

Genetic and Environmental Influences on Psychopathic Personality Traits

A Meta-Analytic Review

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## Genetiska och Miljömässiga Influenser på Psykopatiska Personlighetsdrag

### En meta-analytisk översikt

#### **Sammanfattning**

För att förstå etiologin av psykopatiska personlighetsdrag och därmed i det långa loppet kunna utveckla framgångsrik prevention, är ett första steg att klargöra vilken roll genetiska och miljömässiga effekter spelar. En meta-översikt på 15 tvillingstudier (N=26,981), genomfördes för att uppskatta i vilken grad genetiska och miljömässiga faktorer påverkar psykopatiska personlighetsdrag. Resultaten visade att additiva genetiska (ärflika) och unika miljömässiga faktorer förklarar 50% var av variansen i psykopatiska personlighetsdrag, medan delade miljömässiga faktorer inte var av betydelse. Mått, informant, ålder och kön undersöktes som potentiella moderatorer och visade att informant påverkade resultaten. Denna meta-analys ger en strukturerad syntes av de relativa genetiska och miljömässiga bidrag som påverkar psykopatiska personlighetsdrag genom olika utvecklingsstadier och mellan könen.

*Nyckelord:* psykopati, heritabilitet, genetik, tvillingstudie, meta-analys

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## Genetic and Environmental Influences on Psychopathic Personality Traits

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#### **Abstract**

To understand the etiology of psychopathic personality traits and thus in the long run to be able to develop successful prevention, a first step is to find out what role genetic and environmental effects play. A meta-review of 15 twin studies (N=26, 981), was conducted to estimate the magnitude of genetic and environmental influences on psychopathic personality traits. The results show that additive genetic (heritable) factors and non-shared environmental factors each explain 50% of the variance in psychopathic personality traits, while shared environmental factors were of no importance. Measure, informant, age, and sex were investigated as potential moderators showing that informant had an impact on the findings. This meta-analysis provides a structured synthesis of the relative genetic and environmental contributions in psychopathic personality traits through various stages of development and across sex.

**Keywords:** psychopathy, heritability, genetic, twin study, meta-analysis

## **Genetic and Environmental Influences on Psychopathic Personality Traits**

### **A Meta-Analytic Review**

In society, one in a hundred men is estimated to be a psychopath and among women it is even less common, although psychopaths are estimated to represent as many as between 15 and 20% of all prison populations. Individuals with psychopathic personality traits are believed to be responsible for up to 50% of the most serious crimes. In terms of recidivism, they tend to have a much higher relapse risk than other offenders (Hare, 2003; Neumann & Hare, 2008). In the light of this, it is important to further examine the genetic and etiology of psychopathy in order to make more efficient intervention and prevention strategies.

People with psychopathy, or psychopathic personality traits, do not usually develop lasting relationships, they find it difficult to feel empathy and at the same time they have a manipulative personality which results in that they easily lie and think they are more worth than others. Owning up to societal demands of taking responsibility and conforming to norms that we all are expecting to live by are also issues that they find demanding. In addition, they also find it hard to restrain their impulses. It is the combination of these emotional, interpersonal and behavioral features that define psychopathy (Hare, 2003).

Psychopathy is considered to be a personality disorder, although it has up till now not been included in the Diagnostic and Statistical Manual of Mental Disorders DSM-IV-TR (American Psychiatric Association, 2000). The reason why psychopathy is defined as a personality disorder and not a psychiatric illness or personality change, is because it is an illness that is of a more constant form, being present from a young age and throughout life, as opposed to illnesses *caused* by injuries to the head, traumatic experiences or other influences later in life, which can make you *shift* in the way you think, act and feel (American Psychiatric Association, 2000). APA makes this difference clear by giving psychiatric illnesses one axis and personality disorders another axis. Axis I comprise illnesses that with

sudden onset can more or less strike you, whereas the illnesses on Axis II are disorders that are of a more constant form, being present from a young age and throughout life (American Psychiatric Association, 2000).

In the 1940s, Hervey Cleckley published a list of 16 qualities that became the values or the scale from which psychopathy was measured. Later, in 1980, Robert Hare developed the Psychopathy Checklist (PCL) based on these 16 qualities. The PCL, which is considered to be the “gold standard”, is a clinical tool, containing 20 items, designed to assess psychopathy. The PCL was initially developed to be used in incarcerated populations. It uses semi-structured interviews and journal reviews to assess psychopathy. The PCL contains two broad factors: the first factor deals with deficits in the affective and the interpersonal arena, or a callous-unemotional facet and an interpersonal facet. The callous-unemotional facet is characterized by lack of anxiety and empathy, no feelings of remorse, and limited depth of emotions, whereas grandiosity, manipulation, lying and deceiving for personal gain, characterizes the interpersonal facet. Factor 2 deals with antisocial behavior, comprising two facets: a behavioral one, which is seen in the person’s inability to control one’s impulses and sensation seeking, as well as an incapacity to shoulder responsibility or having goals, combined with a general parasitic lifestyle; secondly, an antisocial facet, which is characterized by criminal behavior, violations against rules and regulations, inadequate control of anger and unstable relationships (Hare, 2003).

In the past two decades several assessment tools have been developed to measure psychopathic personality in community settings (e.g., Psychopathic Personality Inventory (PPI) Lilienfeldt & Andrews, 1996, for use among adults; the Antisocial Process Screening Device, APSD, Frick & Hare, 2002, for use among children and adolescents). Many of these assessment tools have been developed using the PCL as a model.

To measure the relative genetic and environmental influences on psychopathic personality traits researchers use twin design, since, twin studies have the advantage of allowing for the separate estimation of genetic (A), shared environmental (C), and non-shared environmental (E) factors to traits, behaviors and disorders, through comparison of identical (monozygotic, MZ, who are assumed to share 100% of their genes) and fraternal (dizygotic, DZ, who are assumed to share on average 50% of their genes) twins. Shared environmental factors refer to non-genetic influences that contribute to similarity within pairs of twins. Non-shared environmental factors are those experiences that make siblings dissimilar (Plomin, DeFries, McClearn, & McGuffin, 2001). Findings from community samples of twins have also shown that both genetic and environmental influences are important for the development of psychopathic personality traits (e.g., Brook et al., 2010; Hicks et al., ).

In spite of this general understanding of what is germane to the construct of psychopathic personality traits many earlier studies have examined the genetic and environmental influences of the behavioral aspect of psychopathic personality traits (for a summary see Waldman & Rhee, 2006; book chapter in C.J. Patrick, (Ed.), *Handbook of psychopathy*), but fewer studies have examined the genetic and environmental influences on the core features of the psychopathic personality.

