.2)[b]	257
Total	19 (4.0)	245 (51.7)	109 (23.0)	70 (14.8)	12 (2.5)	19 (4.0)	474

[a] $p < .0001$: Pearsons' Chi-square test of significance.
[b] Significantly different proportions in distribution (by post hoc cell contribution analysis).

simple logistic regression analyses (Table 2). Significantly lower Openness and higher Disinhibition were found in high-risk boys but not in girls, whereas only high-risk girls had higher Excitement Seeking and Fast Decision Making. The mean values of platelet MAO activity for boys (n = 216) and girls (n = 253) were 9.6 ± 3.3 and 10.9 ± 4.0, respectively ($t = 3.83$, $p = .0001$). High traffic risk girls were more likely to have lower platelet MAO activity, but

Table 2
Likelihood of being high traffic risk scorer vs. low traffic risk scorer depending on the personality traits and platelet MAO activity[a]

Variable	Odds ratio (95% CI)		
	Boys	Girls	Total
Neuroticism	1.34 (.96–1.89)	1.13 (.85–1.50)	1.21 (.98–1.51)
Extraversion	1.08 (.78–1.48)	1.28 (.96–1.72)	1.19 (.96–1.47)
Openness	.67 (.47–.95)[b]	.79 (.59–1.06)	.74 (.59–.92)[b]
Agreeableness	.41 (.27–.63)[b]	.70 (.53–.93)[b]	.58 (.46–.73)[b]
Conscientiousness	.49 (.34–.72)[b]	.73 (.55–.99)[b]	.62 (.50–.79)[b]
Disinhibition	2.04 (1.43–2.91)[b]	1.25 (.94–1.66)	1.54 (1.24–1.92)[b]
Excitement Seeking	1.34 (.96–1.86)	1.89 (1.36–2.63)[b]	1.61 (1.27–2.03)[b]
Thoughtlessness	2.30 (1.58–3.36)[b]	1.48 (1.10–2.00)[b]	1.78 (1.41–2.25)[b]
Fast Decision Making	1.16 (.85–1.58)	1.25 (.94–1.66)[b]	1.21 (.98–1.49)
MAO activity	.92 (.65–1.29)	.53 (.35–.81)[b]	.72 (.55–.93)[b]

[a] The numbers of subjects in high traffic risk groups in the analyses were: boys 49–53, girls 63–64, total 112–115; and in low traffic risk groups: boys 156–161, girls 186–192, total 343–352.
[b] Significant differences compared with low traffic risk groups.

Table 3
Multiple logistic regression models predicting high traffic risk on the basis of personality traits, platelet MAO activity, smoking, and gender[a]

Variable	Adjusted odds ratio (95% CI)		
	Boys	Girls	Total
Neuroticism	1.04 (.63–1.74)	1.11 (.70–1.74)	1.04 (.75–1.44)
Extraversion	.97 (.57–1.67)	1.24 (.76–2.03)	1.14 (.80–1.61)
Openness	.82 (.53–1.27)	.84 (.59–1.20)	.79 (.61–1.03)
Agreeableness	.55 (.31–.96)[b]	.78 (.52–1.17)	.72 (.54–.97)[b]
Conscientiousness	.96 (.52–1.78)	.86 (.54–1.37)	.89 (.63–1.27)
Disinhibition	1.26 (.75–2.12)	.93 (.59–1.47)	1.01 (.73–1.39)
Excitement Seeking	1.02 (.63–1.65)	1.81 (1.08–3.03)[b]	1.40 (.99–1.97)
Thoughtlessness	1.56 (.86–2.85)	.99 (.61–1.60)	1.26 (.89–1.78)
Fast Decision Making	1.03 (.64–1.68)	.93 (.60–1.45)	.90 (.66–1.23)
MAO activity	1.08 (.72–1.62)	.48 (.29–.78)[b]	.74 (.55–.99)[b]
Smoking	3.37 (1.50–7.58)[b]	5.01 (2.42–10.36)[b]	3.69 (2.22–6.15)[b]
Gender	-	-	1.33 (.81–2.18)

[a] The numbers of subjects in high traffic risk groups in the analyses were: boys 44, girls 62, total 106; and in low traffic risk groups: boys 151, girls 179, total 330.
[b] Significant differences compared with low traffic risk groups.

this was not the case for boys (Table 2). The mean values of platelet MAO activity in high vs. low traffic risk subjects among boys were 9.4 ± 3.1 (n = 52) and 9.7 ± 3.3 (n = 157), respectively, and among girls were 9.6 ± 2.6 (n = 63) and 11.3 ± 4.3 (n = 186), respectively (t = 3.60, p = .0004). Adjusting this effect in logistic regression analyses by number of smoked cigarettes, the difference between MAO activities in high vs. low traffic risk groups remained significant (odds ratio .55; 95% confidence interval .35–.85) in girls.

