Effects of variation in dopaminergic genes on the level of aggression and emotional intelligence in adolescents with conduct disorder

Joanna Halicka-Masłowska, Monika Szewczuk-Bogusławska, Edyta Pawlak-Adamska, Agnieszka Adamska, Błażej Misiak

Summary
It has been reported that altered dopaminergic neurotransmission may contribute to the development of aggressive behaviors and emotional intelligence (EI) impairment. However, less is known about the impact of polymorphisms in dopaminergic genes on the level of aggression and EI. Therefore, we aimed to investigate the association between the catechol-O-methyltransferase (COMT) rs6277 gene polymorphism and the dopamine 2 receptor (DRD2) rs4680 gene polymorphism as well as the level of aggression and EI in adolescents with conduct disorder. Participants were 144 adolescents with conduct disorder recruited at the youth sociotherapy centre. The Buss-Perry Aggression Questionnaire (BPAQ) was administered to record the level of aggression while the Popular Emotional Intelligence Questionnaire (PEIQ) and the Schutte Self-Report Inventory (SSRI) were used to assess EI. We found no significant associations between selected polymorphisms and the scores of BPAQ, PEIQ and SSRI. Our findings do not support the role of the COMT and the DRD2 gene polymorphisms in shaping aggressive behaviors and EI in adolescents with conduct disorder. Longitudinal studies on larger populations are needed to confirm these results.

genetics, dopamine, Conduct Disorder, neurotransmitter, externalizing behaviors

INTRODUCTION
Aggression represents one of typical clinical characteristics of conduct disorders in adolescents. Children who are diagnosed with conduct disorders significantly violate social norms and the rights of other people. Conduct disorders, which occur in about 5% of children during adolescence, are a serious medical and social problem, due to the consequences for the patient, his family and the society [1].

Although the exact mechanisms underlying conduct disorders and aggression remain unclear, the role of biological factors, including genetic backgrounds, is increasingly being recognized. It has been estimated that 65% of variance in the prevalence of aggressive behaviors can be attributed to genetic factors, while the rest is attributable to environmental insults [2]. Many genes are thought to be responsible for the development of aggression. For instance, there is a growing interest in the role of variation in dopaminergic genes as risk factors for aggressive
behaviors. It is believed that the dopaminergic system of the striatum indirectly affects the occurrence of impulsiveness and it has been suggested that different variants of the genes involved in dopaminergic neurotransmission may modulate the pattern of aggressive behaviour.

More specifically, high dopamine levels have been identified in impulsive individuals and attributed to variation in the catechol-O-methyltransferase (COMT) gene [3]. Carriers of the Met allele of the Val158Met polymorphism have a longer dopamine firing time in the prefrontal cortex, also they have increased vulnerability to stress factors, a lower threshold of pain sensitivity, and more efficient information processing [4]. On the contrary, in the COMT 158Val/Val homozygotes, the duration of dopamine activity in the prefrontal cortex is lower due to high activity of the COMT. In addition, these individuals are characterized by higher stress resistance and increased threshold of pain sensitivity [5].

Other way to look at dopamine function is to consider the polymorphism of the dopamine D2 receptor (DRD2) gene. Among children, the DRD2 gene polymorphisms have been linked to aggression such as anger expression, bullying, and cruelty. For instance, it has been found, that aggressive children are significantly more likely to be a carrier for the G allele of the DRD2 A241G polymorphism and the T allele of the DRD2 TaqIA polymorphism. Moreover, this study revealed overrepresentation of the DRD2 rs1079598 CC genotype among aggressive children [6]. The TaqI A1 allele has also been associated with impulsivity [7]. However, less is known about the impact of the DRD2 rs6277 polymorphism, also known as the 957C > T transition, on aggressive behaviors. It has been found that this polymorphism decreases binding activity of the DRD2 in the striatum and extrastriatal areas [8, 9].

It has been reported that a regulation of emotions plays an important role in shaping aggressive behaviors. It is believed that the level of emotional intelligence (EI) is one of the factors that can affect the occurrence of autogression in adolescents. Importantly, according to Goleman [10], the EI is a set of social skills that provide the capacity to understand yourself and own emotions, manage and control them, and the ability to empathize. The EI depends on the ability to take adequate action to adapt or solve the problem [11]. Nowadays the concept of EI is widely used in applied research (psychiatry, developmental psychology, engineering psychology, behavioral economics, etc.). Considering psychological mechanisms of autoimmunity of aggression in adolescents, one should pay attention to their common feature – reduction of basic emotional and interpersonal competences [12] and ineffective regulation of the physical level of arousal [13]. In adolescents showing aggressive behaviors, the ability to deal with negative emotions is more often observed, as well as difficulties in regulating emotions and the transmission and reception of emotional than in the group of non-aggressive youth. The high level of EI is the overriding protection factor against aggression [14].

