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Genetic and environmental influences on antisocial behavior

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Antisocial behavior is a broad term that encompasses many facets of destructive behavior, most of which bring harm to another person or involve the violation of the rights of others. Violence and aggression bring physical and/or psychological harm to a person, while property destruction and theft show disregard and possible damage to another person. Antisocial behavior often involves breaking the law, although other forms of rule violations (e.g., disruptive behavior, manipulation, lying, deception) are also considered to be antisocial in the broadest definition. Further, antisocial behavior tends to co-occur with a range of other behavior problems, including substance abuse and dependence (Miles, Van den Bree, & Pickens, 2002; White et al., 2001), psychiatric illnesses (e.g., attention deficit hyperactivity disorder, depression, anxiety) and pathological gambling (Kim-Cohen et al., 2003; Tuvblad et al., 2009). Antisocial behavior is also associated with various types of psychosocial problems, including unstable relationships, unreliable parenting and underachievement in education and at work (Moffitt, Caspi, & Harrington, 2002; Rutter, Kim-Cohen, & Maughan, 2006). Moreover, this type of behavior is prevalent; self-reports have shown that between 50–80% of all youth participate in some form of antisocial behavior during their development (Rutter, Giller, & Hagell, 1998). The prevalence of conduct disorder is 1.8–16% (Loeber et al., 2000). The prevalence of antisocial personality disorder is 1–3% in community settings and up to 30% in forensic settings (American Psychiatric Association, 2004). Antisocial behavior not only imposes high social burden to society, but also economic burden, including costs of the criminal justice system and compensations for victims and their families (McCollister, French, & Fang, 2010).

The focus of this special issue is three-fold: 1) to examine the genetic and environmental influences on antisocial behavior; 2) to examine some of the biological and individual-level risk factors associated with antisocial behavior; and 3) to examine the relationship between candidate genes for antisocial behavior and their risk factors. We briefly summarize the papers included in this special issue here, starting with the papers examining the genetic and environmental influences on antisocial behavior, next we summarize the papers on biological and individual level risk factors associated with antisocial behavior, and lastly we summarize the papers on candidate genes and antisocial behavior.

Genetic and environmental influences on antisocial behavior

What factors contribute to individual differences in antisocial behavior? Behavioral genetic research can help shed light on this topic. Behavioral genetic research relies on the different levels of genetic relatedness between family members in order to estimate the contribution of heritable and environmental factors to individual differences in a phenotype of interest, in our case antisocial behavior. The early adoption studies typically demonstrated that the

combination of a genetic predisposition (i.e., psychopathology in biological parents) with a high risk environment (i.e., adverse adoptive home environment) lead to greater pathology than what would be expected from either factor acting alone or both in an additive combination (Bohman et al., 1982; Cloninger et al., 1982; Mednick, Gabrielli, & Hutchings, 1984). In the past two decades adoption samples have become less accessible, instead studies utilizing large twin, sibling and/or parent-child (multi generation) samples have emerged. One of the key methodological designs in behavioral genetic research is the classical twin design. In the classical twin design monozygotic (identical) twin pairs are assumed to share their common environment and 100% of their genes. Dizygotic (fraternal) twin pairs also share their common environment and they are assumed to share on average 50% of their genes. By comparing the resemblance for antisocial behavior between monozygotic and dizygotic twins the variance of antisocial behavior can be divided into additive genetic factors (or heritability, h^2), shared environmental factors (c^2), and non-shared environmental factors (e^2). Shared environmental factors refer to non-genetic influences that contribute to similarity within pairs of twins. Non-shared environmental factors refer to experiences that make siblings dissimilar (Neale & Cardon, 1992).

There is compelling evidence from behavioral genetic research that heritable influences are of importance in the development of antisocial behavior; approximately 50% of the total variance in antisocial behavior is explained by genetic influences. Yet, there is also evidence of a large environmental effect, both shared and non-shared environmental influences have been found to explain the remaining half of the variance (see reviews by Burt, 2009; Miles & Carey, 1997; Moffitt, 2005; Rhee & Waldman, 2002; Waldman & Rhee, 2006).

Wang et al. (2013) examined the influence of genetic and environmental factors on aggressive and non-aggressive antisocial behavior in a community sample of 780 twin pairs. The heritability of aggressive and non-aggressive antisocial behavior increased with age in males (9–18 years), but decreased for females' non-aggressive antisocial behavior. These results reinforce the importance of differentiating among various forms of antisocial behavior and further investigate sex differences typically seen in antisocial behavior, both phenotypically and biometrically.

