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Effects of *MAOA* genotype and childhood experiences of physical and emotional abuse on aggressive behavior in adulthood

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Abstract

A functional polymorphism in the monoamine oxidase A (*MAOA*) gene located on the X chromosome (Xp11.23-11.4) has earned the nickname "warrior gene" because of its association with antisocial behavior and delinquency. Previous findings on adults and adolescents have found some evidence that the *MAOA* gene moderates the impact of childhood abuse experiences on the risk of developing aggressive behavior. Thus far, however, attempts to replicate these findings have been mixed. The aims of the present study were to investigate whether the *MAOA* polymorphism affects aggressive behavior alone and in combination with childhood abuse experiences. We tried to replicate this using a sample of 1447 male and 2179 female Finnish twins and their siblings. In the present study, the Childhood Trauma Questionnaire and Aggression Questionnaire were used. There was a positive correlation between childhood abuse experiences and later aggressive behavior in adolescence or adulthood both for men and women. The results showed the effects of the 4-repeat allele of *MAOA* promoter polymorphism on physical aggressive behavior for women. It seems that there is an interaction between the 3-repeat allele of *MAOA* promoter polymorphism and emotional abuse experiences on aggressive behavior for women. In conclusions, this study, using a large population-based sample, found partial support for an interaction between *MAOA* genotype and childhood abuse experiences on aggressive behavior.

Keywords: aggressive behavior, childhood abuse, monoamine oxidase A, *MAOA*, abuse experiences

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1. Introduction

Abuse of children by their parents or other caregivers can have serious effects on the victims' physical and mental health, well-being, and development throughout their lives, and, by extension, on society in general (Butchart & Harvey, 2006; Gilbert et al., 2009). Research suggests that there are over one million victims of childhood maltreatment per year in the USA alone (Haberstick et al., 2005). Maltreatment is often divided into physical, sexual, and emotional abuse, as well as neglect (Gilbert et al., 2009); although it is possible to have experienced only one form of childhood maltreatment, they can often occur together (Huizinga et al., 2006).

Taylor et al. (2009) found that childhood maltreatment was associated with decreased moral internalization and the mental health of the child and problems in the parent-child.

Childhood maltreatment has also been shown to be a statistical risk factor for an increased level of antisocial behavior. Men who have been subjected to physical abuse, cruelty and neglect in general, are vulnerable to antisocial behavior disorders (Widom, 1989; Rutter, Giller, & Hagell, 1998; Connor, 2004).

The results of a study by Gilbert et al. (2009) also indicated a strong relationship between childhood abuse and later aggressive behavior in adulthood.

Huizinga et al. (2006) conducted a longitudinal study of the relationship between childhood maltreatment and subsequent antisocial behavior in a population-based sample of 277 Caucasian boys (aged 11–15 years). The results revealed that parental maltreatment during childhood or adolescence predicted later antisocial behavior and violence in adulthood.

There is, however, a great deal of variability in individuals' responses to adverse childhood experiences, that is, at least half of the children who have experienced severe childhood maltreatment do not go on to exhibit antisocial behaviors in a later age (Widom, 1997; Haberstick et al., 2005; Åslund et al., 2010). Besides genes influencing aggressive behavior directly, individual differences can be explained by interactions between genes and environmental factors (e.g., G × E interaction) (Moffitt et al., 1996). This means that individuals can react differently to the effects of an environmental factor based on their genetic variants. Such an environmental factor could be, for example, childhood abuse. Such G × E interactions could partly explain why not all individuals who have been maltreated go on to show increased aggressive behavior as adults. One candidate for the genetic moderation of the effect of childhood maltreatment on antisocial and aggressive behaviors is the monoamine oxidase A gene (*MAOA*). Monoamine oxidase A is an important monoamine degrading enzyme encoded by *MAOA* located on the X chromosome (Xp11.23-11.4). *MAOA* comprises a functional polymorphism shown to influence interindividual differences in human behavior and brain function (Caspi et al., 2002; McDermott et al., 2009; Beaver et al., 2010; Gallardo-Pujol, Andrés-Pueyo, & Maydeu-Olivares, 2013).