### **Previous meta-analyses of examining the genetic and environmental influences on psychopathic personality traits**

A meta-analysis including 51 twin and adoptions studies was carried out on the related disorder, antisocial behavior (Rhee & Waldman, 2002). Studies from the early 1960s to late 1990s were included. Genetic influences were found to account for 41% of the total variance in antisocial behavior shared environmental influences explained 16%, and the non-shared environment accounted for the remaining 43% (Rhee & Waldman, 2002). These estimates of

genetic and environmental influences on antisocial behavior were later presented together with a summary on the published literature on genetic and environmental influences on psychopathy, a total of nine studies (Waldman & Rhee, 2006). Genetic influences explained 49% of the total variance in psychopathic personality and the non-shared environment explained 51%, as compared to antisocial behavior (genetic influences =41%, non-shared environment = 43%). The results showed that a notable difference between these two related disorders was that shared environmental influences did not account for any of the variance in psychopathic personality, whereas it accounted for as much as 16% of the variance in antisocial behavior (Waldman & Rhee, 2006).

An important limitation with the previous meta-analysis (Waldman & Rhee, 2006) is that the majority of the included studies only measured the antisocial aspect of psychopathic personality traits, whereas the present meta-analysis focuses on the core features of psychopathy, that is the interpersonal-affective factor. Another limitation is that it included only nine studies, whereas the present meta-analysis includes fifteen studies.

### **Potential Moderators**

Moderators are variables or factors that might affect the findings, in strength or direction. The moderators either characterize the study, like measure, informant, study design and publication date, or they characterize the participants, such as age and sex (Rhee & Waldman, 2002). In the present study the following potential moderators were examined: measure, informant, age, and sex.

*Measures.* Previous studies examining the genetic and environmental influences on psychopathic personality traits have used different types of measures to assess these traits. Some studies used measures specifically designed to assess psychopathy or psychopathic personality traits, such as the CPS and the PPI (e.g., Bezdjian et al., 2011a; Blonigen et al.,

2003), whereas others used measures that were developed to assess more general personality traits, such as the MPQ (e.g., DiLalla, Carey, Gottesman, & Bouchard, 1996; Fontaine, Rijdsdijk, McCrory, & Viding, 2010). The examination of the studies using different measures reported heterogeneous results and as such measure was examined as a potential moderator in the current study.

*Informant.* There are different ways for researchers to acquire information of the subject, self-report is one way and it basically means that the subject is reporting on his/her own behaviors. A disadvantage with using self-report to assess people with psychopathic personality traits is that it can cause problems in misreporting, since this group is characterized by lack of insight into their own psychological diagnosis and they have an inclination to deceive, lie and manipulate (Lilienfeld & Fowler, 2006). Although there are some problematic questions remaining about self-report as a valid instrument, it is the current view that it is a rewarding instrument as a measurement of identifying psychopathy (Lilienfeld, 1994, 1998).

Caregiver ratings can also give valid information regarding different types of behavior, including psychopathy and its related traits (Andershed, Kerr, Stattin, & Levander, 2002; Bezdjian, Tuvblad, Raine, & Baker, 2011b). The intimate relationship between the caregiver and child is an excellent source of knowledge, and being adult makes it easier to understand and retell information in a broader and more complex perspective (Bartels et al., 2003).

Teacher reports has shown to be a reliable instrument for measuring different types of conduct problems since teachers are in contact with a large number of children. They are also experienced and knowledgeable about child development. Analysis of twin studies indicates that teacher ratings are less biased than parent ratings (Nadder, Silberg, Rutter, Maes & Eaves, 2001). It is also important to remember that we often act differently in different situations, such as home, school and peer settings, which could mean that a teacher might see

a side of a child that the caregiver would not encounter and vice versa (Bartels et al., 2003). It is possible that by using different raters will provide a more complete picture of these complex traits (see for instance, Tuvblad, Raine, & Baker, unpublished). Different raters are also likely to provide their own unique perspective on these traits; as such assessment method was examined as a potential moderator.

It is possible that the genetic and environmental influences for a specific trait or behavior vary across age. For example, behavioral genetic research has shown that the heritability of both general personality and cognitive ability increases during the life span, whereas the effects of the shared environment decrease from moderate during childhood to negligible levels after adolescence (Plomin et al., 2001). This suggests that it is possible that genetic and environmental influences on psychopathic personality traits vary across development. Age was therefore examined as a potential moderator.

It is generally seen that psychopathy is more prevalent among males than females (Moffitt, Caspi, Rutter & Silva, 2001). The majority of previous twin studies do not report finding any sex differences in the genetic and environmental variance components of psychopathic personality traits (e.g., Forsman, Lichtenstein, Andershed, & Larsson, 2008). So, even though there is a sex difference in prevalence, the underlying genetic and environmental etiology of psychopathic traits appears to be similar in males and females.

Since previous research examining genetic and environmental influences on general personality have not reported any sex differences (Plomin, 2001), we do not expect to find any sex differences when investigating heritability of psychopathic personality traits.

## **The Present Study**

In the present study, the results from the behavior genetics literature on psychopathic personality traits were reviewed and summarized. The aim of the current study was two-fold: (1) to synthesize to what degree genetic and environmental factors influence psychopathic personality, and (2) to examine the influence of potential moderators (measure, informant, age and sex) on the magnitude of genetic and environmental influences on these traits.

## **Method**

### **Search Strategy**

An extensive literature search was undertaken using online databases PsycInfo (<http://search.proquest.com.db.ub.oru.se/psycinfo/advanced?accountid=8028>) and PubMed (<http://www-ncbi-nlm-nih-gov.db.ub.oru.se/pubmed?otool=iseorebulib>). The search terms that were used included: *twins, psychopathy, callous, callousness, heritability, intraclass, genes, genetic, correlation, environment, environmental, interpersonal, covariate, traits, personality, etiology, disorder, and unemotional*. These search terms were used in different combinations and some of the words were truncated (- \*) to make sure the endings of the keywords did not limit the search. The reference lists of the articles included in the present paper were scrutinized in order to identify relevant articles that might have been missed in the database searches, and appropriate keywords found in these articles were added to the above search terms.

The searches were conducted from October 1<sup>st</sup> to December 31<sup>st</sup> 2012.

**Inclusion criteria**

The search resulted in 22 studies on genetic and environmental influences on psychopathic personality traits, from which 15 studies were selected based on whether or not the study gave genetically informative data, such as twin correlations, often referred to as intraclass correlation, see Table 1. The primary studies must also have used the classical twin design, which was a fundamental inclusion criterion.

The study with the largest sample from the same population was included in our calculation and analyses, since it is often the case that the same sample or rather the data from the same sample is used in different published studies. We have included studies with the same sample if the studies have used different measures, informant or ages.

