Published in final edited form as:
Psychiatry Res. 2011 February 28; 185(3): 382–386. doi:10.1016/j.psychres.2010.08.026.

Psychopathy, PCL-R, and *MAOA* genotype as predictors of violent reconvictions

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Abstract

The Revised Psychopathy Checklist (PCL-R) has shown a moderate association with violence. The efficacy of PCL-R in varying monoamine oxidase A (*MAOA*) genotypes is, however, unexamined. The aim of this study was to investigate the effect of PCL-R and psychopathy on the risk for violent reconvictions among 167 *MAOA* genotyped alcoholic offenders. Violent reconvictions and PCL-R scores among violent offenders were assessed after a 7-year non-incarcerated follow-up. Regression analysis was used to evaluate the alcohol exposure and age-adjusted effect of PCL-R score and psychopathy on the risk for reconvictions among differing *MAOA* genotypes. Results suggest that the PCL-R total score predicts impulsive reconvictions among high-activity *MAOA* offenders (6.8% risk increase for every one-point increase in PCL-R total score, P=0.015), but not among low-activity *MAOA* offenders, whereas antisocial behavior and attitudes predicted reconvictions in both genotypes (17% risk increase among high-activity MAOA offenders and 12.8% increase among low-activity MAOA offenders for every one-point increase in factor 2 score). Both narcissistic self-image with related interpersonal style (factor 1 score) and psychopathy (PCL-R≥30) failed to predict future violence. Results suggest that the efficacy of PCL-R is altered by *MAOA* genotype, alcohol exposure, and age, which seems important to note when PCL-R is used for risk assessments that will have legal or costly preventive work consequences.

Keywords

Monoamine oxidase; Psychopathology; Antisocial personality disorder; Borderline personality disorder; Personality inventory; Violent crimes; Alcoholism

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1. Introduction

Given the multitude of negative effects resulting from inter-individual violence, there is a continuous need for instruments that help to predict violent behavior. Many methodological obstacles exist in the effort to improve on long-term predictions of violent recidivism. For instance the Revised Psychopathy Checklist (PCL-R) (Hare, 1991), which assesses features of psychopathy (Cleckley, 1976) and previous antisocial conduct, has been regarded as a useful predictor of violence, but the effect sizes have varied greatly within different study settings. Recent meta-analyses by Leistico et al. (2008) and Walters et al. (2008), however, suggest that the PCL-R has a moderate effect size for predicting acts of violence.

As a new contribution to the field, we attempted to examine how the monoamine oxidase A (*MAOA*) genotype, alcohol exposure, and age moderate PCL-R and psychopathy (PCL-R≥30) as predictors of violent reconvictions among Finnish alcoholic violent offenders. The rationale for including these predictors in our analyses is that *MAOA* genotype (Brunner et al., 1993; Caspi et al., 2002; Reif et al., 2007; Tikkanen et al., 2009, 2010), alcohol consumption, (Tikkanen et al., 2009) and age (Tikkanen et al., 2009) relate to violence. However, it is unclear which *MAOA* alleles associate with violence. Moreover, alcoholism (Brewer and Swahn, 2005) and age (Harpur and Hare, 1994) may affect PCL-R scores. The wide variety in effect sizes reported in the predictive literature on violent behavior may partly be attributed to the fact that biasing variables have rarely been considered. The few studies that have accounted for some biasing variables have reported either a diminished (Skeem and Mulvey, 2001) or non-existent (Douglas et al., 1999) effect of psychopathy on the risk for violence-related recidivism.

MAOA is a mitochondrial outer membrane enzyme that profoundly affects brain chemistry, as it inactivates monoamines such as serotonin, noradrenalin, and dopamine (Shih et al., 1999). The *MAOA* gene is located on the X chromosome (Xp11.23–11.4) (Levy et al., 1989). A common polymorphism in the *MAOA* gene's transcriptional control region ("*MAOA*-linked polymorphism region" [*MAOA-LPR*]) alters the transcriptional activity and causes a high (*MAOA-H*) or low (*MAOA-L*) *MAOA* enzyme activity (Sabol et al., 1998). Alleles (2, 3, 3.5, 4, 5, or 6) vary in the number of copies of a 30-bp repeat and the most common alleles are those that contain three or four copies of the 30-bp repeat sequence. The 4-repeat and 3.5-repeat alleles (*MAOA-H*) correspond to a greater amount and higher activity of *MAOA* when compared with the 2-repeat, 3-repeat, and 5-repeat alleles (*MAOA-L*) (Sabol et al., 1998; Denney et al., 1999).

