Dark Triad traits mediate the interaction between childhood abuse and *COMT* Val158Met polymorphism on aggression among incarcerated Chinese males

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Abstract

Both childhood abuse and Catechol-O-methyltransferase (*COMT*) Val158Met polymorphism are implicated in aggression; however, their interactive effects on aggression and the related psychological mechanisms have not been clearly established. Furthermore, the Dark Triad traits (i.e., Machiavellianism, narcissism, and psychopathy), which are closely related to aggression, may mediate the abuse-aggression link. The current study aims to examine how Dark Triad traits mediate the childhood abuse × *COMT* polymorphism genotype-aggression link. A total of 680 incarcerated Chinese males completed the Reactive-Proactive Aggression Questionnaire, Adverse Childhood Experiences Questionnaire, and the Dirty Dozen Scale. DNA was extracted from their venous blood. When controlling for the inter-correlation between the two types of aggression, the results show indirect effects of childhood abuse on proactive aggression through all three Dark Triad traits, but only through narcissism on reactive aggression. Additionally, the *COMT* Val-158Met polymorphism moderated the relation between childhood abuse and psychopathy; specifically, carriers of the Val/Val homozygote who perceived higher levels of childhood abuse demonstrated higher levels of psychopathy, which was related to higher proactive aggression. These findings have implications for understanding mechanisms of the abuse-aggression link.

Keywords Childhood Abuse · Aggression · Dark Triad Traits · *COMT* Val[158]Met · Gene-Environment Interaction

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Introduction

Aggression is a risk factor for violent crime and violent behavior in jail (Sarchiapone et al., 2009) and has serious ramifications for inmates' well-being and safety. It is of paramount importance to have a parsimonious theoretical and conceptual understanding of the antecedents of aggression among inmates to help improve forensic risk assessment and prison security (Gardner et al., 2015). Biological and environmental factors are posited to influence proximal personality traits and situational perceptions that ultimately increase aggression (Allen et al., 2018). Thus, biological factors (e.g., genetic polymorphisms) may interact with environmental exposures (e.g., gene-environment interaction) to influence aggressive traits. A particularly relevant environmental contributor to aggression is childhood abuse, as the prevalence of childhood abuse is higher among incarcerated samples compared to the general population (Bodkin et al., 2019; Wolff & Shi, 2012). However, not everyone who experiences abuse goes on to engage in aggressive behavior (Choi et al.,

2019). This could be explained by the moderating effects of genetic vulnerabilities on violent behavior or aggressive traits (Caspi et al., 2002; Moffitt, 2005). To this end, the current study further investigates the moderating role of genotype and the mediating role of personality on the relations between childhood abuse and aggression among a sample of incarcerated males.

Childhood abuse is an environmental modifier empirically associated with aggressive behavior (Debowska et al., 2017). A recent meta-analysis indicates that individuals exposed to maltreatment experiences during childhood are more likely to display violent behaviors in adulthood (Fitton et al., 2020). However, this observed maltreatment-aggression link may depend on the type of maltreatment. A meta-analysis of 33 longitudinal studies found that physical, sexual, and emotional childhood abuse are more strongly associated with aggressive behaviors than general antisocial behaviors, while neglect increased the risk of general antisocial involvement (Braga et al., 2017). Thus, it appears that physical, sexual, and emotional forms of childhood abuse may act as environmental modifiers contributing to aggression.

Genetic dispositions may be one of the most salient biological factors associated with aggression as findings consistently indicate that aggression is partly heritable, with genetic factors explaining nearly 50% of the observed variance in aggression (Odintsova et al., 2019). The catechol-O-methyltransferase (*COMT)* gene, in particular, may be the most relevant candidate genes related to aggression (Qayyum et al., 2015). The *COMT* gene is responsible for metabolizing catecholamine neurotransmitters like dopamine, which is essential to executive functioning in the prefrontal cortex (Diamond, 2007). Specifically, the valine (Val) allele (vs. Methionine [Met] allele) at codon 158 (i.e., rs4680) is associated with higher activation of *COMT* enzyme (Lachman et al., 1996), which increases prefrontal dopamine catabolism and reduces executive functioning (Chen et al., 2004; Goldberg et al., 2003). Impaired executive functioning (e.g., low self-control and planning) is related to antisocial behavior including criminality, physical aggression, and clinical syndromes such as psychopathy (Ogilvie et al., 2011).