There is a scarcity of studies investigating the association between variation in dopaminergic genes and the EI. Some studies have shown that variation in the COMT gene is associated with the success of the recognition of negative emotions [15], which is a component of EI. Carriers of the Met allele of Val158Met polymorphism have been found to present with more efficient emotional information processing [5] and higher level of insight problem solving [16]. According to another study the COMT Met/Met homozygotes [17], have an increased risk of behaviors and emotional problems in childhood compared to heterozygous or homozygous carriers of Val158Met polymorphism, but only if they were born with reduced body weight and were subjected to prenatal stress. To our knowledge, results of studies investigating the association between the DRD2 gene polymorphisms and the EI have not been published so far. In light of these research gaps, we aimed to investigate the association between two single nucleotide polymorphisms in dopaminergic genes (the COMT rs4680 polymorphism and the DRD2 rs6277 polymorphism) and the measures of aggression and the EI in adolescents with conduct disorder.

PARTICIPANTS AND MEASURES

The study was conducted among the students of the Youth Sociotherapy Centre No. 2 in Wroclaw, Poland. It was approved by the Bioethics
Committee of Wroclaw Medical University. All participants and their statutory representatives gave written consent to all procedures carried out as the part of this study.

There were following inclusion criteria: diagnosis of conduct disorders and written consent of the patient and statutory representative to participate in the study. A total of 144 adolescents (85 girls aged 13-18 years and 61 boys aged 13-18 years) were found to be eligible for participation.

The following diagnostic tools and psychological questionnaires were used in this study:

1) The Mini International Neuropsychiatric Interview for children and adolescents (MINI-Kid) is the structured diagnostic interview, developed jointly by psychiatrists and clinicians in the United States and Europe, for the DSM-IV and the ICD-10 criteria. This tool was used to establish a diagnosis of conduct disorder and exclude individuals with other mental disorder [18, 19].

2) The Schutte’s Self-Report Emotional Intelligence Test (SSEIT) is a measure of general EI. It includes a 33 self-report items that are based on a 5-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). This questionnaire consists of four sub-scales: emotion perception, utilizing emotions, managing self-relevant emotions, and managing others’ emotions. The SSRI is based on the EI model developed by Salovey and Mayer (1990) [20]. Cronbach’s alpha in our sample was 0.90.

3) The Popular Emotional Intelligence Questionnaire (PEIQ) also measures EI and consists of 94 items of self-descriptive nature, using a five-point Likert scale. The PEIQ consists of the following subscales: acceptance (expressing and using own emotions), empathy (understanding and recognizing emotions of other people), control (control over ones’ emotions), and understanding (understanding and awareness of own emotions) [21]. The Cronbach’s alpha for the PEIQ was estimated at 0.89 in our sample.

4) The Buss-Perry Aggression Questionnaire (BPAQ) is a 29-item self-report measure of aggression. It has been designed to assess four dispositional components of aggression: physical aggression, verbal aggression, anger, and hostility [22]. The standardization study [23] confirmed sufficient internal compliance rates. The Cronbach’s alpha was 0.80.

5) The Children’s Depression Inventory 2 (CDI2) includes 28 items. It is a measure which allows for a comprehensive assessment of depressive symptoms in children and adolescents. The questionnaire also includes scales measuring emotional problems and problems related to everyday functioning; in addition the self-rating version includes subscales measuring negative mood/somatic symptoms, low self-esteem, lack of behaviour efficacy and interpersonal problems [24]. The Cronbach alpha coefficient has been used to calculate the internal consistency of the scale, and the results indicated that internal consistency for all subscales was at a satisfactory level. The Cronbach’s alpha for CDI2 was 0.94 in our sample.

6) The State-Trait Anxiety Inventory (STAI) consists of two subscales measuring anxiety understood as a transient and situationally determined state of the individual (trait anxiety subscale) and anxiety understood as a relatively stable personality component (state anxiety subscale). Each subscale consists of 20 items which the subject answers by selecting one of four pre-categorized answers. Both subscales have high internal consistency and stability [25]. The standardization study [26] Cronbach’s alpha in our sample was 0.94 for state anxiety and 0.99 for trait anxiety.