Relying on the meta-analyses by Leistico et al. (2008) and Walters et al. (2008) according to which the factor 2 (F2; antisocial behavior and related attitudes) is a stronger predictor of criminality across different samples as compared with factor 1 (F1; Grandiose self-image and callous-unemotional traits with related disturbed interpersonal style), we hypothesized that PCL-R total score and F2 score in our sample would predict violent reconvictions whereas F1 score would have a smaller effect size. Based on previous observations suggesting that *MAOA* genotype may be characteristic of certain subgroups of violent behavior and criminality (Reif et al., 2007; Tikkanen et al., 2009), we expected that PCL-R would predict reconvictions differently among *MAOA-H* and *MAOA-L* genotyped offenders.

2. Methods

2.1. Subjects

Subjects were 167 Finnish male (Caucasian) non-psychotic violent alcoholic offenders who were recruited between 1990 and 1998 during a two month court-ordered mental status

examination in the inpatients care unit of the Department of Forensic Psychiatry of Helsinki University Central Hospital.

Mean age at time of evaluation was 32.3 (S.D.=9.6), and mean intelligence quotient (IQ) (Wechsler Adult Intelligence Scale [WAIS]) was 97.3 (S.D.=14.4). The majority of the offenders belonged to the lower socioeconomic groups. Their occupational status was mainly semi-skilled workers and many were unemployed at the time of recruitment in the study. The sample under study in the present paper corresponds closely to the general Finnish violent offender population and included many subjects who participated in genetic studies concerning violent alcoholic offenders (Ducci et al., 2006).

2.2. Psychiatric assessment

Each subject was interviewed with the Structured Clinical Interview for the Revised third edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R) (Spitzer et al., 1990) to detect lifetime mental disorders (APA, 1987). Interviewers were experienced licensed psychiatrists, and diagnoses were double checked by psychiatrists at the National Institute of Alcohol Abuse and Alcoholism, Bethesda, Maryland, US. The most prevalent DSM-III-R personality disorders were antisocial personality disorder (ASPD) (N=57; 34%), borderline personality disorder (BPD) (20; 12%), and an ASPD and BPD comorbidity (46; 28%). Early onset conduct disorder (CD) was diagnosed in 70 (42%) subjects. Alcohol dependence was diagnosed in 134 (77%) subjects and alcohol abuse in 40 (23%) subjects. The sample featured higher traits of impulsiveness and stimulus seeking as compared with healthy controls (Tikkanen et al., 2007).

2.3. Assessment of psychopathy

The PCL-R scores were obtained by file-based rating blinded to outcome and genotype. Items 1–17 were rated using the mental status examination reports (description of the violent act, criminal career, life event history, psychiatric morbidity, observations of behavior, psychological tests, and assessment of responsibility during the violent act). Items 18–20 were rated from criminal records. Outcome crimes were not accounted for rating criminal versatility (item 20) to avoid criterion contamination. Being a psychopath was defined as PCL-R total score ≥30. Eighteen (11%) randomly chosen participants were separately rated by two authors (RT and LA-L). No significant mean-score difference (21.0, S.D.=6.2 versus 19.6, S.D.=5.6; F=0.54, d.f.=1, P=0.468) emerged and the dichotomous psychopathy classification was identical.

2.4. Alcohol exposure

Alcohol exposure was measured with the Lifetime Drinking History questionnaire (Skinner and Sheu, 1982), which is a structured interview where subjects are asked about patterns of alcohol exposure from the first year of regular drinking to the present. We divided the subject's lifetime alcohol exposure by the number of years of drinking to form a variable describing the lifetime yearly mean alcohol exposure. The all-offender mean exposure was 50 kg (S.D.=36) ethanol per year, which is five times greater than the Finnish mean exposure.

2.5. Assessment of violent behavior

The violent convictions preceding the follow-up were generally serious, impulsive, and committed under alcohol-intoxication (144/167; 86%; rated from the mental status examination reports). The most common convictions were manslaughter, attempted manslaughter, assault, or battery (63%), defined as impulsive by the Finnish medico-legal system. Other conviction categories were murder or attempted murder (17%), arson (16%),

and rape (4%). Recidivism in violent behavior was assessed using register data provided by the Legal Register Centre in August 2005. Out of the sixty-five recidivistic offenders (39%) fifty-three (81.5%) were reconvicted of manslaughter, attempted manslaughter, assault, or battery, five (7.7%) for murder or attempted murder, five (7.7%) for arson, and two (3.1%) for rape.