Research examining the link between the *COMT* Val-158Met polymorphisms and aggression yields mixed results. For example, Caspi et al. (2008) and Monuteaux et al. (2009) found that the Val homozygotes were more aggressive (e.g., more likely to engage in aggressive conduct behaviors and be convicted of criminal offenses) compared to the Met carriers in samples of individuals with attention-deficit/hyperactivity disorder. Conversely, Albaugh et al. (2010) found that youth carrying the Met allele scored higher on both direct (e.g., physically attacks people) and relational aggression (e.g., easily jealous) compared to the Val homozygotes. Disparities in the *COMT*-aggression link may suggest the interactive effect of genetic and environmental factors.

Interaction between the *COMT* Val158Met polymorphism and childhood abuse on aggression and aggression-related traits varies across studies. For example, the Val homozygotes who experienced abuse or other stressors during childhood are more likely to display high levels of aggression compared to carriers of the Met allele (Hygen et al., 2015). Additional results in a sample of adults show that Val allele carriers who experienced sexual abuse have a greater disposition toward anger than the Met homozygotes (Perroud et al., 2010). Contrarily, studies in adolescent samples found that Met allele carriers, compared to the Val-homozygotes, display more externalizing problems (Nederhof et al., 2012) and higher reactive aggression (Zhang et al., 2016) after experiencing childhood stressors, such as parental divorce (Nederhof et al., 2012) and low positive parenting (Zhang et al., 2016). These inconsistent findings may be attributed to the use of different samples and varying measures of aggression (Qayyum et al., 2015). Taken together, it seems opportune for future research to narrow the focus of the *COMT*-aggression link to specific aggression types within specific populations (Qayyum et al., 2015), such as incarcerated males with relatively higher aggression.

Aggression is often classified as being either reactive or proactive (Dodge & Coie, 1987; Fite et al., 2018). Reactive aggression is considered a "hot" and retaliatory form of aggression, and is typically conceptualized within the frustration-aggression model (Gelles & Berkowitz, 1994). Alternatively, proactive aggression is framed within social learning paradigms (Berkowitz, 1978; Card & Little, 2007; Fite et al., 2018) and involves goal-oriented and socially dominant aggression. Previous studies indicate that different types of childhood abuse may be differentially related to reactive and proactive aggression (Richey et al., 2016; Zhu et al., 2020). However, more research needs to test whether the interaction between childhood abuse and *COMT* influences the observed variation in the manifestation of these aggressive subtypes (Zhang et al., 2016).

Personality traits are potential mediators of the Gene × Environment effects on aggression (Allen et al., 2018). Three personality traits comprising the Dark Triad (i.e., Machiavellianism, narcissism, and psychopathy; Paulhus & Williams, 2002) are associated with childhood adversity (Csatho & Birkas, 2018) and aggression (Jones & Neria, 2015). The Dark Triad traits also seem to mediate the link between childhood abuse and cyberbullying (Kircaburun et al., 2019), as well as the link between early adversity and interpersonal aggression (Figueredo et al., 2020). From the perspective of the Life History Theory (Roff, 2002), the Dark Triad traits emerge when adapting to adverse, harsh, and unpredictable environments (Brumbach et al., 2009; Plouffe et al., 2020). Several studies report significant associations between the Dark Triad traits and different types of aggressive behavior, such as bullying (Baughman et al.,

2012), cyberbullying (Kircaburun et al., 2019), and intimate partner violence (Kiire, 2017). Additionally, variance in narcissism and psychopathy is also explained by genetic and non-shared environmental factors, while Machiavellianism may only be attributable to environmental effects (Veselka et al., 2011). Taken together, these findings suggest that the Dark Triad traits may mediate the link between childhood abuse and trait aggression, however, it is not yet clear how the *COMT* Val158Met polymorphism modifies the abuse-aggression link as mediated by personality. Accordingly, this study tests whether the direct and indirect effect of childhood abuse on trait aggression is moderated by the *COMT* Val-158Met polymorphism which is then be mediated by Dark Triad traits. Due to mixed results of the moderation effect by the *COMT* genotypes, no specific direction regarding the moderation effect was hypothesized.

Method

Participants

Participants were recruited from a centralized male prison in a southern province of China who were convicted of crimes in several cities and towns surrounding this province. Participants included male inmates without a recorded diagnosis of a severe somatic pathology or psychopathological disorder upon intake. Male inmates were chosen given that they display higher levels of aggression (Falk et al., 2017) and are more likely to commit violent crimes than female inmates (Anderson & Huesmann, 2007). To achieve a statistical power level of 0.80, with effect sizes (partial R square) between 0.01 to 0.03 and $\alpha = 0.05$ for G×E interaction under the assumption of a linear multiple regression fixed model (Wang et al., 2019), power analysis using G*Power (Faul et al., 2009) indicated the recommended minimum sample size to detect gene-environment interaction effects was 256 to 779. Participants were recruited only if they were within one month of their imprisonment and had completed the required prison adaptation and health services administrative courses.