**GENOTYPING**

Venous blood samples were collected from all participants. Genomic DNA was obtained from peripheral white blood cells as described previously with use of the Maxwell® 16 L.E.V. Blood DNA Kit (Promega Corporation, Madison, USA) according to the manufacturer’s protocol.

The single-nucleotide polymorphisms were genotyped: the COMT rs4680 polymorphism (Val158Met) and the DRD2 rs6277 polymorphism (957C > T) using the Allelic discrimination (AD) technique with appropriate TaqMan®SNP Genotyping Assays (C__25746809_50, and
In the AD assay, a unique pair of fluorescent dye detectors was used (two unique allele-specific TaqMan®MGB probes that target a SNP site) and the change in fluorescence of the dyes associated with the probes was measured. All the Assays were validated and predesigned. Reaction components and amplification parameters were based on the manufacturer’s instructions. The ABI Prism® 7300 (ThermoFisher Scientific Inc., USA) sequence-detection system was used for amplification for TaqMan®SNP Genotyping Assay plates. The SDS, version 2.1 software (ThermoFisher Scientific Inc., USA) was used for data acquisition and analysis. The same software was used for the allelic discrimination-analysis module.

Plate genomic control DNA samples (with defined genotypes) and non-template controls (Nuclease-free water) were included for each reaction plate. The TaqMan®SNP Genotyping Assay was controlled (25% of randomly chosen samples from both groups) to check for genotyping accuracy. Identical genotypes were identified in all repeated samples.

### Statistical Analysis
Descriptive statistics were presented as mean and standard deviation. Agreement of genotype distribution with the Hardy-Weinberg equilibrium (HWE) was tested by comparing expected and observed distributions using the χ² test. We conducted statistical analyses using the Statistical Package for Social Sciences, version 20 (SPSS Inc., Chicago, Illinois, USA). Due to non-normal distribution of continuous variables (assessed using the Kolmogorov-Smirnov test), a series of Mann-Whitney U tests were performed to test between-group differences. Differences were considered statistically significant if the p-value was less than 0.05.

### Results
General characteristics of the sample were shown in Table 1. The distribution of the COMT rs4680 genotypes was in agreement with the HWE ($\chi^2 = 1.95$, $p = 0.162$). However, there was a significant deviation from the HWE for the DRD2 rs6277 genotypes ($\chi^2 = 15.67$, $p < 0.001$). Altogether, 28.5% of the sample met criteria for a diagnosis of any mood and/or anxiety disorder.

Tables 2 and 3 present differences in the levels of aggression and EI between with respect to the COMT rs4680 and the DRD2 rs6277 allele status. There were no significant differences in the level of various aggression categories and EI between the DRD2 rs6277 TT homozygotes and the C allele carriers (Table 2). Similarly, no significant differences in these measures were found between the COMT rs4680 Val/Val homozygotes and the Met allele carriers. However, there was trend toward significantly higher level of acceptance among the COMT rs4680 Val/Val homozygotes compared to the Met allele carriers ($p = 0.079$).

#### Table 1. General characteristics of the sample.

| Variable                      | Mean ± SD or n (%) |
|-------------------------------|--------------------|
| Sex                           | 60 (41.7) / 84 (58.3) |
| Age                           | 14.85 ± 1.22       |
| CDI 2 – total score           | 16.61 ± 12.76      |
| STAI – state anxiety          | 42.78 ± 12.67      |
| STAI – trait anxiety          | 45.02 ± 12.9       |
| BPAQ – total score            | 70.26 ± 23.551     |
| BPAQ – physical aggression    | 20 ± 7.14          |
| BPAQ – verbal aggression      | 13.19 ± 5.064      |
| BPAQ – anger                  | 18.7 ± 6.257       |
| BPAQ – hostility              | 18.41 ± 7.901      |
| PEIQ – total score            | 304.96 ± 34.007    |
| PEIQ – empathy                | 64.5 ± 11.782      |
| PEIQ – acceptance             | 48.31 ± 10.201     |
| PEIQ – control                | 31.66 ± 91         |
| PEIQ – understanding          | 28.48 ± 6.147      |
| SSRI – total score            | 109.9 ± 25.7       |