All included articles are peer-reviewed, with the exception of Tuvblad et al., which is submitted for publication. Peer-reviewed means that they have been circulated for comment, like a referral, among peers in the same field, who will estimate the value and worth of the article from a quality and relevance perspective. This process which the primary studies go through is very important for the credibility of a meta-analysis, given that the empirical data in this case are the articles. Further, only articles published in English were included.

Most earlier behavioral genetic studies have focused on the behavioral aspect of psychopathy (see Waldman & Rhee, 2002, for a summary), that is the antisocial traits, but in this meta-analysis we have focused our examination on studies that explicitly state that they are investigating genetic and environmental influences on psychopathy or psychopathic personality traits. If they investigate related disorders and therefore address the core features of psychopathy, such as the interpersonal-affective factor, and its etiology, then they were considered for inclusion.

Table 1. *Inclusion – Exclusion based on independence, size and availability of twin correlations*

Population Study	Assessment	Age at assessment (Mean age)	Sex	N	Inclusion - Exclusion
<b>Add Health</b> Beaver et al., 2011	Self-report	Middle and high school 11-17yrs	M+F	N/A	Included-independent
<b>MISTRA</b> DiLalla et al., 1996	Self-report	≤18 yrs (40.4, 45.1)	M+F	238	Included-independent
<b>MTR</b> Blonigen et al., 2003	Self-report	17 yrs	M	353	Included
<b>MTFS</b> Blonigen et al., 2005	Self-report	17 yrs	M, F	1252	Excluded
Blonigen et al., 2006	Self-report	17, 24 yrs	M, F	1252	Excluded – no twin correlations
Hicks et al., 2012	Self-report	17 yrs	M, F	2604	Included - largest
Loney et al., 2007	Self-report	16-18 yrs	M	475	Excluded – no twin correlations
Taylor et al., 2003	Self-report	22-24 yrs (17)	M	398	Included
<b>RFAB</b> Bezdjian et al., 2011a	Caregiver report	9-10 yrs	M, F	1219	Included
Bezdjian et al., 2011b	Caregiver report Child self-report	9-10 yrs	M, F	1219	Excluded
Tuvblad et al., unpublished	Caregiver report Child self-report	14-16 yrs	M, F	1087 1060	Included
<b>TCHAD</b> Forsman et al., 2008	Self-report	16, 19 yrs	M, F	2196	Included
Larsson et al., 2006	Self-report	16-17 yrs	M, F	2198	Included - largest
Larsson et al., 2007	Self-report	16-17 yrs	M, F	1912	Excluded
<b>TEDS</b> Fontaine et al., 2010	Teacher ratings	7, 9, 12 yrs	M, F	9462	Included
Viding et al., 2005	Teacher ratings	(7.10)	M+F	7374	Excluded – no twin correlations
Viding et al., 2007	Teacher ratings	7 yrs	M, F	3198	Included
<b>US-Canada</b> Vernon et al., 2008	Self-report	17-92 yrs (41.4)	M+F	278	Included
<b>Vancouver &amp; London, Canada</b> Jang et al., 2000	Self-report	18-86 yrs (32.5)	M+F	1318	Included
Livesley et al., 1993	Self-report	16-71 yrs (29.07, 28.29)	M+F	296	Excluded
Livesley et al., 1998	Self-report	(31.2) (30.6)	M+F	1372	Included – largest
<b>VETR</b> Brook et al., 2010	Self-report	(47.8)	M	545	Included

*Note:* Population (for full references, see *Note* below Table 2): Add Health - National Longitudinal Study of Adolescent Health, MISTRA - Minnesota Study of Twins Reared Apart, MTR - Minnesota Twin Registry, MTFS - Minnesota Twin & Family Study, RFAB - The University of Southern California Risk Factors for Antisocial Behavior Twin Study, TCHAD - Twin Study of Child and Adolescent Development, TEDS - Twins Early Development Study, US-Canada, Vancouver & London, Canada, VETR - Vietnam Era Twin Registry

### **Reasons for exclusion**

Any studies before 1990 were excluded in the present meta-analysis. The primary reasons are, that the way of measuring psychopathy in community settings has changed, and the number of participants (N) in twin studies before 1990 were relatively small (Moffitt, 2005).

The most widely used measure to assess psychopathy in clinical settings has been, and still is, the PCL. Recently, in order to measure psychopathic personality traits in large community samples, new measurement tools like Childhood Psychopathy Scale, CPS (Lynam, 1997), and Antisocial Process Screening Device, APSD (Frick & Hare, 2001; 2002), and Youth Psychopathic Traits Inventory, YPI (Andershed et al., 2002) have been developed. Only one study in the present meta-analysis used the PCL-YV with the intention to compare the results 'across measures' (Tuvblad et al., unpublished).

A consequence of the exclusion of studies from before 1990 is that other study designs like adoption studies are not available to us. In the 1970s, adoptions within a country, which earlier provided data from both the biological family and the adopting family became more uncommon resulting overall in fewer adoption studies (Moffitt, 2005).

## **Statistical analyses**

### **Twin studies**

All the included articles based their analyses on twin samples. Studies on twins are used to estimate the relative contribution of hereditary and environmental factors - to traits, behaviors and disorders. In all studies included, the twins were raised together, with the exception of DiLalla et al. (1996) in which the twins were reared apart. In the twins-reared-apart design twins share part of their genetic make-up, but 0% of their environment (Livesley, Jang, Jackson, & Vernon, 1993).

The two categories of twins: monozygotic twins (MZ) and dizygotic twins (DZ) differ in their genetic make-up. MZ twins are assumed to be - 100% genetically identical and are the result of a single sperm fertilizing a single egg. The fertilized egg is then divided into two identical parts. DZ twins, on the other hand, have developed from two different eggs that have been fertilized by two separate sperms at the same time. The two eggs then grow separated from each other in the womb. DZ twins share approximately 50% of their genes and differ genetically in the same way as ordinary siblings do (Neale & Cardon, 1992).

By comparing MZ twin correlations with DZ twin correlations it is possible to estimate how much of the phenotypic variance of a measured trait that is due to additive genetic factors (A), dominant genetic effects (D), shared environmental factors (C), and non-shared (unique) environmental factors (E). Non-shared environmental factors also includes measurement error. Heritability is the proportion of total phenotypic variance due to genetic variation. Two times the difference between the MZ and DZ correlations provides a first estimate of the relative contribution of additive genetic influences (A) to the phenotypic variation in a trait ( $A = 2[r_{MZ} - r_{DZ}]$ ). The contribution of the dominant genetic effect (D) is obtained by subtracting four times the DZ correlation from twice the MZ correlation ( $D = 2r_{MZ} - 4r_{DZ}$ ). The proportion of the variance that is due to shared environmental influence (C) is given by subtracting the MZ correlation from twice the DZ correlation ( $C = 2[r_{DZ}] - r_{MZ}$ ). Finally, the contribution of the non-shared environmental influences (E) can be obtained by subtracting the MZ correlation from unit correlation ( $E = 1 - r_{MZ}$ ) (Plomin, 2001; Neale & Cardon, 1992).