There is initial evidence for the role of the *MAOA* promoter polymorphisms activity level in the prediction of symptoms of aggressive and antisocial behavior (Brunner et al., 1993; Gallardo-Pujol, Andrés-Pueyo, & Maydeu-Olivares., 2013). Studies suggest that individuals carrying the low functioning variant of the *MAOA* gene are at an increased risk of displaying antisocial or aggressive behaviors (Gabel et al., 1995; Lawson et al., 2003; Weder et al., 2009; Gallardo-Pujol, Andrés-Pueyo, & Maydeu-Olivares, 2013).

Beaver et al. (2010), for example, tested the role of variation in the *MAOA* genotype in gang membership and weapon use in a study of the adolescent health of 1041 men and 1155 women.

The study concluded that the low-activity polymorphism of the *MAOA* increased the risk of becoming engaged in violence and antisocial behavior in men, but not in women.

Nilsson et al. (2006) tested the role of psychosocial factors in 16- to 19-year-olds in a sample of 81 men adolescent criminal activities in Sweden. The study concluded that the presence of the low-activity polymorphism of the *MAOA* gene increased the risk of boys engaging in adolescent delinquency or aggressive behavior together with psychosocial factors. A recent meta-analysis, however, did not find consistent evidence of a main effect of the *MAOA*-gene on aggressive behavior (Vassos, ollier, & Fazel, 2014).

Instead, it seems that the majority of evidence suggesting involvement of the *MAOA* gene in the development of aggressive and antisocial behaviors originates from interactions with environmental factors, specifically childhood maltreatment (Caspi et al., 2002; Foley et al., 2004; Kim-Cohen et al., 2006; Beach et al., 2010).

There are a number of studies that have tested the role of genetic variants of the *MAOA* gene explaining in interaction with childhood maltreatment variations in aggressive behavior and conduct disorder in men (Caspi et al., 2002; Foley et al., 2004; Kim-Cohen et al., 2006). Caspi et al. (2002) studied 442 men in New Zealand and Australia who had been followed from birth until the age of 26 and found that there was an interaction between the *MAOA* genotype and childhood maltreatment on the development of antisocial behavior in adolescent and adulthood so that maltreated individuals carrying the high activity variant of the *MAOA* genotype were less likely to show later antisocial behaviors compared to the low activity variant of the *MAOA* genotype.

Foley et al. (2004) studied, using a sample of 514 male twins (aged 8–17), how childhood adversity affected development; adversity was defined as exposure to parental neglect. They found that the low activity subtype of the *MAOA* gene increased risk for conduct disorder only in the presence of adverse child environment.

Edwards et al. (2010) studied a sample of 250 men in a longitudinal study from the ages of 6 to 22 and found, in line with previous studies, a significant interaction effect between the *MAOA* genotype and physical discipline on antisocial behavior.

Åslund et al. (2010) studied the interaction between childhood maltreatment and genotype at the *MAOA* polymorphism on adolescents' delinquency in a sample of 943 men and 882 women (aged 17–18). They found that the *MAOA* polymorphism interacted with maltreatment in predicting delinquent behavior in both boys and girls.

Haberstick et al. (2005) studied 744 Caucasian men in a longitudinal North American sample and showed that the interactive effects between childhood and adolescent maltreatment and *MAOA* genotype on antisocial behavior were not significant.

Young et al. (2006) examined the interaction between *MAOA* genotype and maltreatment in the risk for antisocial behavior in a sample of 247 men. They found no interaction between the *MAOA* genotype and maltreatment.

In summary, the majority of studies having investigated an interaction between the *MAOA* genotype and childhood maltreatment on later aggressive or antisocial behaviors, indicate that carrying the low activity variant of the polymorphism increases the likelihood of later antisocial behavior for individuals who have been maltreated in childhood.

This is further corroborated by the results of a recent meta-analysis showing a significant interaction between the *MAOA* repeat polymorphism and childhood maltreatment on antisocial behavior (Buades-Rotger & Gallardo-Pujol, 2014; Byrd & Manuck, 2014).

Based on previous research, the following research questions were formulated:

(1) Is there an association between childhood physical and emotional abuse experiences and aggressive behavior in men and women?
(2) Is there an association between the *MAOA* polymorphism and aggressive behavior in men and in women?
(3) Are there interactions between abuse experiences and the *MAOA* polymorphism on aggressive behavior in men and in women?