Data expressed as mean ± SD

Abbreviations: CDI 2 – Children’s Depression Inventory 2; BPAQ – the Buss-Perry Aggression Questionnaire, PEIQ – The Popular Emotional Intelligence Questionnaire; SSRI – The Schutte Self-Report Inventory.
**Table 2.** The measures of aggression and EI with respect to the DRD2 rs6277 polymorphism.

| Variable                | TT (n = 18)     | CC + TT (n = 91) | p-value |
|-------------------------|-----------------|------------------|---------|
| BPAQ – total score      | 67.44 ± 25.53   | 68.88 ± 23.926   | 0.816   |
| BPAQ – physical aggression | 18.44 ± 9.624  | 19.67 ± 6.738    | 0.762   |
| BPAQ – verbal aggression | 12.44 ± 5.044   | 13.11 ± 5.295    | 0.375   |
| BPAQ – anger            | 16.72 ± 6.596   | 18.82 ± 6.164    | 0.213   |
| BPAQ – hostility        | 19.5 ± 7.618    | 17.59 ± 8.188    | 0.391   |
| PEIQ – total score      | 294.25 ± 23.702 | 307.08 ± 36.8    | 0.115   |
| PEIQ – empathy          | 64.65 ± 12.21   | 64.16 ± 12.275   | 0.649   |
| PEIQ – acceptance       | 44.85 ± 9.922   | 48.64 ± 10.449   | 0.216   |
| PEIQ – control          | 30.5 ± 5.577    | 32.31 ± 7.147    | 0.239   |
| PEIQ – understanding    | 26.65 ± 5.976   | 28.92 ± 6.205    | 0.173   |
| SSRI – total score      | 106.32 ± 21.331 | 111.01 ± 25.812  | 0.373   |

Data expressed as mean ± SD

Abbreviations: BPAQ – the Buss-Perry Aggression Questionnaire, PEIQ – The Popular Emotional Intelligence Questionnaire; SSRI – The Schutte Self-Report Inventory.

**Table 3.** The measures of aggression and EI with respect to the COMT rs4680 polymorphism.

| Variable                | Val-/Val (n = 24) | Met-/Val + Met-/Met (n = 82) | p-value |
|-------------------------|-------------------|------------------------------|---------|
| BPAQ – total aggression | 68.67 ± 26.189    | 68.27 ± 23.886               | 0.816   |
| BPAQ – physical aggression | 19.13 ± 7.64     | 19.48 ± 7.242                | 0.762   |
| BPAQ – verbal aggression | 13.04 ± 5.473    | 12.8 ± 5.17                  | 0.375   |
| BPAQ – anger            | 19.04 ± 7.123     | 18.3 ± 6.081                 | 0.213   |
| BPAQ – hostility        | 17.17 ± 8.899     | 18.05 ± 7.891                | 0.391   |
| PEIQ – total score      | 311.52 ± 36.361   | 303.18 ± 35.022              | 0.115   |
| PEIQ – empathy          | 65.48 ± 12.686    | 64.13 ± 12.149               | 0.649   |
| PEIQ – acceptance       | 51.64 ± 10.132    | 47.02 ± 10.505               | 0.216   |
| PEIQ – control          | 31.8 ± 7.681      | 31.86 ± 6.811                | 0.239   |
| PEIQ – understanding    | 28.92 ± 6.952     | 28.48 ± 6.121                | 0.173   |
| SSRI – total score      | 115.25 ± 22.305   | 109.37 ± 26.038              | 0.373   |

Data expressed as mean ± SD

Abbreviations: BPAQ – the Buss-Perry Aggression Questionnaire, PEIQ – The Popular Emotional Intelligence Questionnaire; SSRI – The Schutte Self-Report Inventory.

**DISCUSSION**

In this study, we failed to find any significant associations between variation in dopaminergic genes and the levels of aggression and EI in adolescents with conduct disorder. The mesolimbic dopaminergic innervations have an important modulating role in aggressive behaviors. Dysfunction in this system can contribute to conduct disorders [5]. The current study explored the role of dopaminergic system genes in the etiology of aggressive behaviour in adolescents with conduct disorders. The aim of this study was characterize the the impact of the COMT Val158Met polymorphism and the DRD2 gene polymorphism on EI and aggressive behaviors. This functional variant of the COMT gene has been found to account for a four-fold reduction...
enzymatic activity resulting in increased dopamine levels. To our knowledge, this is the first study addressing the association between polymorphisms in the COMT and DRD2 genes, aggressive behavior and the EI level in adolescents with conduct disorder.