Invitation letters were distributed to participants following completion of the prison adaption courses discussed above. An initial sample of 774 incarcerated Chinese males were contacted, with 752 of these inmates accepting the invitation for participation. These participants were provided with invitation letters and informed consent for the current study. Participants were compensated with a notepad as an incentive following data collection. Data collection was carried out by a group of trained researchers acquainted with the aims and measures of the study. Participants' demographics (e.g., age, educational level, and criminal offenses) were provided by prison administrative staff. Participants'

biological material (i.e., three milliliters of venous blood) was collected by certified phlebotomists from the prison infirmary on a weekday morning during a routine physical examination. Biological material was then sent to the Northwest University for genotyping. All aspects of this study were approved by the Ethics Committee of the College of Psychology, Shenzhen University.

The final analytic sample included 680 participants ($M_{age} = 32.49$ years, $SD = 9.20$, 18–74 years; 5.3% of non-Han ethnicity, $n = 36$). A total of 72 participants were removed from the initial recruitment sample because they either voluntarily dropped out of the study, provided incomplete responses to questionnaires, or did not provide biological material. The education levels of the analytic sample were as follows: 29.9% below middle school, 57.8% middle school, and 12.3% above middle school (including vocational school, high school, and college). Participants were incarcerated for a variety of offenses including violent crimes ($n = 196$, 28.8%), property crimes ($n = 327$, 48.1%), drug crimes ($n = 73$, 10.7%), sex crimes ($n = 38$, 5.6%), and other crimes ($n = 46$, 6.8%).

Measures

Childhood Abuse Childhood abuse experiences were assessed with the abuse subscale of the Chinese version (Fan et al., 2011) of the Adverse Childhood Experiences Questionnaire (Dong et al., 2004). The abuse subscale includes two items, respectively, for emotional and physical abuse with five response categories (*never* = 1, *once or twice* = 2, *sometimes* = 3, *often* = 4, or *very often* = 5), and four items for sexual abuse with two responses (*yes* = 1, *no* = 0). Experiencing each type of abuse was coded as 1, else as 0, according to the criteria by Dong et al. (2004), which generates three binary indicators. Confirmatory factor analysis indicated that the three-factor abuse subscale provided a good fit to our data ($\chi^2 = 21.231$, $df = 17$, RMSEA = 0.02, CFI = 0.99, TLI = 0.99, SRMR = 0.06). Referring to the previous study (Cheong et al., 2017), the three abuse types were averaged (Cronbach's $\alpha = 0.72$) to obtain a score of childhood abuse ($M = 0.19$, $SD = 0.26$).

Reactive and Proactive Aggression Reactive and proactive aggression was assessed with the Chinese version (Zhang et al., 2014) of the Reactive–Proactive Aggression Questionnaire (Raine et al., 2006). This scale consists of 23 items, scored on a 3-point Likert scale ranging from 0 (*never*) to 2 (*often*). Confirmatory factor analysis indicated that the two-factor construct provided a good fit to our data ($\chi^2 = 735.69$, $df = 229$, RMSEA = 0.06, CFI = 0.89, TLI = 0.88, SRMR = 0.05). The Cronbach's α was 0.84 for reactive aggression and 0.87 for proactive aggression. Scales were averaged into reactive ($M = 0.82$, $SD = 0.37$)

and proactive ($M = 0.21$, $SD = 0.29$) aggression scores, with a higher value indicating higher levels of trait aggression.

Dark Triad Traits The Dark Triad traits (i.e., Machiavellianism, narcissism, and psychopathy) were assessed by the Chinese version (Geng et al., 2015) of the Dirty Dozen scale (Jonason & Webster, 2010). The Dirty Dozen scale includes 12 items with four items for each trait, scored on a Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Confirmatory factor analysis indicated that the three-factor model provided a good fit to our data ($\chi^2 = 240.73$, $df = 51$, RMSEA = 0.07, CFI = 0.92, TLI = 0.89, SRMR = 0.05). The Cronbach's α for Machiavellianism, narcissism, and psychopathy were 0.80, 0.84, and 0.76, respectively. An average score was derived for each trait (Machiavellianism, $M = 2.30$, $SD = 1.29$; narcissism, $M = 4.34$, $SD = 1.65$; psychopathy, $M = 2.53$, $SD = 1.39$), with higher scores indicating higher levels for that specific trait.