2. Methods

2.1. Participants

The analyses of the present study were based on the responses of 1447 male and 2179 female twins and their siblings. The mean age of the men was 26.5 (SD = 4.9) and of the women 26.5 (SD = 5.3) years. The participants were a subset of the second data collection of the population-based Genetics of Sex and Aggression (GSA) survey conducted in 2006. All Finnish-speaking twin-pairs residing in Finland born between 22 July 1973 and 1 March 1988 as well as their siblings. Eighteen years or older were contacted by mail. A total of 10524 participants responded to the GSA survey in Finnish (the instruments were translated into Finnish for the purposes of the present study), indicating an overall participation rate of 44.6%. However, a total of 403 surveys were returned by postal services due to false address information. Since the postal services are not obliged to return undelivered mail, it is hard to estimate the actual number of respondents who never received the inquiry and consequently the response rate might be considerably higher. According to Statistics Finland (www.stat.fi), approximately 15% of Finns move each year. For further information on the data collection see Johansson et al. (2013).

The participants could, in addition to answering the survey, also notify whether they wanted to participate by giving samples of saliva for DNA and hormone analyses that were carried out as a part of the research project. The present study consists of the participants who gave DNA sample (3956). Furthermore, some twin pairs had unknown zygosity – in which case we chose to randomly exclude one of the twins in a twin pair with unknown zygosity. Participants who did not answer the Childhood Trauma Questionnaire (CTQ; Bernstein & Fink, 1998) or the Aggression Questionnaire (AQ; Buss & Perry, 1992) were excluded from the sample for the present analyses resulting in a final sample of 3626.

2.2. Measures

2.2.1. Childhood Trauma Questionnaire

The CTQ is a 28-item retrospective self-report questionnaire and was used in the present study to assess two types of traumatic childhood experiences of adults and adolescents: emotional abuse (e.g., "*People in my family said hurtful or insulting things to me*") and physical abuse (e.g., "*I was punished with a belt, a board, a cord, or some other hard object*"). These experiences were each assessed by five items. Items on the CTQ are rated on a 1 ("*never*") to 5 ("*very often*") Likert scale. Scores range from 5 to 25 for both physical and emotional abuse. The CTQ has demonstrated good reliability and validity, including test–retest reliability coefficients ranging from 0.79 to 0.86 over an average of four months, internal consistency reliability coefficients

ranging from a median of 0.66 to a median of 0.92 across a range of samples (Bernstein & Fink, 1998), convergent validity with both a clinical-rated interview if childhood abuse and therapists' ratings of abuse, and a consistent five-factor structure (Bernstein et al., 1997; Bernstein & Fink, 1998). In the present sample, Cronbach's α for the items measuring physical abuse was 0.70, and 0.81 for the items measuring emotional abuse.

2.2.2. *Aggression Questionnaire*

The original AQ consists of 29 items measuring four different factors (Buss & Perry, 1992). In the current study, two factors were used: (1) Physical Aggression consists of nine items (N items, e.g., "*If I have to resort to violence to protect my rights, I will*"), (2) Verbal Aggression consist of five items (N items, e.g., "*I tell my friends openly when I disagree with them*"). The total scores for these two aggression variables were calculated as the sum of the responses on the items. Items on the AQ are rated on a 1 ("*extremely uncharacteristic of me*") to 5 ("*extremely characteristic of me*") Likert-type scale. The AQ has shown good reliability, both for internal consistency and test–retest correlations, as well as convergent validity with other self-report measures of aggressions. In the present sample, Cronbach's α was 0.66 both for the items measuring physical aggression and for the items measuring verbal aggression.

2.3. Genotyping

Saliva samples were collected using the Oragene DNA self-collection kits that were posted to the participants and returned by them by mail. The participants were instructed to follow the manufacturer's instructions in collecting the samples (DNA Genotek, Inc., Kanata, Ontario, Canada) and to deposit approximately 2 mL of saliva into the collection cup. When an adequate sample was collected, the cap was placed on the cup and closed firmly. The collection cup is designed so that a stabilizing solution from the cap is released when closed. This solution mixes with the saliva and stabilizes the saliva sample for long-term storage at room temperature or in low-temperature freezers. Genomic DNA was extracted from saliva samples using AGOWA DNA Isolation Maxi kit with a Hamilton ML STAR (LGC Limited, Teddington, and Middlesex, UK). Genotyping was achieved by amplifying part of the promoter region with the polymerase chain reaction on a Perkin Elmer 9700 (PerkinElmer, Waltham, Massachusetts, USA) thermal cycler using 40 ng of genomic DNA, 0.5 mm each of forward (5′-CCCAGCGTGCTCCAGAAAC-3′, fluorescently labeled with VIC) and reverse primer (5′-GGACCTGGGCAGTTGTGC-3′) in an AmpliTaq Gold 360 Master Mix (Applied Biosystems Inc., Foster City, California, USA) solution. The cycling conditions for amplification consisted of an initial denaturation period of 5 minutes at 95°C, followed by 37 cycles of 30 seconds at 95°C, 30 seconds at 63°C, and 30 seconds at 72°C, followed by a final extension of 7 minutes at 72°C. The fluorescently labeled DNA fragments were analyzed by size with automated capillary electrophoresis using an ABI PRISM 3730 Genetic Analyzer (Applied Biosystems). Individuals with other than 3- or 4-repeat alleles of *MAOA* promoter polymorphism types were excluded.