Niv et al. (2013) also focused on aggression and non-aggressive (rule-breaking/delinquency) behavior and found that they were influenced by a latent common antisocial behavior factor within each wave of data collection (9–10; 14–15 years). The childhood-age common antisocial behavior factor was influenced by 41% genetics, 40% shared environment and 19% non-shared environment. In adolescence, 41% of influences on the common antisocial behavior factor were novel and entirely genetic, while the remainder of influences was stable across time. Future research should identify adolescence-specific environmental influences on the development of antisocial behavior problems.

Biological and individual level risk factors associated with antisocial behavior

Biosocial research, which integrates biological and social factors, seeks to understand why some individuals but not others become antisocial in the presence of high (or low) social risk. This line of research has identified several biological risk factors for antisocial behavior, e.g., low resting heart rate (De Vries-Bouw et al., 2011; Ortiz & Raine, 2004; Scarpa & Raine, 2000; Sijtsema et al., 2010) and low levels of skin conductance, both at rest and during task performance (Lorber, 2004).

In line with this research Portnoy et al. (2013) reviewed the literature on biological protective factors for antisocial behavior. Among neuropsychological factors, high IQ was

found to be the best-replicated protective factor, though executive functioning was also found to be a promising candidate as a protective factor. High resting heart rate, as well as enhanced autonomic fear conditioning and attentional processing were also found to have protective effects.

Further, classic criminological theories emphasize the role of impaired self-control as a key risk factor for antisocial behavior (Gottfredson & Hirschi, 1990). Following this line of research, Beaver et al. (2013) examined the genetic and environmental stability and change in self-control measured at three time points (1994, 1996, and 1998; N = 2,412 total sibling pairs). Data were drawn from the Child and Young Adult Supplement of the National Longitudinal Survey of Youth 1979 (CNLSY). Results showed that genetic factors accounted for between 74–92% of the stability in self-control and between 78–89% of the change (i.e., “new” genetic variance) in self-control. Shared and non-shared environmental factors explained the rest of the stability and change in levels of self-control.

Reduced amplitude of the P300 brain response has been found in individuals with antisocial and substance problems. This suggests that P300 brain response may serve as a neurophysiological indicator of deficiencies in self-control. Yancey et al. (2013) examined the relationship between P300 brain response and behavioral deviancy (symptoms of antisocial/addictive disorders) in a sample of adult twins (N = 419 twin pairs). Greater disorder symptoms and higher trait disinhibition scores each predicted smaller P300 amplitude. Trait disinhibition scores and disorder symptoms also shared a common genetic liability. These results provide evidence that heritable weaknesses in self-control capacity confer liability to antisocial/addictive outcomes and that P300 brain response indexes this dispositional liability.

Coyne et al. (2013) employed a different approach by utilizing longitudinal data from Swedish national registers. A sibling-comparisons (both full- and half-siblings) model was conducted to identify the extent to which there is an association between teenage childbirth and mothers' likelihood of later criminal conviction, or if the association is confounded by familial (including genetic or environmental) factors that make sisters similar (356,750 mothers; 706,494 offspring). Women who began child-bearing as teenagers were more likely to be convicted of a crime in young adulthood compared to women who delayed childbearing. The association between teenage childbirth and early adulthood criminal convictions was confounded by genetic and shared environmental factors that influence both the likelihood of teenage childbirth and risk of early adulthood criminal conviction.

Brendgen et al. (2013) reported a significant gene-environment interaction, indicating that a strong genetic disposition for physical aggression was much more likely to be expressed when peer group norms were favorable of such behavior (N = 192 kindergarten twins pairs). Relational aggression was primarily explained by environmental influences regardless of peer group norms. These findings emphasize the importance of the peer group influences in forming aggression in children by either condoning or penalizing such behavior.

Further, psychopathy in its adult form is comprised of different dimensions, behaviorally; a psychopath is an impulsive risk-taker with antisocial tendencies. Interpersonally, a psychopath is grandiose and manipulative. Affectively they lack empathy, anxiety, and remorse, and they have difficulties maintaining close relationships (Cleckley, 1941, 1976; Hare, 2002, 2003). Even though the prevalence of psychopathy is <1% in the community, psychopaths are believed to make up as much as between 15 and 20% of all prison populations, and they are thought to be associated with ~50% of all serious crimes (Blair, Mitchell, & Blair, 2007; Hare, 2003; Neumann & Hare, 2008). Behavioral genetic studies have reported that genetic factors influence psychopathic traits across the entire lifespan

from childhood (Bezdjian et al., 2010; Bezdjian et al., 2011; Fontaine et al., 2010; Viding et al., 2005), through adolescence (Blonigen et al., 2006; Forsman et al., 2008; Larsson, Andershed, & Lichtenstein, 2006; Larsson et al., 2007; Taylor et al., 2003) and into adulthood (Blonigen et al., 2006; Brook et al., 2010; Tuvblad et al., under review).

