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 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.
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 non-smoking 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 ± .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 sonificationated four times for 10 seconds each, and estimation of the enzyme activity performed by incubation at 37°C for four minutes with 14C-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 1010 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 (χ² = 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
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 1
Self-reported traffic behavior in schoolchildren in the total sample and by gender

<table>
<thead>
<tr>
<th>Activity</th>
<th>1 Never</th>
<th>2 Mostly not</th>
<th>3 Occasionally</th>
<th>4 Mostly not</th>
<th>5 Never</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>Using a seat belt in the front seat</td>
<td>8 (3.7)</td>
<td>95 (44.4)</td>
<td>67 (31.3)</td>
<td>30 (14.0)</td>
<td>11 (5.2)</td>
<td>3 (1.4)</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>9 (3.6)</td>
<td>129 (51.4)</td>
<td>67 (26.7)</td>
<td>38 (15.1)</td>
<td>6 (2.4)</td>
<td>2 (0.8)</td>
</tr>
<tr>
<td>Total</td>
<td>17 (3.7)</td>
<td>224 (48.2)</td>
<td>134 (28.8)</td>
<td>68 (14.6)</td>
<td>17 (3.6)</td>
<td>5 (1.1)</td>
</tr>
<tr>
<td>Using a seat belt in the back seat</td>
<td>20 (9.5)</td>
<td>45 (21.4)</td>
<td>42 (20.0)</td>
<td>36 (17.2)</td>
<td>41 (19.5)</td>
<td>26 (12.4)</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>12 (4.7)</td>
<td>56 (22.0)</td>
<td>69 (27.0)</td>
<td>43 (16.9)</td>
<td>49 (19.2)</td>
<td>26 (10.2)</td>
</tr>
<tr>
<td>Total</td>
<td>32 (6.9)</td>
<td>101 (21.7)</td>
<td>111 (23.9)</td>
<td>79 (17.0)</td>
<td>90 (19.3)</td>
<td>52 (11.2)</td>
</tr>
<tr>
<td>Using a reflector while moving on streets and roads in darkness periods</td>
<td>5 (2.4)</td>
<td>37 (17.4)</td>
<td>54 (25.4)</td>
<td>48 (22.5)</td>
<td>41 (19.2)</td>
<td>28 (13.1)</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>3 (1.2)</td>
<td>50 (19.4)</td>
<td>66 (25.6)</td>
<td>77 (29.8)</td>
<td>46 (17.8)</td>
<td>16 (6.2)</td>
</tr>
<tr>
<td>Total</td>
<td>8 (1.7)</td>
<td>87 (18.5)</td>
<td>120 (25.5)</td>
<td>125 (26.5)</td>
<td>87 (18.5)</td>
<td>44 (9.3)</td>
</tr>
<tr>
<td>Using crosswalks on their way to school</td>
<td>77 (36.0)</td>
<td>36 (16.8)</td>
<td>37 (17.3)</td>
<td>36 (16.8)</td>
<td>15 (7.0)</td>
<td>13 (6.1)</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>75 (29.1)</td>
<td>55 (21.3)</td>
<td>58 (22.5)</td>
<td>52 (20.1)</td>
<td>11 (4.3)</td>
<td>7 (2.7)</td>
</tr>
<tr>
<td>Total</td>
<td>152 (32.2)</td>
<td>91 (19.3)</td>
<td>95 (20.1)</td>
<td>88 (18.6)</td>
<td>26 (5.5)</td>
<td>20 (4.2)</td>
</tr>
</tbody>
</table>

Bicycle racing or motorbike racing with cars in traffic

<table>
<thead>
<tr>
<th>Car racing</th>
<th>1 Never</th>
<th>2 Mostly not</th>
<th>3 Occasionally</th>
<th>4 Mostly not</th>
<th>5 Never</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>Boys</td>
<td>2 (.8)</td>
<td>85 (39.2)</td>
<td>55 (25.4)</td>
<td>51 (23.5)</td>
<td>8 (3.7)</td>
<td>16 (7.4)</td>
</tr>
<tr>
<td>Girls</td>
<td>17 (6.6)</td>
<td>160 (62.2)</td>
<td>54 (21.0)</td>
<td>19 (7.4)</td>
<td>4 (1.6)</td>
<td>3 (1.2)</td>
</tr>
<tr>
<td>Total</td>
<td>19 (4.0)</td>
<td>245 (51.7)</td>
<td>109 (23.0)</td>
<td>70 (14.8)</td>
<td>12 (2.5)</td>
<td>19 (4.0)</td>
</tr>
</tbody>
</table>

*p < .0001: Pearson's Chi-square test of significance.  
*b Significantly different proportions in distribution (by post hoc cell contribution analysis).

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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>1.34 (.96–1.89)</td>
</tr>
<tr>
<td>Extraversion</td>
<td>1.08 (.78–1.48)</td>
</tr>
<tr>
<td>Openness</td>
<td>.67 (.47–.95)</td>
</tr>
<tr>
<td>Agreeableness</td>
<td>.41 (.27–.63)</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>.49 (.34–.72)</td>
</tr>
<tr>
<td>Disinhibition</td>
<td>2.04 (1.43–2.91)</td>
</tr>
<tr>
<td>Excitement Seeking</td>
<td>1.34 (.96–1.86)</td>
</tr>
<tr>
<td>Thoughtlessness</td>
<td>2.30 (1.58–3.36)</td>
</tr>
<tr>
<td>Fast Decision Making</td>
<td>1.16 (.85–1.58)</td>
</tr>
<tr>
<td>MAO activity</td>
<td>.92 (.65–1.29)</td>
</tr>
</tbody>
</table>

*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.
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
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.

Acknowledgments

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