To identify the combination of independent variables, differentiating subjects according to the traffic risk multiple logistic regression analysis was carried out (Table 3). Analysis included all measured personality traits, platelet MAO activity, and smoking. High traffic risk scorers were more likely to have lower Agreeableness and lower platelet MAO activity. In the girls, the model revealed also a significant effect of Excitement Seeking. All high traffic risks groups (in boys and in girls) were approximately three to five times more likely to be smokers as low-risk groups.

Discussion

This study showed that subjects with riskier traffic behavior had higher impulsivity (both adaptive as maladaptive facets) as well as lower Openness, Agreeableness, and Conscientiousness, when analyzed by simple logistic regression analysis. When focusing on the gender differences, girls with high traffic risk were more likely to have higher scores in all facets of impulsivity. In boys, high traffic risk was positively associated with Disinhibition and Thoughtlessness, the traits that describe the maladaptive side of impulsivity and have been characterized as inability to plan and think one's actions through, leading to negative consequences [20]. In the final multiple regression model, the impulsivity measures did not appear as independent predictors of the high traffic risk scorers, although in girls, Excitement Seeking was a significant predictor. Excitement Seeking is the trait that describes the adaptive side of impulsivity and has been characterized as tendency to crave for excitements and sensations. Excitement Seeking is negatively correlated with Agreeableness [33]. Other aspects of impulsivity are also represented in the Big Five personality dimensions: Disinhibition under Neuroticism and Excitement Seeking under Extraversion. Furthermore, it is known that Conscientiousness is inversely associated with impulsivity, and low Conscientiousness supports risk-taking through mechanisms similar to impulsivity [19]. A study on the relationship between personality as measured with the five-factor model and risky health behavior, including behavior in traffic, has found that low Agreeableness and low Conscientiousness contributed to high-risk behavior [34]. Regarding the Big Five traits in our study, lower Agreeableness was most consistently associated with high-risk traffic behavior. By simple logistic analysis, low Conscientiousness contributed to high-risk traffic behavior, and high traffic risk scoring boys were more likely to have lower Openness, but in multiple logistic regression models these traits did not reach statistical significance. The reason for this may be explained by the positive correlation between Openness and Agreeableness, and between Conscientiousness and Agreeableness [32].

Platelet MAO activity, a marker of central serotonergic activity, was consistently lower in girls with higher risk traffic behavior, also after taking into account the effect of smoking. Many studies have reported low platelet MAO activity in risk groups, such as gambling-dependent, mountaineers, criminals, and subjects with psychiatric disorders [17,24]. Some, but not all these findings could be related to the direct effect of smoking on the enzyme activity. It has

been suggested that low platelet MAO itself predicts smoking [35,36], and indeed, in a longitudinal study, it has been demonstrated that not only does smoking inhibit platelet MAO activity, but platelet MAO activity contributes to becoming a regular smoker [37]. However, in the latter study as well as in the investigation of Alm et al [38], which reported that among juvenile delinquents, both low and high platelet MAO activity subjects were over-represented, the factor contributory to deviant behavior was the deviation from the population mean enzyme activity. Thus, it should be acknowledged that both lower and higher serotonergic activity could be related to unhealthy behavior. Regarding behavior in traffic, we have found, in a population-based sample of male volunteers, that drunk driving was associated with low platelet MAO activity [26] and that, in contrast, exceeding legal speed limits was associated with higher platelet MAO activity in subjects who admitted such a behavior being a health risk [27]. The present study suggests that high-risk traffic behavior may be associated with central serotonergic activity also in adolescents, especially in girls. Alternatively, it should be considered that antisocial behavior is much rarer in women than in men, and it is also much less socially and culturally accepted. In one study on behaviorally disturbed adolescents, girls who had been admitted for treatment had lower platelet MAO activity whereas the boys had not [39]. Thus, it is possible that, to take risks and reject social norms, females should have a more deviant central serotonergic system that is reflected in lower platelet MAO activities. The fact that in boys we found no association between platelet MAO activity and traffic behavior although this was described for male adult drivers [26,27] may relate to the fact that both low and high platelet MAO activity were in these studies related to specific major traffic violations, which may not be comparable to the relatively mild risk-taking behavior in adolescents.