The dopaminergic system is a complex structure encoded by many genes. The majority of previous studies have demonstrated that any single gene polymorphism is related to aggressive behavior [27-31]. Our results are in agreement with recent reports showing no association between the COMT gene polymorphism and other dysfunctional behaviors, such as suicidal behavior [28, 29]. However, both the COMT gene polymorphism [30-36], and the DRD2 gene polymorphism [37, 38] have been associated with susceptibility to specific mental disorders, including attention deficit hyperactivity disorder (ADHD), schizophrenia, schizoaffective disorder, alcohol dependence or mood disorders.

One of potential directions for this field would be to test the effects of potential gene x environment interactions on the level of aggression and EI. Indeed, interactions between variation in the DRD2 gene, family dysfunction and adolescent behavioral disorders have been found [39, 40]. More specifically, have been reported to be greater among the A1-allele carriers. In another study, no significant effects of interaction between the DRD2 gene polymorphisms and early separation on aggression in adolescents was found [41]. Discordant findings between these studies can therefore be explained by differences in the conceptualization of externalizing behavior and/or family adversity. The DRD2 genotype in adolescents might not affect the relation between parental separation, which might not necessarily correlate with the experience of aggressive behavior and family dysfunction, while it may affect the relationship between adverse familial events, such as the experience of having an incarcerated father or a lack of family closeness, and delinquency [42]. Alternatively, variation in the DRD2 gene might interact with family adversity in predicting aggressive behavior in adolescent, but not in predicting other or broader forms of behavior. Moreover, a meta-analysis carried out by Weeland, et al. [43] showed no direct associations between the COMT gene polymorphism and externalizing psychopathology [43], but it was proposed that heterozygosity might be a protective factor for psychopathology [44]. The existing data are contradictory: some studies have shown that the effect of family adversity is greater among the Met allele carriers while other studies have shown this effect among the Val allele carriers. For example, Thompson et al. [17] demonstrated that the effect of maternal stress on behavioral disorders is greater in homozygous children with the Met allele than in children with the Val allele. In turn, Hygen et al. [28] found that children who had to deal with many serious life events and were Val homozygotes are more aggressive than their Met allele-carrying counterparts. In particular, in the absence of serious life events, the Val allele homozygotes have been demonstrated to display significantly lower aggression scores than the Met allele carriers. In the case of the COMT gene polymorphism, this apparent contradiction might be explained by a cognitive/emotional compromise [10], in which the Met allele is associated in cognitive processing and the Val allele is related to an advantage in emotional processing [45]. At the same time, this allele might create a genetic predisposition to increased emotional agitation and lower emotional control. This might further mean that a lower level of EI can contribute to emotional dysregulation, aggressive behavior as consequences reported in the Met/Met homozygotes. Two different alleles may therefore function both as genetic risk and/or protective factor in different environments. These findings might suggest that the individuals with the COMT gene alleles, leading to decreased enzymatic activity, are more sensitive to stressful life events in terms of developing aggressive behavior. Importantly, this does not mean that adolescents with other genotypes are not susceptible to the effects of environmental exposures but rather that they might respond to different levels or types of environmental exposures. Whether adolescents will develop aggressive behaviors may depend on the combined effect of genes and environmental factors on dopamine activity in the brain.

There are certain limitations of this study that need to be addressed. Firstly, our sample was not large and thus a type II error cannot be excluded. The small sample size does not provide sufficient data to detect a significant statistical
difference, and the power of this study to detect genetic associations might be insufficient. Similarly, some clinical correlations might have been overlooked due to small sample size. In this regard, our results should be considered preliminary and warrant further studies in larger samples. Another downside of this study is the lack of a control group. When planning future research, one should consider comparing the results of the study group with randomly selected peers.

Moreover, it should be noted that genes encoding proteins involved in dopaminergic neurotransmission are highly polymorphic. Therefore, assessment of two single nucleotide polymorphisms provides a limited insight into genetic variability of the dopaminergic system. Examining additional polymorphisms across these genes is required to provide more comprehensive insights. Finally, caution should be taken as to the way our results with respect to the DRD2 rs6277 polymorphism are being interpreted. Indeed, the distribution of the DRD2 rs6277 polymorphism did not follow the HWE. This might be due to population stratification as our study was based on individuals with conduct disorder. Similar disagreement was also reported in one of our previous studies based on a different population [39].