## Results

### Analyses of all Data

All the included studies meeting the inclusion criteria (N= 15 samples, and 26,981 participants) showed that the additive genetic and unique (non-shared) environmental factors explained all of the variance in psychopathic personality traits, whereas shared environmental factors played an insignificant role in explaining the variance of psychopathic personality traits, see Table 2.

The results showed that genetic factors (A) varied from 17% to 78%, with a mean of 46%. The vast majority, thirteen out of fifteen included studies reported shared environmental factors (C) that varied from 0% to 4%. The remaining two studies reported that shared environmental factors explained 20% and 75% of the variance of psychopathic personality traits, both studies measuring callous-unemotional traits (Viding, Frick, & Plomin, 2007; Fontaine et al., 2010). Interestingly, this only applied to females, for the males in these studies, the shared environment explained between with 4% and 1%, respectively (Viding et al., 2007; Fontaine et al., 2010). Another tendency, regarding shared environmental factors, is that it is only found in the studies assessing children, 7-12 years old, with one exception (Vernon, Villani, Vickers, & Harris, 2008), though neither of these three results were significant.

Unique environmental factors (E) varied from a moderate 20% to 81%. The study using the clinical tool, PCL-YV, reported considerably higher estimates of the unique (non-shared) environmental factors, ranging from 67-81% (Tuvblad et al., unpublished), in comparison to all other included studies, where non-shared environmental factors explained 20-68%, with a mean value of 44%.

Next the relative magnitude of the variance of additive genetic factors (A), shared environmental factors (C) and unique environmental factors (E) of psychopathic personality traits for all studies combined were calculated.

For males, the calculations were:  $A=2(0.47-0.19)=0.56$ ,  $C=2(0.19)-0.47=-0.09$ , and  $E=1-0.47=0.53$ , meaning that for males additive genetic factors explained 56% of the total variance in psychopathic personality traits; 53% was explained by unique environmental influences, whereas shared environmental influences did not account for any part in the variance of psychopathic personality traits.

For females the calculations were:  $A=2(0.52-0.26)=0.52$ ,  $C=2(0.26)-0.52=0$ , and  $E=1-0.52=0.48$ , that is for females additive genetic factors explained 52%, shared environmental 0% and unique environment factor 48% of the total variance of psychopathic personality traits.

The last group, males and females combined were,  $A=2(0.49-0.25)=0.48$ ,  $C=2(0.25)-0.49=0.01$ , and  $E=1-0.49=0.51$ , that is, of the total variance of psychopathic personality traits 48% was explained by additive genetic influences, 1% was explained by shared environmental factors and 51% was explained by unique environmental factors.

Finally, the calculations for all the included articles in the meta-analysis regarding the total variance in psychopathic personality traits  $A=2(0.49-0.24)=0.50$ ,  $C=2(0.24)-0.49=-0.01$ , and  $E=1-0.49=0.51$ , in words that would mean that 50% of the variance being accounted for by additive genetic factors and 51% of the variance being accounted for by unique environmental factors, with shared environmental factors reporting a negative value, -1%.

(the text continues on p. 26)

Table 2. *Twin studies considered for inclusion in the meta-analysis*

Author, year	Name of Study	Measure	Informant	Age range (mean)	Population N=Total	Sex(N)	MZ r(N)	DZ r(N)	Subscales	A genetic factors/ heritability	C shared environmental factors	E unique environmental factors	Sex-differences
<b>Beaver et al., 2011</b>	<i>Psychopathic Personality Traits, Genetic Risk and Gene-Environment Correlations</i>	FFM 23 items	Self-report	Data were collected 1994-1995 in 132 middle and high schools	Add Health N=N/A	M+F	.38*(614)	.18*(904)	Psychopathic Personality	37%		63%	N/A
<b>Bezdjian et al., 2011a</b>	<i>Psychopathic Personality in Children: Genetic and Environmental Contributions</i>	CPS	Caregiver report	9-10 yrs (9.6)	RFAB N=1219	M F OS	.63*(276) .53*(278)	.11(168) .30*(194) .26*(294)	Callous/ Disinhibited	64% 49%	0% 6% n.s	36% 44%	Sex-differences
						M F OS	.50*(276) .58*(278)	.02(168) .35*(168) .27*(294)	Manipulative /Deceitful	46% 58%	1% n.s. 4% n.s.	53% 37%	Sex-differences
Bezdjian et al., 2011b	<i>The Genetic and Environmental Covariation among Psychopathic Personality Traits</i>	CPS	Caregiver (mainly mother) report and Child self-report	9-10 yrs (9.6)	RFAB N=1219	M F OS  M F OS	.63*(276) .53*(278)  .39*(276) .34*(278)	.11(168) .30*(194) .26*(294)  .17(168) .08(194) .13(294)	Callous/ Disinhibited (caregiver)  Callous/ Disinhibited (child self-report)	N/A  N/A	N/A  N/A	N/A  N/A	N/A
						M F OS  M F OS	.50*(276) .58*(278)  .42*(276) .25*(278)	.02(168) .35*(168) .27*(294)  .11(168) .23*(194) .04(294)	Manipulative /Deceitful (caregiver)  Manipulative /Deceitful (child self-report)	N/A  N/A	N/A  N/A	N/A  N/A	N/A
<b>Blonigen et al., 2003</b>	<i>A twin study of self-reported psychopathic personality traits</i>	PPI	Self-report	17 yrs	MTR N=353	M	.46*(226)	-.26(127)	Total PPI score	40%	0%	61%	N/A Only males
Blonigen et al., 2005	<i>Psychopathic personality traits: heritability and genetic overlap with internalizing and externalizing psychopathology</i>	MPQ	Self-report	17 yrs	MTFS N=1252	M F M+F	.42(376) .45(446) .44(822)	.20(202) .21(228) .22(430)	Fearless Dominance	46% 45% 45%		54% 55% 55%	N/A