Tuvblad et al. (2013) examined the direction and the genetic and environmental etiology of the association between negative parent-to-child affect and psychopathic personality from ages 9–10 years to 14–15 years in a community sample of 780 twin pairs. Significant parent-driven effects were found, negative parent-to-child affect at ages 9–10 years influenced psychopathic personality at ages 14–15 years, independently of early heritable child psychopathic personality. Significant child driven effects were also found. Psychopathic personality at age 9–10 years influenced negative parent-to-child affect at age 14–15 years. Thus in part, children's genetically influenced psychopathic personality seemed to evoke parental negativity at ages 14–15 years.

Gao and Tang (2013) also focused on psychopathic personality, specifically they examined the relationship between psychopathic personality and responses to a moral judgment test. College students scoring higher on psychopathic traits were more likely to make utilitarian responses to moral dilemmas. This relationship was more pronounced for the behavioral factor of psychopathy and was mediated by aggression, but not moderated by anxiety.

Candidate genes and antisocial behavior

Several candidate genes have been identified to be associated with antisocial behavior or their known risk factors. Many of these candidate genes findings have also been replicated in both human and animal studies. A majority of these candidate genes were identified through examination of (1) the dopamine system, which is involved in mood, motivation and reward, arousal, and other behaviors; (2) the serotonin system, which is involved in impulse control, affect regulation, sleep, and appetite; or (3) the epinephrine/norepinephrine system, which facilitate fight-or-flight reactions and autonomic nervous system activity (Bartels et al., 2011). All three of these systems are affected by monoamine oxidase A (*MAO-A*) function (Niv & Baker, 2010; Tuvblad & Baker, 2011). The low-activity alleles of *MAO-A* interacts with maladaptive childhood environment (Caspi et al., 2002) and has been associated with aggression, violent delinquency, externalizing behavior, and lower inhibitory control (Brunner et al., 1993; Guo et al., 2008).

Barnes et al. (2013) examined whether genetic risk factors (*DAT1*, *DRD2*, and *DRD4*) for antisocial behavior were predictive of exposure to disadvantage and violent crime measured at the county level. Data were drawn from the National Longitudinal Study of Adolescent Health; $N = 2,212$ – $2,268$. County-level disadvantage was measured via Census data and violent crime rates were measured via the FBI's Uniform Crime Reports. Findings revealed that individuals with a greater number of dopamine risk alleles were more likely to live in a disadvantaged county and were more likely to live in a county with higher violent crime rates.

Stogner and Gibson (2013) examined whether adolescents possessing low activity alleles for the *MAO-A* genotype are more likely to respond to stressful life experiences by initiating substance use. Data were drawn from the National Longitudinal Study of Adolescent Health, 2,574 adolescents; ages of 11–19. For males, a significant interaction emerged between stressful life experiences and the *MAO-A* gene for alcohol and marijuana initiation. Those with a low activity *MAO-A* allele were more likely to initiate substance use than those with a high activity allele when exposed to stressful experiences.

The different studies included in this special issue cover various aspects of antisocial behavior, i.e., aggression, non-aggressive (rule-breaking/delinquency) behavior, psychopathic personality and criminal behavior. The authors have employed different methodological approaches, spanning from behavioral genetic modeling to phenotypic analyses. A number of biological and individual level risk factors have been examined, including IQ, autonomic measures, poor self-control, negative parenting, responses to moral dilemmas, peer influences as well as teen-age child bearing. The relationship between candidate genes for antisocial behavior and their risk factors (i.e., disadvantaged county, stressful life events) were also examined. All of the included papers touch on important topics that will add to our understanding of antisocial behavior. At the same time the findings presented in this special issue point to gaps in the literature that need attention in future research.