Moreover, testing gene x environment interactions by taking into account the effects of various environmental exposures, such as early-life stress, might provide more comprehensive insight into the role of variation in dopaminergic genes in shaping aggressive behaviors. Finding explanations for behavioral disorders and their aggressive behaviour during adolescence is particularly important because they are known to be a strong predictor of psychopathological outcomes later in life [46].

Acknowledgements
This study was supported by the statutory project funded by the Wroclaw Medical University, Wroclaw, Poland (task number: ST.C230.17.041).

REFERENCES

1. Antisocial behaviour and conduct disorders in children and young people: recognition and management. NICE Clinical Guidelines, No. 158 London: National Institute for Health and Care Excellence (UK), 2013 Mar 27. ISBN-13: 978-1-4731-0055-8.

2. Dell’Agnello G, Masciottio D, Bravaccio C, Calamoneri F, Masi G, Curatolo P, et al. Atomoxetine hydrochloride in the treatment of children and adolescents with attention-deficit/hyperactivity disorder and comorbid oppositional defiant disorder: a placebo-controlled Italian study. European Neuropsychopharmacology. 2009;19:822–34.

3. Duica L, Antonescu, Piriorg M, Purnichi T, Szakac J, et al: Clinical and Biochemical Correlations of Aggression in Young Patients with Mental Disorders. Revista de Chimie București. 2018; 69(6) DOI: 10.37358/RC.18.6.6365.

4. Vorobyeva E, Fatima Hakunova F, Irina Skirtach I, Kovsh E: A review of current research on genetic factors associated with the functioning of the perceptual and emotional systems of the brain. 2019; DOI: 10.1051/shsconf/20197009009.

5. Vorobyeva E: Psychogenetics (Publ. h. of the SFU, Rostov-on-Don, 2014)

6. Zai CC, Ehtesham S, Choi E, Nowrouzi B, de Luca V, Stankovich L: Dopaminergic system genes in childhood aggression: Possible role for DRD2. The World Journal of Biological Psychiatry. 2012; 13(1):65–74.

7. Eisenberg D, MacKillop J, Modi M, Beauchemin J, Dang D, Lisman SA, et al: Examining impulsivity as an endophenotype using a behavioral approach: A DRD2 TaqI A and DRD4 48-bp VNTR association study. Behavior and Brain Functions. 2007; 3(e2), e2. Doi:10.1186/1744-9081-3-2.

8. Hirvonen M, Lumme V, Hirvonen J, Pesonen U, Någren K, Vahlberg T, Scheinin H, Hietala J: C957T polymorphism of the human dopamine D2 receptor gene predicts extrastriatal dopamine receptor availability in vivo. Progress in Neuro-Psychopharmacology and Biological Psychiatry. 2009; 33(4) 630-636.

9. Hirvonen M, Laakso A, Någren K, Rinne JO, Pohjalainen T, Hietala J: C957T polymorphism of the dopamine D2 receptor (DRD2) gene affects striatal DRD2 availability in vivo. Molecular Psychiatry. 2004; 9, 1060–1061. https://doi.org/10.1038/sj.mp.4001561.

10. Goleman D, Boyatzis R: Social intelligence and the biology of leadership. Harv Bus Rev. 2008; 9: 74-81.

11. Mayer JD, Salovey P, Caruso DR: Emotional intelligence: Theory, findings, and implications. Psychological Inquiry. 2004; 15: 197–215.

12. Klosnky ED: The functions of deliberate self-injury: A review of the evidence. Clin Psychol Rev. 2007;27(2):226-39.

13. Nock MK, Joiner TE, Gordon KH, Lloyd-Richardson E, Prinstein MJ: Non-suicidal self-injury among adolescents: diagnostic correlates and relation to suicide attempts. Psychiatry Res. 2006; 144 (1):65–72.

14. Dominguez-Garcia E, Fernandez-Berrocal P: The Association Between Emotional Intelligence and Suicidal Behavior: A Systematic Review. Front Psychol. 2018; 9: 2380. doi:10.3389/fpsyg.2018.02380.
15. Gohier B, Senior C, Radua J, El-Hage W, Reichenberg A, Protsi P, Surguladze SA, Eur. Psychiat. 2014; 29, 4, 197-202. doi.org/10.1016/j.eurpsy.2013.03.003.