The mean total follow-up period (from enrolment in the study to the examination of criminal records) was 11.6 years (139 months, S.D.=28, range 85–182, Skewness −0.320 [s.e.=0.171]). We subtracted the time spent in prison from the total follow-up time, resulting in a non-incarcerated follow-up period of 6.5 years (78 months, S.D.=37, range 1–180, Skewness 0.068 [s.e.=0.188]).

2.6. MAOA-LPR genotyping

The *MAOA-LPR* was genotyped with PCR primer sequences: Forward 5′-(CCC AGG CTG CTC CAG AAA CATG 3)-3′ and Reverse 5′-(GTT CGG GAC CTG GGC AGT TGT G)-3′. Owing to the high GC content in the region where the *MAOA-LPR* is located, amplification was performed using Invitrogen's PlatinumTaq and PCRX Enhancer System kits according to the manufacturer's protocol (Invitrogen, Carlsbad, CA, USA). A detailed description of the genotyping method appears in the paper by Ducci et al. (2006).

As the study sample comprised only males, genotypes were grouped by relative transcriptional activity into two categories: high-activity (4 repeats, 55%) versus low-activity (3 repeats, 45%). These alleles accounted for 97% of the *MAOA-LPR* variety among the offenders. Alleles with 3.5 and 5 repeats were detected on only two and three chromosomes, respectively. No 2-repeat alleles were observed. The distribution of *MAOA-H* and *MAOA-L* alleles is similar to those in other Caucasian male samples (Manuck et al., 2000; Caspi et al., 2002; Ni et al., 2007; Reif et al., 2007).

2.7. Statistical analyses

Bonferroni corrected ANOVA was applied for comparisons of PCL-R mean scores. Multivariate logistic regression analyses were applied to measure risk for violent reconvictions (dependent). Independent variables entered in the regression models were *MAOA* genotype, *MAOA-H* genotyped psychopaths, *MAOA-L* genotyped psychopaths (Table 2), and PCL-R total score, F1, and F2 separately and stratified by *MAOA-LPR* (Table 4). Regression analyses were run with and without both alcohol exposure and age as covariates. The significance level was set at 95% CI. Analyses were performed with SPSS 16.0 for Windows.

3. Results

3.1. Frequency of violent reconvictions among psychopaths

Psychopaths committed a new act of violence more frequently than did the sample overall (22/43; 51% versus 65/167; 39%). Moreover, recidivistic violence was more frequent among *MAOA-H* genotyped psychopaths (14/22; 64%) than among *MAOA-L* psychopaths (8/21; 38%). The frequency distribution comparison of reconvictions among *MAOA-H* genotyped psychopaths as compared with all non-psychopaths showed significance but a similar comparison of *MAOA-L* psychopaths showed no significance (Table 1).

3.2. The effect of psychopathy on risk for violent reconvictions

Table 2 shows that psychopathy as an independent risk factor for reconvictions approached significance (P=0.058). However, in an MAOA genotype, alcohol exposure and age-adjusted model psychopathy, MAOA genotype, and alcohol exposure showed no risk

increase whereas age decreased the risk significantly (B=−0.134, s.e.=0.06, W=4.8, P=0.029) (the first adjusted analysis in Table 2 under "Psychopaths"). Psychopathy increased the risk for reconvictions (OR 3.4, P=0.011) among MAOA-H genotyped offenders in the non-adjusted model but this risk increase vanished when the model was adjusted for alcohol exposure and age (P=0.086). Psychopathy among MAOA-L genotyped offenders were not at an increased risk for violent reconvictions.

3.3. Comparison of PCL-R scores

Table 3 shows that recidivistic offenders featured higher PCL-R total and F2 (but not F1) scores as compared with non-recidivists but there were no differences in the scores between the *MAOA-LPR* genotypes. Table 3 also displays the difference in PCL-R total, F1, and F2 scores between psychopaths and non-psychopaths.