Genotyping

Genomic DNA was extracted from venous blood using the TIANamp Genomic DNA Kit (DP304; Tiangen Biotech Co., Ltd., Beijing, China). The *COMT* Val158Met polymorphism was amplified by polymerase chain reaction (PCR) with an upstream primer, 5'-CCAGCGGATGGTGGATTTCGC ACGC-3' and a downstream primer 5'-TGGGGGGGTCTT TCCTCAGCC-3'. The genotyping procedures and details were described in a previous study (Gong et al., 2013). Upon genotyping, six samples were randomly selected from each genotype group for sequencing to determine the specific genotypes. The genotypes were scanned with the Multi-Spectral imaging System. Participants genotypes were classified as the Val/Val ($n = 396$, 58.2%), Met/Val ($n = 220$, 32.4%), and Met/Met ($n = 64$, 9.4%), which is consistent with the distribution of this genotype across other samples taken from Asian ancestries (Sindermann et al., 2018). The distribution of the genotype deviated from the Hardy–Weinberg equilibrium ($\chi^2 = 15.387$, $p < 0.001$). Owing to a small number of participants with the Met/Met genotype, participants' genotypes were coded as 0 = Met allele carriers (Met/Met and Met/Val) and 1 = Val homozygotes (Val/Val) according to the previous studies (Hygen et al., 2015; Zhang et al., 2016).

Statistical Analyses

Continuous variables (age, childhood abuse, proactive and reactive aggression, and Dark Triad traits) and the ordinal variable (educational level) were standardized prior to analyses, to create similar scales and to avoid multicollinearity. Considering the correlation between proactive and reactive aggression, we took standardized residuals while controlling for the other aggression scale as an additional

indicator of the outcomes in the following analysis (Raine et al., 2006). This method allows us to assess the "refined" proactive or reactive aggression measure independent of the other aggression scale effect. The analyses then proceeded in a series of linked steps. First, we ruled out potential gene-environment correlations (*r*GE) by assessing bivariate correlations and ANOVAs (Kim-Cohen et al., 2006) between the *COMT* genotype and all the variables in the analysis. Following this, and in line with suggestions from previous candidate gene-environment interaction (cGxE) studies (Dick et al., 2015), we then entered gene-by-covariate (i.e., age, educational level) and environment-by-covariate interaction terms into a series of conditional process models. The first model was a mediation model (Model 4 in PROCESS 3.5 macro; Hayes, 2013) examining the mediating roles of Dark Triad traits (measured with the Dirty Dozen scale) on the relation between abuse and reactive/proactive aggression. Then, a moderation model (Model 1 in PROCESS) was built to test the interactive effects of childhood abuse and the *COMT* genotype on reactive/proactive aggression and Dark Triad traits. Finally, a conditional process moderated-mediation model (Model 8 in PROCESS) was applied to assess whether the Dark Triad traits mediated the abuse-aggression relation as moderated by the *COMT* genotype.

We used the Bias-Corrected Bootstrap approach with 10,000 bootstrap resamples to compute the 95% confidence intervals (CI) for estimating effects. If the 95% CI does not contain zero, then the direct or indirect effects are considered significant. The index of moderated-mediation (Hayes, 2015) was calculated to examine differences in indirect effects between the two genetic groups. An index that is significantly different from zero indicates that the indirect effects are significantly different between the two genotypes. As our participants included non-Han ethnicities ($n = 36$), the robustness of results were examined through a sensitivity analysis (Zhang et al., 2018) after excluding these participants.

Results

Preliminary Analysis

Table S1 presents means, *SD*s, and bivariate correlations among study variables. The *COMT* Val158Met polymorphism was not significantly correlated with childhood abuse ($r = -0.001$, $p = 0.990$), and there was no significant difference in childhood abuse between the two *COMT* genotypes ($M_{\text{Met carriers}} = 0.185$ vs. $M_{\text{Val/Val}} = 0.185$, $t = 0.013$, $p = 0.990$). These results indicate that any *r*GE effects would be small in the present study, though correlations among unmeasured genes and environments (e.g., parental phenotypes and positive environment) cannot be ruled out.

Simple Mediation Analyses

As shown in Figs. 1A and 1B, Machiavellianism, narcissism, and psychopathy mediated the abuse-aggression links ($b = 0.030$–0.044 for reactive aggression and $b = 0.012$–0.077 for proactive aggression). Childhood abuse had a significant direct effect on reactive aggression ($b = 0.146$, $SE = 0.034$, $p < 0.001$) and proactive aggression ($b = 0.069$, $SE = 0.034$, $p = 0.042$). When controlling the inter-correlation between the two aggression types, different paths emerged (see Fig. 1C and 1D). Specifically, only narcissism mediated the abuse-reactive aggression link ($b = 0.046$, CI [0.022, 0.076]), while all the Dark Triad traits mediated the abuse-proactive aggression link ($b = 0.073$, CI [0.039, 0.115] for Machiavellianism; $b = -0.018$, CI [-0.035, -0.006] for narcissism; $b = 0.037$, CI [0.017, 0.061] for psychopathy). Childhood abuse had a significant direct effect on "refined" reactive aggression ($b = 0.131$, $SE = 0.038$, $p < 0.001$), but not on "refined" proactive aggression ($b = -0.023$, $SE = 0.037$, $p = 0.536$), which implies narcissism partially mediated the abuse-reactive aggression link, while all the Dark Triad traits fully mediated the abuse-proactive aggression link.