16. Jiang W, Shang S, Su Y: Genetic influences on insight problem solving: the role of catechol-O-methyltransferase (COMT) gene polymorphisms Front. in psych 2015; 6, 1569 doi.org/10.3389/fpsyg.2015.01569.

17. Thompson JM, Sonuga-Barke EJ, Morgan AR, Cornforth CM, Turic D, Ferguson LR, et al. The catechol-O-methyltransferase (COMT) Val158Met polymorphism moderates the effect of antenatal stress on childhood behavioural problems: longitudinal evidence across multiple ages. Developmental Medicine & Child Neurology. 2015; 54(2), 148-154. doi.org/10.1111/j.1469 – 8749.2011.04129.x

18. George D, Mallery P: IBM SPSS Statistics 23 Step by Step: A Simple Guide and Reference. New York, NY: Routledge; 2016.

19. Adamowska S, Adamowski, T, Frydecka D, Kiejna A: Diagnostic validity of the Polish language version of the questionnaire MINI-KID (Mini International Neuropsychiatric Interview for Children and Adolescent, Comprehensive Psych. 2016; Apr; 66: 219-219. doi: 10.1016/j.comppsych.2015.09.013

20. Salamone JD, Correa M, Nunes EJ, Randall PA, Pardo M: The Behavioral Pharmacology of Effort-related Choice Behavior: Dopamine, Adenosine and Beyond. J Exp Anal Behav. 2012; Jan; 97(1): 125–146. doi: 10.1901/jeab.2012.97-125.

21. Matczak, A. (red.): Inteligencja emocjonalna – kierunki i metody badań. Psychologia, Edukacja i Społeczeństwo. 2007; 4.

22. Buss AH, Perry M: The aggression questionnaire. Journal of personality and social psychology. 1992; 63(3), p. 452.

23. Tucholska S: Pomiar agresji: Kwestionariusz Agresji A. 27. Tucholska S: Pomiar agresji: Kwestionariusz Agresji A. 2016.

24. Bae Y: Test Review: Children’s Depression Inventory 2 (CDI 2). Journal of Personality Assessment 90(3):280-5 2016.

25. Bussa i M. Perry’ego. Studia z Psychologii w Katolickim Uniwersytecie Lubelskim, 9, 1998; 369-378.

26. Vigneau F, Cormier S, The Factor Structure of the State-Trait Anxiety Inventory: An Alternative View. 2008. doi:10.1080/00223890701885027

27. Hohmann S, Zohsel K, Buchmann AF, Blomeyer D, Holz N, Boecker-Schlier R, et al: Interacting effect of MAOA genotype and maternal prenatal smoking on aggressive behavior in young adulthood. J. Neural Transm. 2016; 123, 885–894. doi: 10.1007/s00702-016-1582-x.

28. Hygen BW, Belsky J, Stenseng F, Lydersen S, Guze IC, Wichstrom L: Child exposure to serious life events, COMT, and aggression: testing differential susceptibility theory. Dev. Psychol. 2015; 51, 1098–1104. doi: 10.1037.

29. Zhang Y, Ming QS, Yi JY, Wang X, Chai QL, YaoS Q: Genegene-environment interactions of serotonin transporter, monoamine oxidase a and childhood maltreatment predict aggressive behavior in Chinese adolescents. Front. Behav. Neurosci. 2017; 11:17. doi: 10.3389/fnbeh.2017.00017

30. Wang M, Li H, Deater-Deckard K Zhang W: Interacting Effect of Catechol-O-Methyltransferase (COMT) and Monoamine Oxidase A (MAOA) Gene Polymorphisms, and Stressful Life Events on Aggressive Behavior in Chinese Male. 2018; doi: 10.3389/fpsyg.2018.01079

31. Tuvblad C, Narusyte J, Comasco E, Andershed H, Andershed AK, Collins OF, et al: Physical and verbal aggressive behavior and COMT genotype: sensitivity to the environment. Am. J. Med. Genet. B Neuropsychiatr. Genet. 2016; 171, 708–718. doi: 10.1002/ajmg.b.32430

32. Zalsman G, Huang Y, Oquendo MA, Brent DA: No Association of COMT Val158Met Polymorphism with Suicidal Behavior or CSF Monoamine Metabolites in Mood Disorders. Arch Suicide Res. 2008; 12(4): 327–335. doi.org/10.1080/138111108023234912.