2.4. Statistical analyses

Statistical analysis was performed with Statistical Package for the Social Sciences (Version 21.0; SPSS. Inc, Chicago, Illinois, USA). A correlation was used to identify the association between CTQ variables (emotional and physical abuse) and AQ variables (physical and verbal aggression).

Generalized Estimating Equations (GEE) were used to determine the effect of the 3- and the 4-repeat alleles of *MAOA* promoter polymorphism groups on physical and verbal aggression for men and women and also to detect the interactive effects between the 3- and the 4-repeat alleles of *MAOA* promoter polymorphism groups and CTQ variables on AQ variables for men and women.

The sample used in the present analysis consisted of twins and siblings. This means that responses from different members of the same family are correlated due to shared genetic and environmental factors reducing variance in the measures. To correct for this effect in the data analyses, we used GEE, which take such dependence between data units into account. In our model, family membership was the factor for which the results were corrected. A two-sided *p*-value less than 0.05 was considered significant in all analyses of direct effects and for the presence of interactions.

2.5. Hardy–Weinberg Equilibrium

An analysis of the Hardy–Weinberg Equilibrium (HWE) suggested a possible deviation ($p < 0.0024$) in women. It is important to point out that the *MAOA* promoter polymorphism is located on the X chromosome and that women have two X chromosomes, while men have one X chromosome and one Y chromosome. Thus, this analysis was only available for women for the *MAOA* genotype.

3. Results

3.1. Descriptive statistics and effects of gender

Physical aggression correlated positively with verbal aggression both for men and women indicating that a person displaying physical aggression is also likely to display verbal aggression (Table 1).

There were positive correlations between childhood maltreatment (i.e., physical and emotional abuse) and aggressive behaviors in men and women, indicating that a person who has experienced a physical and emotional abuse in childhood tends to demonstrate aggressive behavior in adolescence or adulthood (Table 1).

Table 1: Correlations between childhood trauma and physical and verbal aggression.

		AQ physical aggression	*AQ verbal aggression*
Men	AQ physical aggression	1	0.489***
	AQ verbal aggression	0.489***	1
	CTQ emotional abuse	0.167***	0.149***
	CTQ physical abuse	0.242***	0.136***
Women	AQ physical aggression	1	0.467***
	AQ verbal aggression	0.467***	1
	CTQ emotional abuse	0.252***	0.205***
	CTQ physical abuse	0.269***	0.166***

Note: Higher values indicate more aggression and more traumatic experiences.
***$p < 0.000$; **$p < 0.01$; *$p < 0.05$.

Men ($M = 1.39$, SE = 0.01) reported having experienced less emotional abuse than women ($M = 1.58$, SE = 0.01, $t = 8.74$, $p < 0.001$). On the other hand, men ($M = 1.35$, SE = 0.00) reported having experienced more physical abuse than women ($M = 1.31$, SE = 0.01, $t = 2.07$, $p < 0.038$).

With regards to gender differences in aggressive behaviors, men ($M = 1.88$, SE = 0.01) displayed higher levels of physical aggression than women ($M = 1.66$, SE = 0.01, $t = 239.10$, $p < 0.000$). Men ($M = 2.40$, SE = 0.01) and women ($M = 2.38$, SE = 0.01) did not, however, differ in their levels of verbal aggression ($t = 2.56$, $p > 0.109$).