						M F M+F	.51(376) .49(446) .50(822)	.17(202) .28(228) .24(430)	Impulsive Antisociality	51% 48% 49%		49% 52% 51%	N/A
Blonigen et al., 2006	<i>Continuity and Change in Psychopathic Traits as Measured Via Normal-Range Personality: A Longitudinal-Biometric Study</i>	MPQ MPQ-FD MPQ-IA	Self-report	17, 24 yrs	MTFS N=1252	M F M+F	N/A(376) N/A(446) N/A(822)	N/A(202) N/A(228) N/A(430)					
		MPQ-FD		17 yrs		M+F	N/A(822)	N/A(430)	Fearless Dominance	48%		52%	N/A
				24 yrs		M+F	N/A(822)	N/A(430)	Fearless Dominance	42%		58%	N/A
		MPQ-IA		17 yrs		M+F	N/A(822)	N/A(430)	Impulsive Antisociality	46%		54%	N/A
				24 yrs		M+F	N/A(822)	N/A(430)	Impulsive Antisociality	49%		51%	N/A
Brook, et al., 2010	<i>Psychopathic personality traits in middle-aged male twins: A behavior genetic investigation</i>	MPQ (33 items) NZMPQ (178 items)	Self-report	(47.8)	VETR N=545	M	.48(269)	.17(276)	Fearless Dominance	51%		49%	N/A Only males
							.35(269)	.16(276)	Impulsive Antisociality	32%		68%	N/A Only males
DiLalla et al., 1996	<i>Heritability of MMPI personality indicators of psychopathology in twins reared apart</i>	MMPI	Self-report	≥18 yrs (MZA 40.4) (DZA 45.1)	MISTRA N=238	M+F	.62(130)	.14(108)	Psychopathic Deviate	61%		39%	N/A
Fontaine et al., 2010	<i>Etiology of Different Developmental Trajectories of Callous-unemotional Traits</i>	Callous/ Unemotional traits	Teacher ratings	7, 9, 12 yrs	TEDS N=9462	M(4476) F(4986) OS	.81(N/A) .69(N/A)	.33(N/A) .78(N/A) .13(N/A)	Callous/ Unemotional stable high	78% 0% n.s.	1% n.s. 75%	21% 25%	Sex-differences
						M(4476) F(4986) OS	.51(N/A) .72(N/A)	.30(N/A) .60(N/A) .32(N/A)	Callous/ Unemotional increasing	58% 26% n.s.	3% n.s. 47%	39% 27%	Sex-differences
						M(4476) F(4986) OS	.62(N/A) .80(N/A)	.32(N/A) .53(N/A) .36(N/A)	Callous/ Unemotional decreasing	61% 54%	2% n.s. 26%	37% 20%	Sex-differences

						M(4476) F(4986) OS	.73(N/A) .80(N/A)	.45(N/A) .48(N/A) .36(N/A)	Callous/ Unemotional stable low	68%	8%	24%	No sex differen- ces
<b>Forsman et al., 2008</b>	<i>Genetic Effects Explain the Stability of Psychopathic Personality from Mid- to Late Adolescence</i>	YPI	Self-report	16, 19 yrs	TCHAD N=2196								
				16 yrs		M F OS	.48*(416) .57*(448)	.26*(305) .20*(335) .27*(692)	Grandiose/ Manipulative				No sex differen- ces
						M F OS	.49*(416) .45*(448)	.26*(305) .21*(335) .16*(692)	Callous/ Unemotional				
						M F OS	.58*(416) .54*(448)	.17*(305) .29*(335) .25*(692)	Impulsive/ Irresponsible				
				16 yrs: Total YPI		M+F				62%	0%	38%	
				19 yrs	N=1554	M F OS	.46*(N/A) .63*(N/A)	.19(N/A) .27*(N/A) .23*(N/A)	Grandiose/ Manipulative				No sex differen- ces
						M F OS	.41*(N/A) .49*(N/A)	.05(N/A) .24*(N/A) .12*(N/A)	Callous/ Unemotional				
						M F OS	.59*(N/A) .55*(N/A)	.12(N/A) .07(N/A) .31*(N/A)	Impulsive/ Irresponsible				
				19 yrs: Total YPI		M+F				17%	0%	36%	
<b>Hicks et al., 2012</b>	<i>Psychopathic Personality Traits and Environmental Contexts: Differential Correlates, Gender Differences, and Genetic Mediation</i>	MPQ MPQ-FD MPQ- IA	Self-report	17 yrs	MTFS N=2604								
		MPQ-FD				M(1239) F(1365)	.45(N/A) .47(N/A)	.18(N/A) .16(N/A)	Fearless Dominance	46% 45%	0% 0%	54% 55%	No sex- differen- ces

		MPQ-IA				M(1239) F(1365)	.52(N/A) .57(N/A)	.22(N/A) .30(N/A)	Impulsive Antisociality	52% 48%	0% 8%	48% 44%	No sex- differen- ces
<b>Jang et al., 2000</b>	<i>Personlity Disorder Traits, Family Environment, and Alcohol Misuse</i>	DAPP-DQ	Self-report	18-86 yrs (32.5)	Vancouver & London, Canada N=1318	M+F	.50*(670)	.25*(648)	Dissocial Behaviour	N/A	N/A	N/A	N/A
<b>Larsson, Andershed &amp; Lichtenstein, 2006</b>	<i>A Genetic Factor Explains Most of the Variation in the Psychopathic Personality</i>	YPI	Self-report	16-17 yrs	TCHAD N=2198	M F OS	.48***(386) .61***(452)	.30***(328) .26***(366) .25***(666)	Grandios/ Manipulative	51%	3% n.s.	46%	No sex- differen- ces
						M F OS	.47***(386) .44***(452)	.26***(328) .17***(366) -.06(666)	Callous/ Unemotional	43%	0%	57%	No sex- differen- ces
						M F OS	.57***(386) .57***(452)	.20***(328) .31***(366) .22***(666)	Impulsive/ Irresponsible	56%	0%	44%	No sex- differen- ces
Larsson et al., 2007	<i>A Common Genetic Factor Explains the Association Between Psychopathic Personality and Antisocial Behaviour</i>	YPI	Self-report	16-17 yrs	TCHAD N=1912	M F OS	.46*(362) .59*(404)	.25*(262) .26*(288) .27*(596)	Grandiose/ Manipulative	25% 37%	0% 2%	75% 61%	No sex- differen- ces
						M F OS	.46*(362) .45*(404)	.27*(262) .27*(288) .14*(596)	Callous/ Unemotional	20% 22%	0% 3%	80% 75%	No sex- differen- ces
						M F OS	.56*(362) .55*(404)	.15*(262) .29*(288) .22*(596)	Impulsive/ Irresponsible	42% 45%	3% 0%	55% 55%	No sex- differen- ces
Livesley et al., 1993	<i>Genetic and Environmental contributions to Dimensions of Personality Disorder</i>	DAPP-BQ	Self-report	MZ 16-71 yrs (29.07) DZ 16-62 yrs (28.29)	Vancouver N=296	M+F	.63*(180)	.29*(116)	Callousness	56%	0%	44%	N/A