Simple Moderation Analyses

Simple moderation analyses (see Table S2 and S3) showed that the *COMT* genotype did not moderate the relationship between abuse and aggression ($b = 0.101$, $SE = 0.076$,

$p = 0.185$ for reactive aggression; $b = 0.149$, $SE = 0.076$, $p = 0.050$ for proactive aggression). Moderation effects remained the same for the "refined" types of aggression. The *COMT* genotype moderated the association between childhood abuse and psychopathy ($b = 0.162$, $SE = 0.075$, $p = 0.031$), but not Machiavellianism ($b = 0.137$, $SE = 0.076$, $p = 0.072$) or narcissism ($b = -0.009$, $SE = 0.078$, $p = 0.910$). Simple slopes tests showed that the effect of childhood abuse on psychopathy was larger among the Val/Val carriers ($b = 0.274$, $SE = 0.048$, $p < 0.001$) than the Met carriers ($b = 0.111$, $SE = 0.058$, $p = 0.055$).

Moderated Mediation Analyses

As shown in Figs. 2A and 2B, the indices of moderated mediation were only significantly different from zero for psychopathy (reactive aggression: index = 0.033, CI [0.003, 0.070]; proactive aggression: index = 0.043, CI [0.004, 0.086]), but not for Machiavellianism (reactive aggression: index = 0.015, CI [-0.002, 0.042]; proactive aggression: index = 0.041, CI [-0.004, 0.099]) or narcissism (reactive aggression: index = -0.003, CI [-0.049, 0.045]; proactive aggression: index = -0.001, CI [-0.014, 0.014]). Moderated mediation analyses (see Table S4) showed that the conditional indirect effects of childhood abuse on aggression via psychopathy were higher in the Val homozygotes ($b = 0.056$, CI [0.028, 0.091] for reactive aggression; $b = 0.072$, CI [0.040,