Relatively older men and women reported less physical and verbal aggression than younger participants, as indicated by the negative correlations between physical aggression and age for men ($r = -0.139$, $p < 0.000$) and women ($r = -0.116$, $p < 0.000$), as well as the negative correlations between verbal aggression and age for men ($r = -0.136$, $p < 0.000$) and women ($r = -0.147$, $p < 0.000$).

There was a negative correlation between experiences of emotional abuse and age for women ($r = -0.052$, $p < 0.013$) but not for men ($r = -0.049$, $p > 0.057$). This means that older women reported having experienced less emotional abuse in their childhood compared to younger women. In addition, there was a negative correlation between experiences of physical abuse and age both for men ($r = -0.059$, $p < 0.023$) and women ($r = -0.044$, $p < 0.037$), indicating that older men and women reported having experienced less physical abuse in their childhood compared to younger men and women.

3.2. Genetic results

In women, a significant effect of the *MAOA* polymorphism was seen on physical aggressive behavior but not on verbal aggressive behavior (Table 2). In men, there were no main effects of *MAOA* polymorphism either on physical or verbal aggressive behavior (Table 2).

In women, there was an interaction ($\chi^2 = 6.949$, $p < 0.031$) between emotional abuse and *MAOA* genotype on physical aggression as follows: A stronger correlation was found in carriers of the 3-repeat allele genotype, indicating that women who have the 3-repeat allele together with emotional abuse in childhood tend to express more physically aggressive behaviors than other groups, the weakest a correlation being found in the 4-repeat allele genotype (Table 3).

A tendency toward an interaction between the *MAOA* polymorphism and emotional abuse on verbal aggression was seen in women ($\chi^2 = 5.823$, $p < 0.054$). A stronger correlation was again found in the 3-repeat allele genotype, that is, women who have the 3-repeat allele associated with emotional abuse in childhood tend to express more likelihood of verbal aggression behaviors than other groups. The weakest a correlation was found in the 4-repeat allele (Table 3).

Table 2: The effects of the MAOA polymorphism on aggressive behavior in women and men.

		Genotype 4/4 or 4		Genotype 3-/4-repeat		Genotype 3/3 or 3			
		M	SE	*M*	SE	*M*	SE	Wald χ^2	*p*
Women	AQ physical aggression	1.74	0.01	1.63	0.02	1.69	0.03	31.15	0.001
	AQ verbal aggression	2.34	0.11	2.35	0.017	2.34	0.026	.10	0.949
Men	AQ physical aggression	1.83	0.02	–	–	1.81	0.02	0.45	0.504
	AQ verbal aggression	2.34	0.02	–	–	2.36	0.02	0.433	0.511

Higher values indicate more self-reported aggression. Women are homozygous (4/4 or 3/3) or heterozygous for the different repeat genotypes whereas men are hemizygous for the 3- or 4-repeat allele.

Table 3: The correlation between MAOA polymorphism, childhood trauma, physical and verbal aggression in women and men.

		AQ physical aggression				AQ verbal aggression			
		Genotype 4/4 or 4	Genotype 3/4	Genotype 3/3 or 3	*Wald* χ^2	Genotype 4/4or 4	Genotype 3/4	Genotype3/3 or 3	*Wald* χ^2
Women	CTQ emotional abuse	0.178***	0.253***	0.313***	6.949*	0.156***	0.219***	0.248***	5.823 +
	CTQ physical abuse	0.256***	0.252***	0.271***	0.009	0.156***	0.159***	0.200***	0.516
Men	CTQ emotional abuse	0.126***	–	0.116***	0.494	0.135***	–	0.130***	0.572
	CTQ physical abuse	0.214***	–	0.235***	0.003	0.136***	–	0.124***	0.574

Higher values indicate stronger correlations between aggression and traumatic experiences. Women are homozygous (4/4 or 3/3) or heterozygous for the different repeat genotypes whereas men are hemizygous for the 3- or 4-repeat allele.
***$p < 0.000$; **$p < 0.01$; *$p < 0.05$; +$p < 0.10$.

In men no interaction between *MAOA* polymorphism and childhood abuse experiences on physical or verbal aggressive behavior was found.

4. Discussion

The current study tested whether the *MAOA* polymorphism had main effects on aggressive behavior as well as whether the polymorphism moderated the effect of childhood abuse experiences on aggressive behavior in adulthood.