<b>Livesley et al., 1998</b>	<i>Phenotypic and Genetic Structure of Traits Delineating Personality Disorder</i>	DAPP-BQ	Self-report	MZ (31.2) DZ (30.6)	Vancouver British Columbia N=1372	M+F	.42(680)	.22(692)	Callousness	31%		67%	N/A
Loney et al., 2007	<i>Adolescent Psychopathy Features: 6 year Temporal Stability and the Prediction of Externalizing Symptoms During the Transition to Adulthood</i>	MTI	Self-report	16-18 yrs (17.48) 22-24 yrs (23.49)	MTFS N=475	M	N/A(290)	N/A(138)	Detachment				N/A Only males
<b>Taylor et al., 2003</b>	<i>Genetic and Environmental Influences on Psychopathy trait Dimensions in a Community Sample of Male Twins</i>	MTI	Self-report	Cohort 1: 10-12 yrs (measured at mean age 17)  Cohort 16-18 yrs (17)	MTFS N=398	M	.42*(142)	.17*(70)	Antisocial				N/A Only males
				Cohort 2: 10-12 yrs (measured at mean age 17)  Cohort 16-18 yrs (17)			.36*(128)	.09*(58)	Total (both cohorts)	39%		61%	
				Cohort 2: 10-12 yrs (measured at mean age 17)  Cohort 16-18 yrs (17)			.41*(142)	.15*(70)	Detachment				N/A Only males
				Cohort 2: 10-12 yrs (measured at mean age 17)  Cohort 16-18 yrs (17)			.43**(128)	.25*(58)	Total (both cohorts)	42%		58%	
<b>Tuvblad, et al., unpubl.</b>	<i>The Heritability of Psychopathic Personality in 14 to 16 year Old Twins: A Multi-Rater, Multi-Measure Approach</i>	CPS ASPD PCL-YV	Caregiver report (mainly mother) and Child self-report	14-16 yrs (14.87)	RFAB N=1562	M F OS	(338) (342)	(242) (240) (400)					
		CPS-P			CPS N=1087 Parents	M F OS	.51**(338) .42**(342)	.05(242) .11(240) .41**(400)	Callous/ Disinhibited	46%		54%	No sex differences
					N=1060 Twins	M F OS	.40**(338) .50**(342)	.14(242) .31**(240) .41**(400)	Manipulative/ deceitful	55%		45%	
						M F OS	.44**(338) .57**(342)	.04(242) .21*(240) .46**(400)	Total	56%		44%	

		APSD-P			ASPD N=1010 Parents	M F OS	.67** (338) .63** (342)	.38** (242) .32** (240) .47** (400)	Callous- Unemotional	64%		36%	No sex differen- ces
					N=1076 Twins	M F OS	.41** (338) .37** (342)	.34** (242) .28** (240) .35** (400)	Narcissism	54%		46%	
						M F OS	.54** (338) .53** (342)	.27* (242) .32** (240) .38** (400)	Impulsivity	58%		42%	
						M F OS	.52** (338) .54** (342)	.38** (242) .38** (240) .43** (400)	Total	65%		35%	
		CPS-Y			CPS N=1087 Parents	M F OS	.33** (338) .48** (342)	.19 (242) .10 (240) .22* (400)	Callous/ Disinhibited	43%		57%	No sex differen- ces
					N=1060 Twins	M F OS	.49** (338) .49** (342)	.21 (242) .20* (240) .23** (400)	Manipulative/ Deceitful	47%		53%	
						M F OS	.39** (338) .53** (342)	.26* (242) .15 (240) .27** (400)	Total	48%		52%	
		APSD-Y			ASPD N=1010 Parents	M F OS	.55** (338) .46** (342)	.19 (242) .28** (240) .16 (400)	Callous/ Unemotional	47%		53%	No sex differen- ces
					N=1076 Twins	M F OS	.23* (338) .38** (342)	.14 (242) .18 (240) .18* (400)	Narcissism	28%		72%	
						M F OS	.27** (338) .39** (342)	.23* (242) .09 (240) .33** (400)	Impulsivity	38%		62%	
						M F OS	.39** (338) .54** (342)	.23* (242) .24* (240) .33** (400)	Total	49%		51%	

		PCL:YV			PCL:YV N=943	M F OS	.09(338) .24*(342)	.01(242) .25*(240) .13(400)	Interpersonal	19%		81%	No sex differences
						M F OS	.33**(338) .25*(342)	-.04(242) .09(240) .09(400)	Affective	22%		78%	
						M F OS	.28**(338) .38**(342)	.26*(242) -.05(240) .16(400)	Behavioral	33%		67%	
						M F OS	.28**(338) .32**(342)	.17(242) -.04(240) -.07(400)	Antisocial	19%		81%	
						M F OS	.27**(338) .42**(342)	.13(242) .15(240) .18*(400)	Total	30%		70%	
<b>Vernon et al., 2008</b>	<i>A Behavioral Genetic Investigation of the Dark Triad and the Big 5. Personality and Individual Differences</i>	SRP III-R12	Self-report	17-92 yrs (41.42)	US-Canada N=278	M+F	.54*(150)	.44*(128)	Psychopathy	64%	4% n.s.	32%	N/A
Viding et al., 2005	<i>Evidence for Substantial Genetic Risk for Psychopathy in 7-year-olds</i>	APSD+SDQ	Teacher rating	(7.10)	TEDS N=7374	M+F	N/A	N/A	Callous/Unemotional Scale	67%	6% n.s.	27%	N/A
<b>Viding et al., 2007</b>	<i>Aetiology of the Relationship Between Callous-unemotional Traits and Conduct Problems in Childhood</i>	APSD+SDQ	Teacher ratings	7 yrs	TEDS N=3198	M F OS	.72**(534) .67**(612)	.32**(508) .44**(562) .32**(982)	Callous/Unemotional traits	67% 48%	4% n.s. 20%	29% 32%	Sex-differences
	<b>Weighted Average</b>					<b>M F OS M+F Total</b>	<b>.47 .52 .49 .49</b>	<b>.19 .26 .24 .25 .24</b>		<b>56% 52% 48% 50%</b>	<b>-9% 0% 1% -1%</b>	<b>53% 48% 51% 51%</b>	

Notes. MZ, monozygotic twins; DZ, dizygotic twins; M, male twins; F, female twins; M+F, male and female twins combined; MZA, monozygotic twins reared apart; DZA, dizygotic twins reared apart; OS, opposite sex twins; N, number; N/A, not available; n.s., not significant; Author's name in **bold** indicates that the study has been selected for the estimation of weighted average ; *Italicized* values are calculated by meta-analysis authors; A, genetic factors/heritability; C, shared environmental, E, unique environmental factors; all measures with references can be found in Appendix C. Significant levels, \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$ .