Smoking was an independent predictor of all groups with high traffic risks. It is known that several risky behaviors may be significantly correlated [17,40], and significant positive correlations (.27–.39) between traffic risk behaviors and substance use have been previously described [29]. The present data indicate that such clustering of risk behaviors occurs already in adolescents.

It should be noted that several of the recorded traffic behaviors are likely to be confounded by parental behavior, as the parents can, for example, contribute to responsible use of seat belts by their children or be the drunk drivers with whom the subject had been riding. However, 15-year-old subjects should be reasonably informed of traffic risks and have in most instances the possibility to make appropriate decisions. It should also be considered that personality traits and the capacity of the central serotonergic system are, to a considerable extent, inheritable [24], and thus familial aggregation occurs, which should be examined in more detail in further studies.

Conclusively, personality traits contribute to risky traffic behavior in schoolchildren, the most clear independent contributor being such a basic personality dimension as Agreeableness. Both adaptive and maladaptive aspects of impulsivity are increasing the behaviors considered risks in traffic. Some of these traits, particularly in girls, may be related to the central serotonergic neuronal activity. For future preventive measures, it may be important to consider that innate behavioral tendencies contribute to risk-taking in everyday activities, and the subjects' risk could possibly be reduced if he or she has acknowledged the proneness to act at the spur of moment. Furthermore, girls and boys may require different types of educational programs when promoting traffic safety.

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References

[1] Murray CJ, Lopez AD. Alternative projections of mortality and disability by cause 1990–2020: Global Burden of Disease Study. Lancet 1997;349:1498–504.
[2] Satcher D. Note from the surgeon general. Am J Prev Med 2001;21:1–2 (4 suppl).
[3] Conspicuity and roads safety. ETSC fact sheet [cited 2006 Mar 15]. Available from: http://www.etsc.be/documents/FINAL_Fact_Sheet_Conspicuity.pdf.
[4] Shinar D, Schechtman E, Compton R. Self-reports of safe driving behaviors in relationship to sex, age, education and income in the US adult driving population. Accid Anal Prev 2001;33:111–6.
[5] Golias I, Karlaftis MG. An international comparative study of self-reported driver behavior. Transport Res F-Traf 2002;4:243–56.
[6] Wesson D, Spence L, Hu X, et al. Trends in bicycling-related head injuries in children after implementation of a community-based bike helmet campaign. J Pediatr Surg 2000;35:688–9.
[7] Bastos YGL, de Andrade SM, Soares DA, et al. Seat belt and helmet use among victims of traffic accidents in a city of southern Brazil, 1997–2000. Public Health 2005;119:930–2.
[8] Lace JK, Goldstein B. Kids and motorbikes: the need for speed. Pediatrics 2005;115:1085–6.
[9] Tabibi Z, Pfeffer K. Choosing a safe place to cross the road: the relationship between attention and identification of safe and dangerous road-crossing sites. Child Care Health Dev 2003;29:237–44.
[10] European Transport Safety Council. Priorities for EU Motor Vehicle Safety Design. Brussels, Belgium: European Transport Safety Council, 2001.
[11] Shults RA. Child passenger deaths involving drinking drivers—United States, 1997–2002. JAMA 2004;291:934–5.
[12] Glassbrenner D. Safety belt use in 2005. National Center for Statistics and Analysis [cited 2006 Mar 15]. Available from: http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/Rnotes/2005/809932.pdf.
[13] Dinh-Zarr TB, Sleet DA, Shults RA, et al. Reviews of evidence regarding interventions to increase the use of safety belts. Am J Prev Med 2001;21:48–65 (4 suppl).
[14] Johansson B, Drott P. Informal parental traffic education and children's bicycling behaviour. Ups J Med Sci 2001;106:133–44.