In accordance to the well-acknowledged finding that childhood maltreatment predicts later aggressive behavior, a robust relationship between childhood maltreatment and later aggressive behavior in adulthood was found in the present study for both men and women. This result is consistent with the findings of previous studies (Haberstick et al., 2005; Huizinga et al., 2006; Gilbert et al., 2009; Taylor et al., 2009).

Our results revealed that, for women, there was a main effect of the *MAOA* polymorphism on physical aggressive behavior, indicating that women with the 4-repeat allele of the *MAOA* promoter polymorphism tended to show higher levels of physically aggressive behaviors than women carrying at least one of the 3-repeat or the 3- and the 4-repeat alleles of the *MAOA* promoter polymorphism. These results confirm previous findings that have found a main effect of the *MAOA* (Sjöberg et al. 2007).

In men the effects of different levels of the MAOA polymorphism were no longer statistically significant to predict either verbal or physical aggression. This is in line with the findings made by Nilsson et al. (2006) and Huizinga et al. (2006).

In addition, we found an interaction between the *MAOA* polymorphism and emotional abuse on physical aggression in women, indicating a higher sensitivity to childhood adversity in the presence of the MAOA polymorphism. This result is consistent with the previous findings of Prom-Wormley et al. (2009), in which women with the 3-repeat allele of the *MAOA* promoter polymorphism and childhood maltreated interactions predispose for aggressive behavior in adulthood. This result is consistent with the previous findings found but with rather different groups of the 3.5- and the 4-repeat allele of *MAOA* promoter polymorphism (Sjöberg et al., 2007; McGrath et al., 2012), and even in a large population-based study of adolescent females (Åslund et al., 2010). Nevertheless, there are also previous studies that have found no interaction (Huang et al., 2004; Frazzetto et al. 2007).

This study failed to confirm previous findings in men for the presence of an interaction between *MAOA* polymorphism and childhood maltreatment to predict aggressive behavior in adolescence or adulthood (Caspi et al., 2002; Foley et al., 2004; Kim-Cohen et al., 2006; Nilsson et al., 2006; Widom & Brzustowicz, 2006; Åslund et al., 2010; Edwards et al., 2010; Gallardo-Pujol, Andrés-Pueyo, & Maydeu-Olivares, 2013). Likewise, other researchers have found similar findings to those of our research with a nonsignificant trend (Haberstick et al., 2005; Huizinga et al., 2006; Young et al., 2006).

A meta-analysis by Byrd and Manuck (2014) found the 4-repeat allele of *MAOA* promoter polymorphism to be the "risk" allele for antisocial behavior only in interaction with childhood maltreatment in women (although the effect disappeared when deleting a few studies from the meta-analysis, this pooled evidence contradicts our findings).

It is possible that incomplete X-inactivation at the *MAOA* locus could produce a different expression profile in women (Benjamin, Van Badel, & Craig, 2000) yielding a sex difference in *MAOA* product.

It is worth mentioning that the effect sizes obtained for the gene–environment interaction obtained are low. This is also true for the correlations between age and experiences of abuse and to some extent also of the correlations between age and reported aggression.

There were several differences between the current study and those reporting different results. These include different approaches of measuring childhood maltreatment. In the present study, the CTQ involving two variables emotional and physical abuse and AQ involving two variables verbal and physical aggression were used. The 4-repeat allele and the 3- and the 4-repeat alleles of *MAOA* promoter polymorphism groups were also used.

Furthermore, the sample used consisted of a relatively large population-based Finnish sample of 1447 men and 2179 women. Therefore, this is an important contribution to replicate previous attempts and would contribute to a high sensitivity for a generalized interpretation of the results as an interaction between the genotype and childhood abuse experiences to predict aggressive behavior in adolescence or adulthood. Interestingly, to our knowledge, this study is considered one of the first studies to include a large sample comprising both men and women, while most previous studies examined a sample of exclusively men.

Some limitations of this study should be noted. First, the participants may change the facts or provide incorrect responses in the questionnaire. Second, the questionnaire is about events that occurred in childhood, therefore it is possible that the participants do not remember the events well, or they were not willing to answer accurately.

The measures were based on self-reports, not official reports. This necessarily raises the possibility that the measures could be unreliable. Furthermore, the analyses for this study were confined only to a Finnish-based population.

However, these limitations should not distract from the fact that this study revealed a partial support for an interaction between *MAOA* genotype and childhood abuse experiences to predict aggressive behavior in adolescence or adulthood.

Disclosure statement

No potential conflict of interest was reported by the authors.

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