References

- American Psychiatric Association. American Psychiatric Association DSM-IV-TR Diagnostic and Statistical Manual of Mental disorders. Washington, DC: 2004.
- Barnes JC, Boutwell BB, Beaver KM. Genetic Risk Factors Correlate with County-level Violent Crime Rates and Collective Disadvantage. *Journal Criminal Justice*. 2013; (special issue)
- Beaver KM, Connolly EJ, Schwartz JA, Al-Ghamdi MS, Kobeisy AN. Genetic and Environmental Contributions to Stability and Change in Levels of Self-Control. *Journal Criminal Justice*. 2013; (special issue)
- Bartels M, van de Aa N, van Beijsterveldt CEM, Middeldorp CM, Boomsma DI. Adolescent self-report of emotional and behavioral problems: interactions of genetic factors with sex and age. *Journal of the Canadian Academy of Child and Adolescent Psychiatry*. 2011; 20(1):35–52. [PubMed: 21286367]
- Bezdjian S, Raine A, Baker LA, Lynam DR. Psychopathic personality in children: genetic and environmental contributions. *Psychological Medicine*. 2010; 41(3):589–600. [PubMed: 20482945]
- Bezdjian S, Tuvblad C, Raine A, Baker LA. The genetic and environmental covariation among psychopathic personality traits, and reactive and proactive aggression in childhood. *Child Development*. 2011; 82(4):1267–1281. [PubMed: 21557742]
- Blair, JR.; Mitchell, DA.; Blair, K. *The psychopath, emotion and the brain*. Blackwell Publishing Ltd.; Oxford: 2007.
- Blonigen DM, Hicks BM, Krueger RF, Patrick CJ, Iacono WG. Continuity and change in psychopathic traits as measured via normal-range personality: a longitudinal-biometric study. *Journal of Abnormal Psychology*. 2006; 115(1):85–95. [PubMed: 16492099]
- Bohman M, Cloninger CR, Sigvardsson S, von Knorring A-L. Predisposition to petty criminality in Swedish adoptees. *Archives of General Psychiatry*. 1982; 39:1233–1241. [PubMed: 7138223]
- Brendgen M, Girard A, Vitaro F, Dionne G, Boivin M. Do Peer Group Norms Moderate The Genetic Expression of Physical and Relational Aggression? *Journal Criminal Justice*. 2013; (special issue)
- Brook M, Panizzon MS, Kosson DS, Sullivan EA, Lyons MJ, Franz CE, et al. Psychopathic personality traits in middle-aged male twins: a behavior genetic investigation. *Journal of Personality Disorders*. 2010; 24(4):473–486. [PubMed: 20695807]
- Brunner HG, Nelen M, Breakefield XO, Ropers HH, van Oost BA. Abnormal behavior associated with a point mutation in the structural gene for monoamine oxidase A. *Science*. 1993; 262(5133):578–580. [PubMed: 8211186]
- Burt AS. Are there meaningful etiological differences within antisocial behavior? Results of a meta-analysis. *Clinical Psychology Review*. 2009; 29:163–178. [PubMed: 19193479]
- Caspi A, McClay J, Moffitt TE, Mill J, Martin J, Craig IW, et al. Role of geno-type in the cycle of violence in maltreated children. *Science*. 2002; 297(5582):851–854. [PubMed: 12161658]
- Cleckley, HJ. *The mask of sanity*. Mosby; St. Louis: MO: 1976.