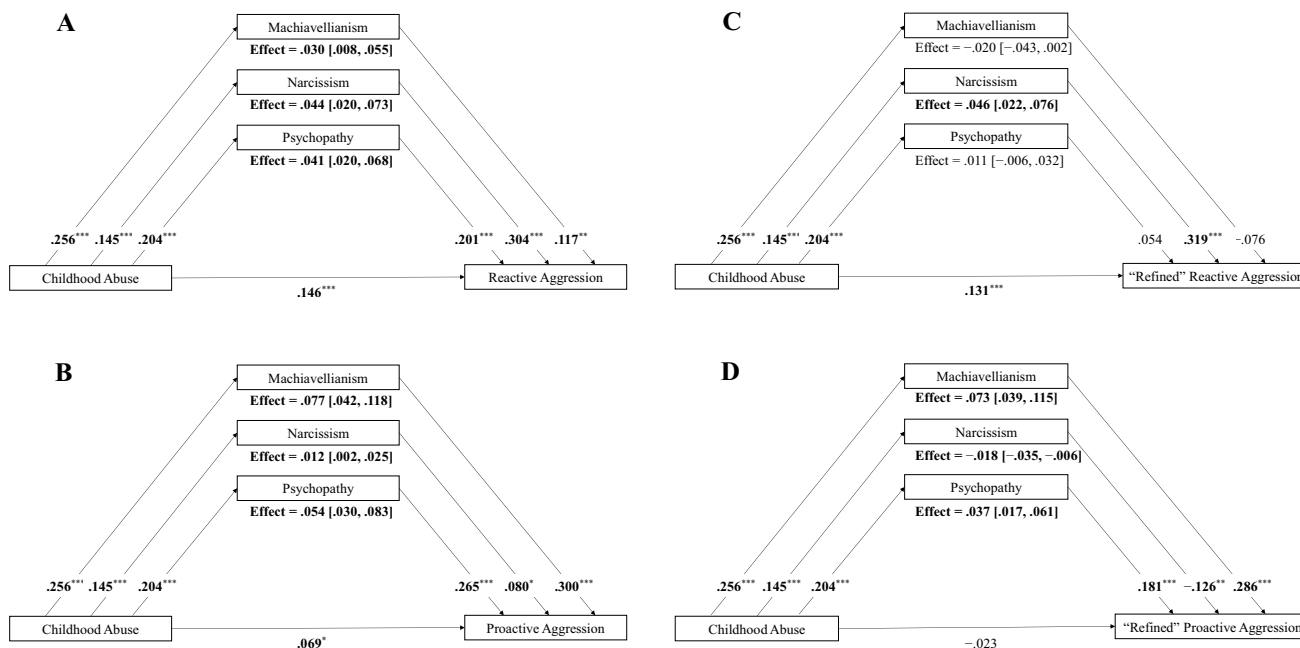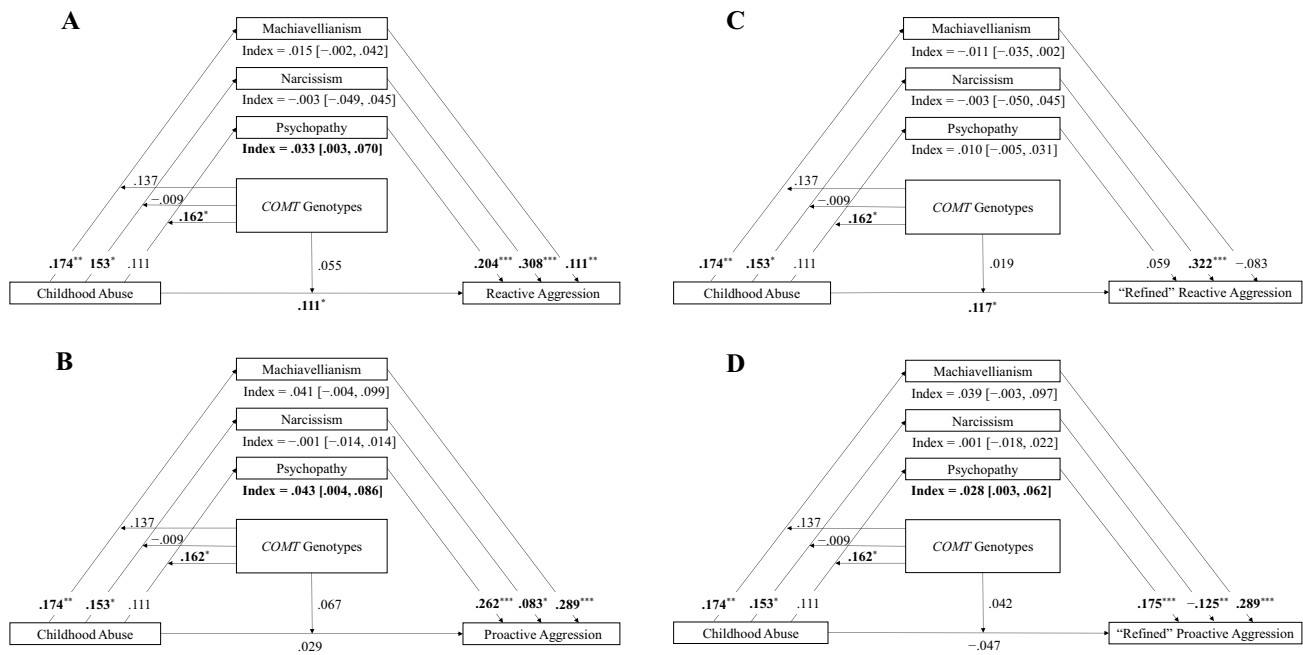

Fig. 1 The simple mediation model: Effects of childhood abuse through Machiavellianism, narcissism, and psychopathy on reactive (panel A), proactive (panel B), "refined" reactive (panel C), and "refined" proactive (panel D) aggression. *Note*. 95% Boot CI of indirect effects are shown in brackets with significant coefficients highlighted in bold. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

Fig. 2 The moderated mediation model: Effects of childhood abuse through Machiavellianism, narcissism, and psychopathy on reactive (panel A), proactive (panel B), "refined" reactive (panel C), and "refined" proactive (panel D) aggression conditionally. *Note.* Index indicates the moderated mediation effects, and 95% Boot CI of the index is shown in brackets with significant coefficients highlighted in bold. $^*p < .05$. $^{**}p < .01$. $^{***}p < .001$

0.110] for proactive aggression) than in the Met carriers ($b = 0.023$, CI [0.001, 0.051] for reactive aggression; $b = 0.029$, CI [0.001, 0.062] for proactive aggression). The *COMT* genotype did not moderate the direct effect of childhood abuse on reactive ($b = 0.055$, $SE = 0.067$, $p = 0.413$) and proactive aggression ($b = 0.067$, $SE = 0.066$, $p = 0.315$).