3.4. The effect of PCL-R scores on risk for violent reconvictions

The PCL-R total score predicted reconvictions in an *MAOA* genotype (B=0.404, s.e.=0.35, W=1.3, P=0.248), alcohol exposure (B=0.011, s.e.=0.01, W=5.2, P=0.023) and age-adjusted model (B=−0.045, s.e.=0.02, W=4.7, P=0.031) (the first adjusted analysis under "PCL-R" in Table 4). However, a *MAOA-LPR* stratified analysis adjusted for both alcohol exposure and age showed that the PCL-R total score predicted future violence in only the *MAOA-H* offender group, with a 6.8% risk increase for each one-point increase in the PCL-R total score (B=0.068, s.e.=0.03, W=5.9, P=0.015). This model explained 14% (R^2=0.141) of the risk for reconvictions in this study group. F2 predicted reconvictions in the whole sample and explained 16% (R^2=0.158) of the risk. A one-point F2 score increase resulted in a 17% risk increase for reconvictions among *MAOA-H* genotyped offenders (B=0.170, s.e.=0.05, W=9.6, P=0.002) and a 13% risk increase among *MAOA-L* genotyped offenders (B=0.128, s.e.=0.05, W=5.9, P=0.015).

4. Discussion

4.1. Efficacy of PCL-R

In line with a recent meta-analysis that relates psychopathy to antisocial conduct in diverse populations (Leistico et al., 2008), our results suggest that the PCL-R F2 score (antisocial behavior and related attitudes) is a robust predictor of future violent behavior among violent alcoholic offenders. The effect size of the F2 score remained significant in both *MAOA* genotypes after controlling for both alcohol exposure and age. The effect size of the PCL-R total score, on the other hand, decreased substantially when *MAOA* genotype, alcohol exposure, and age were accounted for. In the subdivision of offenders by *MAOA* genotype, the PCL-R total score showed significant effect size only in the *MAOA-H* genotyped group. Grandiose self-image and callous-unemotional traits with related disturbed interpersonal style (F1) failed to predict impulsive violent reconvictions in this long-term non-incarcerated follow-up.

4.2. Psychopathy as a predictor of violent reconvictions

A similar alteration of risk emerged when psychopathy (PCL-R ≥30) was examined. Yet, the decrease in effect size after accounting for both alcohol exposure and age and the subdivision into *MAOA* genotypes was more obvious in this dichotomous model when compared to the continuous model (PCL-R score), in that psychopathy failed to predict future violence both on the subgroup level (odds ratios) and in individual cases (small area under the curve [AUC] figures). However, a borderline significant threefold risk increase was noted among *MAOA-H* psychopaths, which implies that a larger sample may be required to confirm that *MAOA-H* genotyped psychopaths are at a significantly higher risk

for impulsive violent reconvictions. Curiously, MAOA-L genotyped psychopaths were not at an increased risk for violent reconvictions.

4.3. The role of MAOA genotype and outcome impulsive violence

Overall, the impact of both psychopathy and PCL-R scores on reconvictions tended to be greater among *MAOA-H* offenders as compared with *MAOA-L* offenders, which may be explained by the dominantly impulsive nature of the observed violence, the putative differing etiology of impulsive and premeditated violence, and the association of *MAOA-H* genotype with impulsivity. These aspects suggest that the *MAOA-H* psychopaths in our sample may differ from the *MAOA-L* psychopaths in several ways and that *MAOA* genotype may be an indicator of two different types of psychopaths.

Psychopaths have been suggested to typically commit premeditated or impulsively premeditated (seemingly impulsive behavior with a premeditated motive) violent crimes (Hart and Dempster, 1997). Assuming that, accordingly, the *MAOA-L* psychopaths in our sample comprise psychopaths prone to premeditated violence it is natural that no significant effect on the risk for impulsive violence was observed. A decreased level of central serotonin corresponding with high-activity *MAOA*, on the other hand, has been linked to impulsive violence (Linnoila et al., 1983; Coccaro, 1989). The observed violence in the current study was mainly impulsive, since the majority of the convictions were for manslaughter, battery, and assault, which are considered impulsive crimes in the Finnish medico-legal system, whereas murder, a minority in our sample, is considered to be premeditated. The fact that the ASPD and BPD comorbidity was high suggests that the offenders were prone to commit impulsive acts of violence, and it may also explain our *MAOA-H* driven results, since it has been shown that *MAOA-H* is associated with borderline personality disorder (Ni et al., 2007, 2009).

The high-activity *MAOA* allele has also been associated with impulsive personality traits in normal males (Manuck et al., 2000). Recent brain imaging studies in healthy males have associated the *MAOA-H* genotype with increased neural activity in the right *ventrolateral* prefrontal cortex (an area engaged in inhibitory processing) within Go/NoGo and working memory paradigms (Passamonti et al., 2006; Cerasa et al., 2008). In contrast, the *MAOA-L* genotype has been linked to abnormalities in neural activity in the *ventromedial* prefrontal cortex (Koenigs et al., 2007; Alia-Klein et al., 2008) (an emotion processing areas of the brain) in individuals who feature aggressive attitudes (Alia-Klein et al., 2008) and utilitarian moral judgment (Koenigs et al., 2007).