- Cloninger CR, Sigvardsson S, Bohman M, von Knorring AL. Predisposition to petty criminality in Swedish adoptees. II. Cross-fostering analysis of gene-environment interaction. *Archives of General Psychiatry*. 1982; 39:1242–1247. [PubMed: 7138224]
- Coyne CA, Fontaine NMG, Långström N, Lichtenstein P, D'Onofrio BM. Teenage childbirth and young adult criminal convictions: A quasi-experimental study of criminal outcomes for teenage mothers: *Journal Criminal Justice*. 2013; (special issue)
- De Vries-Bouw M, Popma A, Vermeiren R, Doreleijers TA, Van De Ven PM, Jansen LM. The predictive value of low heart rate and heart rate variability during stress for reoffending in delinquent male adolescents. *Psychophysiology*. 2011; 48(11):1597–1604. [PubMed: 21824152]
- Fontaine NM, Rijdsdijk FV, McCrory EJ, Viding E. Etiology of different developmental trajectories of callous-unemotional traits. *Journal of the American Academy of Child Adolescent Psychiatry*. 2010; 49(7):656–664.
- Forsman M, Lichtenstein P, Andershed H, Larsson H. Genetic effects explain the stability of psychopathic personality from mid- to late adolescence. *Journal of Abnormal Psychology*. 2008; 117(3):606–617. [PubMed: 18729612]
- Gao Y, Tang S. Psychopathic personality and utilitarian moral judgment in college students: *Journal Criminal Justice*. 2013; (special issue)
- Gottfredson, MR.; Hirschi, T. *A general theory of crime*. Stanford University Press; Stanford, CA: 1990.
- Guo G, Ou X, Roettger M, Shih JC. The VNTR repeat in MAO-A and delinquent behavior in adolescence and young adulthood: associations and MAO-A promoter activity. *European Journal of Human Genetics*. 2008; 16:626–634. [PubMed: 18212819]
- Hare, RD. Psychopathy and risk for recidivism and violence.. In: Gray, J.; Laing, J.; Noaks, L., editors. *Criminal Justice, Mental Health, and Politics of Risk*. Cavendish Publishing; London: 2002. p. 27-47.
- Hare, RD. *The Hare Psychopathy Checklist-Revised (PCL-R)*. 2nd ed.. Multi-Health Systems; Toronto, Ontario, Canada: 2003.
- Kim-Cohen J, Caspi A, Moffitt TE, Harrington H, Milne BJ, Poulton R. Prior juvenile diagnoses in adults with mental disorder: developmental follow-back of a prospective-longitudinal cohort. *Archives of General Psychiatry*. 2003; 60(7):709–717. [PubMed: 12860775]
- Larsson H, Andershed H, Lichtenstein P. A genetic factor explains most of the variation in the psychopathic personality. *Journal of Abnormal Psychology*. 2006; 115(2):221–230. [PubMed: 16737387]
- Larsson H, Tuvblad C, Rijdsdijk FV, Andershed H, Grann M, Lichtenstein P. A common genetic factor explains the association between psychopathic personality and antisocial behavior. *Psychological Medicine*. 2007; 37(1):15–26. [PubMed: 17049102]
- Loeber R, Burke JD, Lahey BB, Winters A, Zera M. Oppositional defiant and conduct disorder: a review of the past 10 years, part I. *Journal of the American Academy of Child and Adolescent Psychiatry*. 2000; 39(12):1468–1484. [PubMed: 11128323]
- Lorber MF. Psychophysiology of Aggression, Psychopathy, and Conduct Problems: A Meta-Analysis. *Psychological Bulletin*. 2004; 130(4):531–552. [PubMed: 15250812]
- McCollister KE, French MT, Fang H. The Cost of Crime to Society: New Crime-Specific Estimates for Policy and Program Evaluation. *Drug and Alcohol Dependence*. 2010; 108(1–2):98–109. [PubMed: 20071107]
- Mednick SA, Gabrielli WF, Hutchings B. Genetic influence in criminal convictions: evidence from an adoption cohort. *Science*. 1984; 224:891–894. [PubMed: 6719119]
- Miles DR, Carey G. Genetic and environmental architecture of human aggression. *Journal of Personality and Social Psychology*. 1997; 72(1):207–217. [PubMed: 9008382]
- Miles DR, Van den Bree M, Pickens RW. Sex differences in shared genetic and environmental influences between conduct disorder symptoms and marijuana use in adolescents. *American Journal of Medical Genetics (Neuropsychiatric Genetics)*. 2002; 114:159–168. [PubMed: 11857577]