**Measure:** Antisocial Process Screening Device – 20 items, 3 subscales (Frick & Hare, 2001; 2002); SDQ, Strengths and Difficulties Questionnaire (Goodman, 1997); CPS, Child Psychopathy Scale – 58 items, 14 subscales (Lynam, 1997; Lynam, 2002); CU traits, Callous-Unemotional traits – 3 items from Antisocial Process Screening Device, APSD (Frick & Hare, 2002) 4 items for Strength and Difficulties Questionnaire, SDQ (Goodman, 1997); DAPP-BQ, Dimensional Assessment of Personality Problems – Basic Questionnaire, 290 items, 18 subscales (Livesley, Jackson & Schroeder, 1989; Livesley, Jang, & Vernon, 1998; Schroeder, Wormworth & Livesley, 1992); DAPP-DQ, Dimensional Assessment of Personality Problems – Differential Questionnaire, 560 items, 18 subscales (Livesley & Jackson, in press); FFM, Five Factor Model – The Big Five Personality Traits (Johns & Strivastava, 1999); MMPI, Minnesota Multiphasic Personality Inventory (Dahlstrom & Welsh, 1960) – 10 standard clinical scales, and the Wiggins content scales (Greene, 1991; Hathaway & McKinley, 1983; Wiggins, 1966); MPQ, Multidimensional Personality Questionnaire – 198 items, 11 primary subscales (Tellegen, unpublished manuscript); MTI, Minnesota Temperament Inventory – 19 items (Loney, Taylor, Butler & Iacono, 2002; Loney, Taylor, Butler, & Iacono, 2007); NZ MPQ, New Zealand Multidimensional Personality Inventory - 178 + 33 items, 10 subscales (Krueger et al., 1994; Tellegen, unpublished manuscript); PCL-YV, Psychopathy Checklist – Youth Version (Forth, Kosson & Hare, 2003); PPI, Psychopathic Personality Inventory - 187 items, 8 subscales, 1 total scale (Lilienfeldt & Andrews, 1996); SRP III-R12, Self Report Psychopathy Scale III, 62 items (Williams, Paulhus & Hare, 2007); YPI, Youth Psychopathy Inventory - 50 items, 10 subscales (Andershed, et al., 2002). **Population:** ADD HEALTH, National Longitudinal Study of Adolescent Health (Udry, 2003); MISTRA, Minnesota Study of Twins Reared Apart (Iacono & McGue, 2002; Iacono, McGue & Krueger, 2006); MTR, Minnesota Twin Registry (Iacono & McGue, 2002; Iacono, McGue, & Krueger, 2006; Lykken, Bouchard, McGue, & Tellegen, 1992); MTFS, Minnesota Twin & Family Study (Iacono & McGue, 2002; Iacono, McGue & Krueger, 2006); RFAB, The University of Southern California Risk Factors for Antisocial Behavior Twin Study (Baker, Barton, Lozano, Raine, & Fowler, 2006; Baker, Barton & Raine, 2002; Baker, Jacobson, Raine, Lozano, & Bezdjian, 2007; Baker, Tuvblad, Wang, Gomez, & Raine, in press); TCHAD, Twin Study of Child and Adolescent Development (Lichtenstein, Tuvblad, Larsson, & Carlström, 2007); TEDS, Twins Early Development Study (Trouton, Spinath, & Plomin, 2002); US-Canada (Vernon et al., 2008); Vancouver & London, Canada (Jang et al., 2000; Livesley et al., 1993; Livesley, 1998); VETR, Vietnam Era Twin Registry (Eisen, True, Goldberg, Henderson, & Robinett, 1987; Goldberg, Curran, Vitek, Henderson, & Boyko, 2002)

### **Assessment of Potential Moderators**

The studies used a variety of different definitions and measures, to capture psychopathy and/or psychopathic personality traits. This variety made it more difficult to detect patterns between the various measures used and the results. Six of the included studies used measures developed to assess psychopathy and/or psychopathic personality traits, such as the clinical tool, PCL-YV, Psychopathy Checklist Youth Version (Tuvblad et al., unpublished), the CPS, Child Psychopathy Scale (Bezdjian et al., 2011a; Tuvblad et al., unpublished), the PPI, Psychopathic Personality Inventory (Blonigen et al., 2003), the YPI, Youth Psychopathy Inventory (Forsman et al., 2008; Larsson et al., 2006), and the SRPIII, Self-Report Psychopathy Scale (Vernon et al., 2008).

The majority used omnibus personality measures, to assess psychopathic personality traits, such as the MMPI, Minnesota Multiphasic Personality Inventory (DiLalla et al., 1996) and the MPQ, Multidimensional Personality Questionnaire (Brook et al., 2010; Hicks et al., 2012). It is clear that personality measures do not use the same constructs to define psychopathy, nor do they measure psychopathic personality traits in the same way since they were developed to assess general personality, not just psychopathy or psychopathic personality traits.

No clear pattern evolved when comparing measure and the results, but the study using the PCL-YV to assess heritability of psychopathic personality (Tuvblad et al., unpublished) was the study reporting notably lower additive genetic factors (A) ranging from 19-33% and high values for the unique environmental factors (E), explaining 67-81% of the variance in psychopathic personality traits.

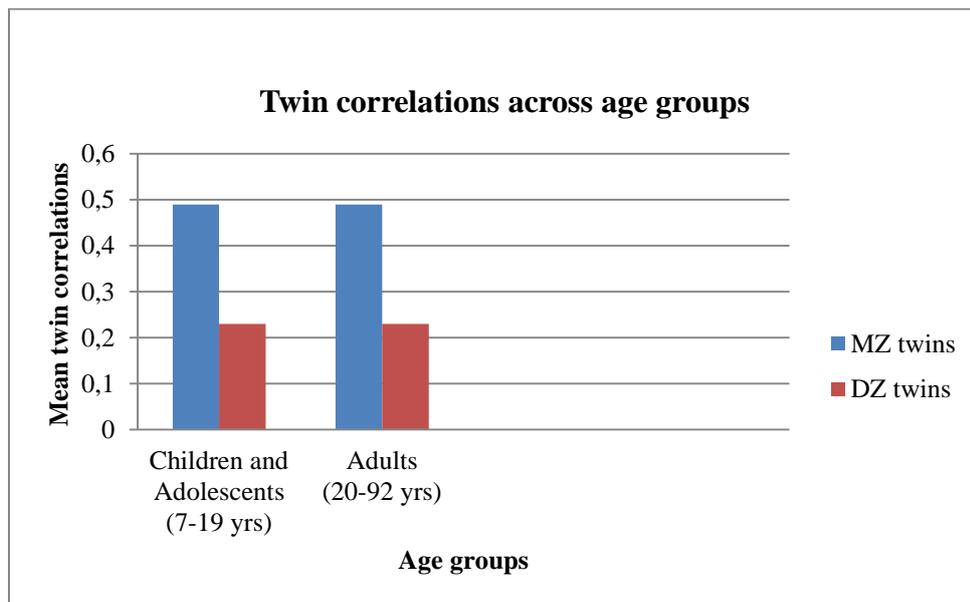
Self-report was the predominant procedure used in twelve of the fifteen studies, reporting heritable influences (A) ranging from 17% to 65%, with a mean of 46%. The study using the PCL-YV as a measure reported generally lower heritable influences (19-33%), than