[15] Pomerantz WJ, Gittelman MA, Smith GA. No license required: severe pediatric motorbike-related injuries in Ohio. Pediatrics 2005; 115:704–9.
[16] Wilson ALG, Lange JL, Brundage JF, et al. Behavioral, demographic, and prior morbidity risk factors for accidental death among men: a case-control study of soldiers. Prev Med 2003;36:124–30.
[17] Zuckerman M, Kuhlman MD. Personality and risk-taking: common biosocial factors. J Pers 2000;68:999–1029.
[18] Jonah BA. Sensation seeking and risky driving: a review and synthesis of the literature. Accid Anal Prev 1997;29:651–65.
[19] Evenden JL. Varieties of impulsivity. Psychopharmacology 1999; 146:348–61.
[20] Dickman SJ. Functional and dysfunctional impulsivity: personality and cognitive correlates. J Pers Soc Psychol 1990;58:95–102.
[21] Arsenault L. The relationship between vigilance deficits and traffic injuries involving children. Pediatrics 1995;95:219–24.
[22] Pitcairn TK, Edlmann T. Individual differences in road crossing ability in young children and adults. Br J Psychol 2000;91:391–410.
[23] Rosenbloom T, Wolf Y. Sensation seeking and detection of risky road signals: a developmental perspective. Accid Anal Prev 2002; 34:569–80.
[24] Oreland L. Platelet monoamine oxidase, personality and alcoholism: the rise, fall and resurrection. Neurotoxicology 2004;25:79–89.
[25] Fahlke C, Garpenstrand H, Oreland L, et al. Platelet monoamine oxidase activity in a nonhuman primate model of type 2 exessive alcohol consumption. Am J Psychiatry 2002;159:2107–9.
[26] Eensoo D, Paaver M, Pulver A, et al. Low platelet MAO activity associated with high dysfunctional impulsivity and antisocial behavior: evidence from drunk drivers. Psychopharmacology 2004;172: 356–8.
[27] Paaver M, Eensoo D, Pulver A, et al. Adaptive and maladaptive impulsivity, platelet monoamine oxidase (MAO) activity and risk-admitting in different types of risky drivers. Psychopharmacology 2006;186:32–40.
[28] Harro M, Eensoo D, Kiive E, et al. Platelet monoamine oxidase in healthy 9- and 15-years old children: the effect of gender, smoking and puberty. Prog Neuropsychopharmacol Biol Psychiatry 2001;25: 1497–511.
[29] Wasilkiw L, Fekken GC. The dimensionality of health behaviors. J Soc Behav Pers 1999;14:585–96.
[30] Mõttus R, Pullmann H, Allik J. Towards more readable Big Five personality inventories. Eur J Psychol Assess 2006;22:149–57.
[31] Martin TA, Costa PT, Oryol VE, et al. Applications of the Russian NEO PI-R. In: McCrae RR, Allik J, eds. The Five-Factor Model of Personality across Cultures. Dordrecht, The Netherlands: Kluwer Academic Publishers, 2002:253–269.
[32] Gow AJ, Whiteman MC, Pattie A, et al. Goldberg's IPIP' Big-Five factor markers: International consistency and concurrent validation in Scotland. Pers Individ Dif 2005;39,317–29.
[33] Pulver A, Allik J, Pulkkinen L, et al. A Big Five personality inventory in two non-Indo-European languages. Eur J Pers 1995;9:109–24.
[34] Vollrath M, Knoch D, Cassano L. Personality, risky health behaviour, and perceived susceptibility to health risks. Eur J Pers 1999; 13:39–50.
[35] von Knorring L, Oreland L. Pesonality traits and platelet monoamine oxidase in tobacco smokers. Psychol Med 1985;15:327–34.
[36] Oreland L, Damberg M, Hallmann J, et al. Smoking only explain part of the associations between platelet monoamine oxidase activity and personality. J Neural Transm 2002;109:963–75.
[37] Harro J, Fischer K, Vansteelandt S, Harro M. Both low and high activities of platelet monoamine oxidase increase the probability of becoming a smoker. Eur Neuropsychopharmacol 2004;14:65–9.
[38] Alm PO, af Klinteberg B, Humble K, et al. Psychopathy, platelet MAO activity and criminality among former juvenile delinquents. Acta Psychiatr Scand 1996;94:105–11.
[39] Cederblad M, Oreland L, Zachrisson E. Thrombocyte monoamine oxidase activity and behavior deviances in adolescence. Dev Pharmacol Ther 1992;18:184–90.
[40] Caspi A, Begg D, Dickson N, et al. Personality differences predict health-risk behaviors in young adulthood: evidence from a longitudinal study. J Pers Soc Psychol 1997;73:1052–63.