4.4. Implications

Our results implicate that the PCL-R total score and psychopathy as predictors of violent reconvictions may be altered by *MAOA* genotype, alcohol exposure, and age. The utility of the PCL-R total score as a predictor of impulsive alcohol-related violence seems to be substantially greater among *MAOA-H* genotyped violent offenders as compared with the *MAOA-L* offenders. Earlier antisocial conduct and antisocial attitudes (F2 score), on the other hand, seem to robustly predict future violence in both genotypes. Moreover, results implicate that psychopathy (PCL-R≥30) may not be used to predict long-term non-incarcerated impulsive violence among habitually violent Finnish alcoholic offenders. The results implicate that it is important to account for biasing variables when PCL-R is used for violence risk assessment with potential legal and costly preventive work consequences.

4.5. Critical assessment of the study setting

A limitation of the study was that the PCL-R rating occurred after collection of outcome data. However, our study may not be considered as purely postdictive since the rating was

based on data collected prior to the follow-up (the outcome crime was not included in the PCL-R rating to avoid criterion contamination) and the rating was totally masked to outcome. A further limitation of our study is that we did not account for childhood maltreatment, which is known to increase risk for violent behavior. A selection bias of impulsive offenders to the study is possible assuming that less impulsive violent individuals are not as easily caught. The main strengths of our study were its large sample size, the long prospective follow-up, the emphasis on impulsive violence, and reliable register based outcome measure of violence. It should also be noted that our sample comprised a homogeneous alcoholic violent offender population and results may not be generalized into other populations. Despite the limitations of this study, we present, as far as we know, the first results of a genetic alteration of psychopathy as a predictor of violent behavior.

Acknowledgments

This research was supported by the Intramural Research Program of the National Institute on Alcohol Abuse and Alcoholism, NIH. We thank the Legal Register Centre for contribution of register data. No financial support was received from anyone benefiting from these results. Ms. Aija Räsänen is to be thanked for diligent secretarial assistance.

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Table 1

Frequency distribution comparison of all psychopaths and psychopaths divided into subgroups by monoamine oxidase A (*MAOA*) genotypes among recidivistic and non-recidivistic violent offenders. Forty-three (26%) offenders were rated as psychopaths (PCL-R≥30).

	Psychopaths, *N*=43	**Non-psychopaths, 124**	**d.f.**	**χ^2**	***P*-value**
Recidivists	22	43			
Non-recidivists	21	81	1	3.65	0.056
MAOA-H	22	70			
MAOA-L	21	54	1	0.36	0.548
	MAOA-H psychopaths, 22	Non-psychopaths, 124	d.f.	χ^2	*P*-value
Recidivists	14	43			
Non-recidivists	8	81	1	6.58	0.010
	MAOA-L psychopaths, 21	Non-psychopaths, 124	d.f.	χ^2	*P*-value
Recidivists	8	43			
Non-recidivists	13	81	1	0.09	0.762

MAOA-H = high-activity genotype, *MAOA-L* = low-activity genotype.

Table 2

Risk for recidivistic violence in a 7-year follow-up among high-activity monoamine oxidase A (*MAOA-H*) and low-activity *MAOA* (*MAOA-L*) genotyped psychopaths.

	B **(s.e.)**	***W***	***P***	**OR**	**95% CI**	R^2	**AUC (*P*)**
Psychopaths							
Non-adjusted	0.680 (0.34)	3.6	0.058	2.0	0.98–4.0	0.026	0.57 (0.149)
Adjusted	0.409 (0.40)	1.0	0.314	1.5	0.68–3.3	0.096	
MAOA-H psychopaths							
Non-adjusted	1.229 (0.48)	6.5	0.011	3.4	1.3–8.8	0.061	0.58 (0.104)
Adjusted	1.076 (0.61)	3.1	0.086	2.9	0.87–9.7	0.139	
MAOA-L psychopaths							
Non-adjusted	0.470 (0.51)	0.9	0.357	1.6	0.59–4.4	0.008	0.53 (0.597)
Adjusted	0.414 (0.53)	0.6	0.434	1.5	0.54–4.3	0.057	

The multivariate logistic regression analyses were separately applied without (non-adjusted) and with (adjusted) consideration of both alcohol exposure and age. *B*=regression coefficient; s.e.=standard error; *W*=Wald's test; *P*=*P*-value, OR=odds ratio, CI=95% confidence interval, R^2=nagelkerke *R* square test, AUC=area under the curve in receiver operating characteristic (ROC) analysis.