- Moffitt TE. The new look of behavioral genetics in developmental psycho-pathology: gene-environment interplay in antisocial behaviors. *Psychological Bulletin*. 2005; 131(4):533–554. [PubMed: 16060801]
- Moffitt TE, Caspi A, Harrington H, Milne BJ. Males on the life-course persistent and adolescence-limited antisocial pathways: follow-up at age 26. *Development and Psychopathology*. 2002; 14:179–207. [PubMed: 11893092]
- Neale, MC.; Cardon, LR. *Methodology for genetic studies of twins and families*. Kluwer Academic Publications; Dordrecht, The Netherlands: 1992.
- Neumann CS, Hare RD. Psychopathic traits in a large community sample: Links to violence, alcohol use, and intelligence. *Journal of Consulting and Clinical Psychology*. 2008; 76(5):893–899. [PubMed: 18837606]
- Niv, S.; Baker, LA. Genetic marker for antisocial behavior.. In: Thomas, C.; Pope, K., editors. *The origins of antisocial behavior: A developmental perspective*. Oxford University Press; New York: 2010.
- Niv S, Tuvblad C, Raine A, Baker LA. Aggression and Rule-breaking: Heritability and stability of antisocial behavior problems in childhood and adolescence. *Journal Criminal Justice*. 2013; (special issue)
- Ortiz J, Raine A. Heart rate level and antisocial behavior in children and adolescents: A meta-analysis. *Journal of the American Academy of Child and Adolescent Psychiatry*. 2004; 43(2):154–162. [PubMed: 14726721]
- Portnoy J, Chen FR, Raine A. Biological Protective Factors for Antisocial and Criminal Behavior. *Journal Criminal Justice*. 2013; (special issue)
- Rhee SH, Waldman ID. Genetic and Environmental Influences on Antisocial Behavior: A Meta-Analysis of Twin and Adoption Studies. *Psychological Bulletin*. 2002; 128:490–529. [PubMed: 12002699]
- Rutter, M.; Giller, H.; Hagell, A. *Antisocial Behavior by Young People*. Cambridge University Press; Cambridge, UK: 1998.
- Rutter M, Kim-Cohen J, Maughan B. Continuities and discontinuities in psychopathology between childhood and adult life. *Journal of Child Psychology and Psychiatry*. 2006; 47(3):276–295. [PubMed: 16492260]
- Scarpa, AS.; Raine, A. Violence associated with anger and impulsivity.. In: Borod, J., editor. *The neuropsychology of emotion*. Oxford University Press; New York: 2000. p. 320-339.
- Sijtsma JJ, Veenstra R, Lindenberg S, van Roon AM, Verhulst FC, Ormel J, et al. Mediation of sensation seeking and behavioral inhibition on the relationship between heart rate and antisocial behavior: the TRAILS study. *Journal of the American Academy of Child and Adolescent Psychiatry*. 2010; 49(5):493–502. [PubMed: 20431469]
- Stogner JM, Gibson CL. Stressful Life Events and Adolescent Substance Use: The Moderating Influence of MAOA Polymorphisms. *Journal Criminal Justice*. 2013; (special issue)
- Taylor A, Loney BR, Bobadilla L, Iacono WG, McGue M. Genetic and environmental influences on psychopathy trait dimensions in a community sample of male twins. *Journal of Abnormal Child Psychology*. 2003; 31(6):633–645. [PubMed: 14658743]
- Tuvblad C, Baker LA, Huber R, Brennan P, Bannasch D. Human Aggression across the Lifespan: Genetic Propensities and Environmental Moderators. *Advances in Genetics (Aggression)*. 2011; 75:171–214.
- Tuvblad C, Bezdjian S, Raine A, Baker LA. Psychopathic Personality and Negative Parent-to-Child Affect: A Longitudinal Cross-lag Twin Study. *Journal Criminal Justice*. 2013; (special issue)
- Tuvblad C, Bezdjian S, Wang P, Raine A, Baker LA. Psychopathic Personality Development from Ages 9 to 18: Genes and Environment. under review.
- Tuvblad C, Zheng M, Raine A, Baker LA. A common genetic factor explains the covariation among ADHD ODD and CD symptoms in 9–10 year old boys and girls. *Journal of Abnormal Child Psychology*. 2009; 37(2):153–167. [PubMed: 19015975]
- Viding E, Blair JR, Moffitt TE, Plomin R. Evidence of substantial genetic risk for psychopathy in 7-year-olds. *Journal of Child Psychology and Psychiatry*. 2005; 46(6):592–597. [PubMed: 15877765]

- Wang P, Niv S, Tuvblad C, Raine A, Baker LA. The Genetic and Environmental Overlap between Aggressive and Non-aggressive Antisocial Behavior in Children and Adolescents Using the Self-Report Delinquency Interview (SR-DI). *Journal Criminal Justice*. 2013; (special issue)
- Waldman, ID.; Rhee, S. Genetic and environmental influences on psychopathy and antisocial behavior.. In: Patrick, CJ., editor. *Handbook of psychopathy*. Guilford; New York: 2006. p. 205-228.
- White HR, Xie M, Thompson W, Loeber R, Stouthamer-Loeber M. Psychopathology as a predictor of adolescent drug use trajectories. *Psychology of Addictive Behaviors*. 2001; 15(3):210–218. [PubMed: 11563798]
- Yancey JR, Venables NC, Hicks BM, Patrick CJ. Evidence for a Heritable Brain Basis to Deviance-Promoting Deficits in Self-Control. *Journal Criminal Justice*. 2013; (special issue)