As shown in Figs. 2C, 2D, and Table S5, when controlling the inter-correlation between the two types of aggression, the direct and indirect effects for both genotypes remained similar to those found in the simple mediation model (see Figs. 1C, 1D). The only exception was the moderated indirect effect via psychopathy (index = 0.028, CI [0.003, 0.062]): The conditional indirect effect of childhood abuse on "refined" proactive aggression was higher in the Val homozygotes ($b = 0.048$, CI [0.022, 0.080]) than in the Met carriers ($b = 0.020$, CI [0.001, 0.044]).

Supplementary Analyses

The sensitivity analyses indicated that the results of the moderated mediation models for the "refined" reactive and proactive aggression remained almost the same (see supplementary material Table S6 and Figure S1) after excluding participants of non-Han ethnicity ($n = 36$).

Discussion

This study examined relations between childhood abuse and aggression in a sample of incarcerated males. We found that the Dark Triad traits mediated the abuse-aggression link and that the *COMT* Val158Met polymorphism moderated the effect of childhood abuse on psychopathy. Specifically, among those who reported higher levels of childhood abuse, carriers of the Val homozygote showed higher levels of psychopathy and higher levels of aggression compared to the Met carriers. We found additional distinct paths after controlling for the inter-correlation between reactive and proactive aggression. Specifically, the three Dark Triad traits mediated the abuse and "refined" proactive aggression link, with a relatively greater effect through psychopathy for the Val carriers. Only narcissism mediated the abuse and "refined" reactive aggression link.

Similar to previous studies (Figueredo et al., 2020; Kircaburun et al., 2019), simple mediation model in the current study found that the Dark Triad traits mediated the abuse-aggression relation. In other words, individuals who experienced more childhood abuse had higher Dark Triad traits which, in turn, were related to higher levels of aggression. These findings is consistent with Life History Theory (Roff, 2002), and suggest a possibility that experiences of abuse may increase the adoption of fast life history strategies. Fast life history strategies are characterized by present-oriented

behaviors and proclivities, such as those captured by the Dark Triad, aimed at maximizing immediate rewards and mating efforts (Csatho & Birkas, 2018; Jonason et al., 2010). Thus aggression, a fast strategy to survive in an early environment that is perceived as threatening, may be adopted by people who have higher Dark Triad traits (McDonald et al., 2012). However, further research is needed to test the potential causality from childhood abuse to Dark Triad, because a reverse or bidirectional path from the Dark Triad to childhood abuse cannot be completely ruled out given the correlational nature of cross-sectional design in the current study.

For the "refined" types of aggression, all the three Dark Triad traits fully mediated the abuse-proactive aggression link, while only narcissism partially mediated the abuse-reactive aggression in male inmates. This finding adds an important contribution to the literature on linkages among childhood abuse, Dark Triad traits, and aggression in samples of inmates, who have relatively high aggression, and even more robust links between childhood maltreatment and psychopathic traits (Plouffe et al., 2020). Specifically, it suggests that incarcerated Chinese males may engage in more reactive and proactive aggression via the different links between early exposure to childhood abuse and Dark Triad traits. This is consistent with prior research which reports that, among males, psychopathy was strongly associated with proactive aggression, while agreeableness was the most important predictor for reactive aggression (Dinic & Wertag, 2018). Broadly, the current findings further suggest that childhood abuse may influence development of an impaired sense of morality and even less empathy, which is related to higher proactive aggression, in male inmates. Future research should test these findings in general populations of males and females.

Notably, childhood abuse was positively associated with higher narcissism, which was related to higher "refined" reactive aggression but lower "refined" proactive aggression. Within the theoretical framework of Dark Triad traits, narcissism involves a grandiose sense of self (e.g., arrogance, Du et al., 2021). This type of grandiose narcissism is associated with both types of aggression, but in opposite directions across different studies (e.g., positive in Du et al., 2021 and negative in Knight et al., 2018). The current study supports the findings that grandiose narcissism, which is relatively higher in men (Grijalva et al., 2015), may develop as a coping mechanism to childhood abuse (Keene & Epps, 2016; Kernberg, 2014). Narcissism and reactive aggression may act as a kind of defensive response to extreme environmental adversity (Csatho & Birkas, 2018; Kjærvik & Bushman, 2021). Individuals may also report using fewer proactively aggressive strategies when faced with a need to achieve social (e.g., narcissistic) goals which may also coincide with a belief in not harming others seen as inferior

to themselves (Knight et al., 2018). Alternatively, the partial mediating effect of reactive aggression may indicate that other paths explain relations between childhood abuse and reactive aggression. Different traits and associated paths like this should be investigated in the future studies. It is also noteworthy that proactive and reactive aggression often share mixed motives (Kjærvik & Bushman, 2021). Hence, future works should explore the motivations for using different types of aggression when examining the abuse-aggression link.