Table 3

Revised Psychopathy Checklist (PCL-R) mean-score comparisons listed separately between recidivists versus non-recidivists, MAOA genotype subgroups, and psychopaths versus non-psychopaths. The sample comprised 167 alcoholic violent offenders exhibiting PCL-R total 23.5 (S.D.=7.4), factor 1 (F1) 8.8 (3.6), and factor 2 (F2) 12.0 (4.0) grand mean scores.

	Mean (S.D.)		***F***	**d.f.**	***P*-value**
	Recidivists	**Non-recidivists**			
Total	25.5 (6.4)	22.2 (7.8)	8.4	1	0.004
F1	8.9 (3.2)	8.8 (3.9)	0.01	1	0.920
F2	13.6 (3.7)	10.9 (3.9)	19.3	1	0.0004
	MAOA-H	MAOA-L			
Total	23.3 (7.0)	23.7 (8.0)	0.10	1	0.745
F1	8.4 (3.4)	9.2 (3.9)	2.0	1	0.156
F2	12.3 (3.9)	11.6 (4.2)	1.2	1	0.269
	Psychopaths	Non-psychopaths			
Total	32.4 (2.4)	20.4 (5.9)	169.4	1	0.0004
F1	12.7 (2.0)	7.5 (3.1)	105.7	1	0.0004
F2	15.7 (2.0)	10.7 (3.8)	67.6	1	0.0004

MAOA-H = high-activity genotype, *MAOA-L* = low-activity genotype. Psychopathy = PCL-R≥30.

Table 4

The efficacy of PCL-R as a predictor of violent reconvictions among *MAOA* genotyped violent offenders.

		B **(s.e.)**	***W***	***P***	**OR**	**95% CI**	R^2
PCL-R	Non-adjusted	0.064 (0.02)	7.9	0.005	1.066	1.01–1.12	0.066
	Adjusted	0.050 (0.03)	4.0	0.045	1.051	1.00–1.11	0.122
MAOA-H	Non-adjusted	0.080 (0.03)	10.4	0.001	1.083	1.03–1.14	0.096
	Adjusted	0.068 (0.03)	5.9	0.015	1.070	1.01–1.13	0.141
MAOA-L	Non-adjusted	0.054 (0.02)	5.2	0.023	1.056	1.01–1.11	0.096
	Adjusted	0.045 (0.03)	3.2	0.075	1.046	0.99–1.10	0.141
F1	Non-adjusted	0.004 (0.04)	0.01	0.920	1.00	0.92–1.10	0.000
	Adjusted	0.011 (0.05)	0.05	0.825	1.011	0.92–1.11	0.088
MAOA-H	Non-adjusted	0.037 (0.05)	0.6	0.499	1.038	0.94–1.14	0.066
	Adjusted	0.039 (0.06)	0.5	0.477	1.040	0.93–1.16	0.098
MAOA-L	Non-adjusted	−0.015 (0.05)	0.1	0.749	0.985	0.90–1.08	0.019
	Adjusted	−0.001 (0.05)	0.0	0.990	0.999	0.91–1.10	0.098
F2	Non-adjusted	0.189 (0.05)	15.9	0.000	1.208	1.10–1.33	0.144
	Adjusted	0.145 (0.05)	7.6	0.005	1.156	1.01–1.28	0.158
MAOA-H	Non-adjusted	0.206 (0.05)	17.6	0.000	1.229	1.12–1.35	0.165
	Adjusted	0.170 (0.05)	9.6	0.002	1.185	1.01–1.32	0.176
MAOA-L	Non-adjusted	0.163 (0.05)	10.5	0.001	1.177	1.07–1.30	0.165
	Adjusted	0.128 (0.05)	5.9	0.015	1.137	1.03–1.26	0.176

The multivariate logistic regression analyses were separately applied without (non-adjusted) and with (adjusted) consideration for both alcohol exposure and age. *B* = regression coefficient (the risk for reconvictions increases with the indicated positive *B* figure when the variable increases one unit, and decreases with the negative figures); s.e. = standard error; *W* = Wald's test; *P* = *P*-value, OR = odds ratio, CI = 95% confidence interval, R^2 = nagelkerke *R* square test. F1 = factor 1 and F2 = factor 2.