33. Toyvila-Zárata C, Juárez-Rojop I, Ramón-Frias T, Villar-Soto M, Pool-García S, et al: No association between COMT val158met polymorphism and suicidal behavior: metaanalysis and new data. BMC Psychiatry. 2011; 11:151

34. Strous RD, Bark N, Pasia SS, Volavka J, Lachman HM: Analysis of a functional catechol-O-methyltransferase gene polymorphism in schizophrenia: evidence for association with aggressive and antisocial behavior. Psychiatry Res. 1997; 69, 71-77. http://dx.doi.org/10.1016/S0165-1718(96)03111-3

35. Soyka M, Zill P, Koller G, Samochowiec A, Grzywacz A, Preuss UW. Val158Met COMT polymorphism and risk of aggression in alcohol dependence. Addict. Biol. 2015; 20, 197-204. doi.org/10.1111/adb.12098.

36. Lachman HM, Nolan KA, Mohr P, Saito T, Volavka J: Association between catechol-O-methyltransferase genotype and violence in schizophrenia and schizoaffective disorder. Am. J. Psychiatry. 1998; 155, 835-837.

37. Fegert J, Findling RL, Fisman S, Greenhill LL, Huss, M, et al: International consensus statement on attention-deficit/hyperactivity disorder (ADHD) and disruptive behavior disorders (DBDs): clinical implications and treatment practice suggestions. Eur. Neuropsychopharmacol., 2004; 14, 11-28. http://dx.doi.org/10.1016/S0924-977X(03)00045-2

38. Kotowicz K, Frydecka D, Gawęda Ł, Prochowicz K, Klosowska J, et al: Effects of traumatic life events, cognitive biases and variation in dopaminergic genes on psychosis proneness. 2019; DOI: 10.1111/eip.12925

Archives of Psychiatry and Psychotherapy, 2021; 2: 15–23
39. Beaver KM, Gibson CL, DeLisi M, Vaughn MG, Wright JP: The interaction between neighborhood disadvantage and genetic factors in the prediction of antisocial outcomes. Youth Violence and Juvenile Justice. 2012; 10(1), 25–40. doi:10.1177/1541204011422085.

40. Boardman JD, Menard S, Roettjer ME, Knight KE, Boutwell BB, Smolen A. Genes in the dopaminergic system and delinquent behaviors across the life course the role of social controls and risks. Criminal Justice and Behavior. 2014; 41, 713–731. doi:10.1177/0093854813514227.

41. Nederhof E, Belsky J, Ormel J, Oldehinkel A. J: Effects of divorce on Dutch boys’ and girls’ externalizing behavior in gene 9 environment perspective: Diathesis stress or differential susceptibility in the Dutch tracking adolescents’ individual lives survey study? Development and Psychopathology. 2012 24(03), 929–939. doi:10.1017/S0954579412000454

42. Weeland J, Overbeek G, de Castro BO, Matthys W: Underlying Mechanisms of Gene–Environment Interactions in Externalizing Behavior: A Systematic Review and Search for Theoretical Mechanisms: Clin Child Fam Psychol Rev. 2015; 18:413–442. DOI 10.1007/s10567-015-0196-4

43. Munafo M, Bowes L, Clark T, Flint J: Lack of association of the COMT (Val158/108 met) gene and schizophrenia: A meta-analysis of case–control studies. Molecular Psychiatry. 2005;10(8), 765–770. doi:10.1016/j.biopsych.2007.08.016.

44. Costas J, Sanjuán J, Ramos-Ríos R, Paz E, Agra S, Ivorra JL, et al: Heterozygosity at catechol-O-methyltransferase Val158Met and schizophrenia: New data and meta-analysis. Journal of Psychiatric Research. 2011; 45(1), 7–14. doi:10.1016/j.jpsychires.2010.04.021.

45. Mier D, Kirsch P, Meyer-Lindenberg A: Neural substrates of pleiotropic action of genetic variation in COMT: A meta-analysis. Molecular Psychiatry,.2009; 15(9), 918–927. doi:10.1038/mp.2009.36.

46. Jokela M, Ferrie J, Kivimäki M: Childhood problem behaviors and death by midlife: the British National Child Development Study. Journal of the American Academy of Child and Adolescent Psychiatry. 2009; 48(1), 19–24. doi:10.1097/CHI.0b013e31818b1c76.