The findings did not replicate previous research on the moderating role of the Val158Met polymorphism on the direct link between abuse and aggression (e.g., Hygen et al., 2015; Perroud et al., 2010). However, results did support the finding that the Val158Met polymorphism moderated the effect of abuse on psychopathy, which was associated with increased proactive aggression. Consistent with Zhang et al. (2018), it seems possible that there could be a decrease in executive function (e.g., behavioral shift) in carriers of the Val homozygotes who experienced childhood abuse compared to carriers of the Met homozygote. This also further supports findings that the Val homozygotes with higher *COMT* enzyme activity have worse performance in executive functions (Chen et al., 2004; Goldberg et al., 2003), which is associated with psychopathy (Ogilvie et al., 2011). Thus, Val/Val carriers may be more likely to develop personality traits consistent with psychopathy in response to early adversity.

Collectively, the current study found abuse-aggression links among incarcerated Chinese males, with different mediation effects of the Dark Triad traits for reactive and proactive aggression. The *COMT* genotype also moderated the mediating effect of psychopathy on proactive aggression. These findings support Life History Theory, indicating that early environmental adversity can influence Dark Triad traits, which are then related to aggression in adulthood especially among samples of incarcerated males. These findings contribute to a more comprehensive view of the antecedents of trait aggression for male inmates who display relatively high trait aggressiveness. Specifically, childhood abuse is associated with higher reactive aggression via narcissism and higher proactive aggression via all the Dark Triad traits. Increased psychopathy was especially pronounced among the Val homozygotes with childhood abuse.

Limitations

There were several limitations to consider when interpreting the findings of this study. First, the sample used for genotyping might not be representative of all incarcerated populations or general populations, as it only consisted of male inmates. Additionally, genotype distributions showed

a significant deviation from Hardy–Weinberg Equilibrium. This is most likely due to the unique homogeneity of the sample. Future studies need to examine whether the gene-moderated mediation path from childhood abuse to aggression through Dark Triad traits generalizes to female inmates and broader populations. Second, the current study only examined one candidate gene (i.e., *COMT*) and the findings have not been replicated in an independent sample due to limited sample sizes of inmates. As suggested by Dick et al. (2015), using genome-wide analyses (GWAS) and replication samples are warranted to corroborate and extend the present findings. Third, the effect of *r*GE and other confounders cannot be entirely ruled out because other relevant covariates were unavailable (e.g., familial phenotypes, substance use, prior criminal history). Fourth, causal relationships cannot be established based on the current cross-sectional study with self-reported measures only. Future longitudinal studies using other methods for measuring childhood abuse are recommended.

Research Implications

Despite the limitations, this study adds to the literature examining mechanisms associated with the relation between abuse and aggression among incarcerated males. Using a cross-sectional design, we tested whether the *COMT* genotype would moderate the effect of childhood abuse on proactive and reactive aggression through the Dark Triad traits in a sample of incarcerated males. In addition to observed differences in the paths for reactive and proactive aggression, we found that the effects of childhood abuse on proactive aggression via psychopathy was larger for the Val homozygotes. These findings provide evidence for indirect and direct relations among environmental, genetic, and personality factors on aggressive traits. These findings may be helpful for developing risk assessment tools and tailored behavioral interventions for male inmates.

Authors' contributions Jieting Zhang: Conceptualization, Methodology, Writing—Original Draft, Supervision.

Junhui Leng:Data Curation, data analysis, Writing—Original Draft.
Cuimei Yang: Data curation, Validation, Writing—Review and Editing.
Eric M. Cooke: Writing – Review, Revision and Editing.
Pingyuan Gong: Methodology, Conceptualization, Genotyping.
Jinting Liu: Methodology, Conceptualization, Resources.

Availability of data and material Due to the sensitive nature of participants, the data cannot be available to access in public.

Code availability Not applicable.

Declarations

Ethical Approval All aspects of this study were approved by the Ethics Committee of the College of Psychology, Shenzhen University.

Consent to participate All participants were provided with invitation letters and informed consent which explicitly stated the purpose of the study, participation incentives, and the voluntary nature of their participation as well as their rights during the study and the confidentiality of their personal information used in the study.

Consent to publish Informed consents were obtained from participants prior to the study.

Conflicts of interest The authors declare that they have no conflict of interest.

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