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the majority. Caregiver ratings were used together with child self-reports in one recent study (Tuvblad et al., unpublished), making it easy to compare the ratings by the parents with the reports by the children self-report. This study showed higher explanation percentage for additive genetic factors ( $A = 56\%$  and  $65\%$ ) for caregiver report on both assessment scales, CPS and ASPD, compared to self-report ( $A = 48\%$  and  $49\%$ ). These findings are in accordance to previous results (Rhee & Waldman, 2002) that showed that report by others compared to self-report gave a higher magnitude for the influence of genetic factors (A).

Teacher ratings, which are also 'report by others', were used in two studies. These also follow the tendency to report higher additive genetic factors (A) for explaining the magnitude of psychopathic personality traits, ranging from 48-78%, with a small but clear difference between males and females; males ranging from 58-78% and females 48-54%. Worth noting is that the results for shared environmental factors (C), in the two studies using teacher ratings, differ remarkably from the other studies, with estimates ranging from 20%-75% and only for females (Fontaine et al., 2010; Viding et al., 2007). The other thirteen studies reported shared environmental factors (C) explaining 0-4% of the variance in psychopathic personality traits, none of them being significant. So it seems that depending on who the rater is, it has an impact on the overall results.

The ages represented in the present meta-analysis range from 7 to 92 years old. To be able to detect difference between the age groups, the studies were divided into two groups, a younger group including 7-19 year olds, and an older group for the 20-92 year olds. Figure 1 shows that both the younger and older group got the same mean twin correlations for MZ twins and DZ twins (.49, .23) which would seem to indicate that genetic factors and environmental factors influence the variance of psychopathic personality traits similarly over time.

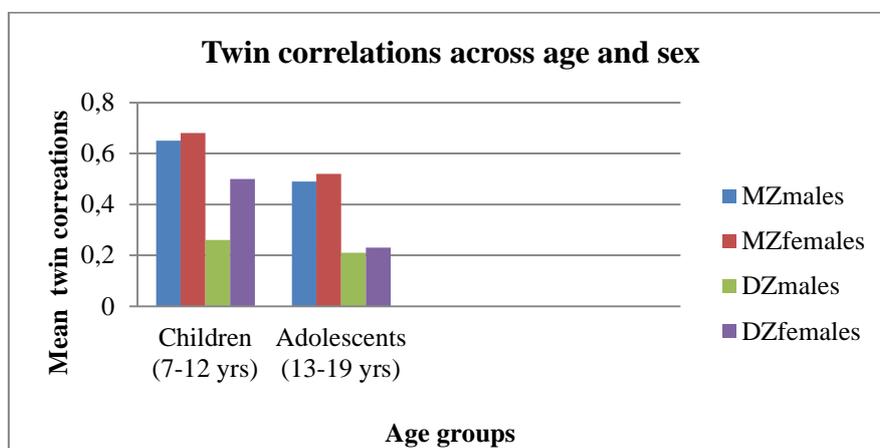
*Figure 1.* Twin correlations across age groups, both sexes included

Only three studies reported finding significant sex differences concerning the genetic and environmental influences of psychopathic personality traits (Bezdjian et al., 2011a; Fontaine et al., 2010; Viding et al., 2007). These three studies also had two other characteristics in common. First they all used reports by others as assessment method, caregiver report and teacher ratings respectively, and the participants in these studies were also young, between 7-12 years old. Another three studies (Blonigen et al., 2003; Brook et al., 2010; Taylor, Loney, Bobadilla, Iacono, & McGue, 2003) only included male participants, which meant that they could not check for sex differences. Four studies reported finding no sex differences (Forsman et al., 2008; Hicks et al., 2012; Larsson et al., 2006; Tuvblad et al., unpublished) and one of the studies that reported significant sex differences, reported finding no sex differences for one of the four subscales (Fontaine et al., 2010, subscale Callous/unemotional stable low). The remaining five did not examine sex differences (Beaver et al., 2011; DiLalla et al., 1996; Jang, Vernon, & Livesley, 2000; Livesley et al., 1998; Vernon et al., 2008). Based on these data, the majority of studies report finding no sex difference in the variance of genetic and environmental influences. The total mean twin correlation for males and females

were also similar, for MZ males was .47, for MZ females .52, and for DZ males .19 and DZ females .26, see Table 2.

Sex differences in the genetic and environmental components of psychopathy seem to be only evident early on in development (see Fontaine et al., 2010; Viding et al., 2007). Figure 2, shows that the difference between sex in mean correlations for MZ twins and DZ twins; males and females respectively, is only distinct between the younger male and female DZ twins.

Figure 2. Twin correlations across age and sex



## Discussion

The purpose with the present study was to review and summarize the results from the published literature on psychopathy; to synthesize to what degree genetic and environmental factors influence psychopathic personality; and to examine the influence of potential moderators (measure, informant, age, and sex) on the magnitude of genetic and environmental influences on psychopathic personality traits. Our findings show that additive genetic factors and unique environmental factors each explain half of the variance in psychopathic personality traits. Shared environmental factors seem to be of no importance for psychopathic personality traits. These results give a clearer understanding of existing twin studies on

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psychopathic personality traits by providing a structured synthesis of the relative genetic and environmental contributions in psychopathic personality traits through various stages of development and across sex.

The majority of the included studies reported that the restrictive AE model fit their data best, as can be assumed from the results in the present meta-analysis, showing that additive genetic and unique environmental factors each accounted for half of the variance, and where shared environmental influences seem to have little or no importance. This is in line with the results from the previous meta-analysis on psychopathy, where the AE was the best fitting model; additive genetic factors explaining 49% of the variance, and the remaining 51% of the variance being explained by unique environmental factors (Waldman & Rhee, 2006).

This can also be compared with the meta-analysis carried out on the related disorder antisocial behavior. Genetic factors explaining 41%, shared environmental influences (C) explaining 16% and the remaining 43% being accounted for by unique environmental factors (E) (Rhee & Waldman, 2002).

Measure was examined as a potential moderator, but the results showed no obvious connection between how psychopathy and psychopathic personality traits were measured and to what extent genetic and unique environmental factors explained the concept, but interestingly the study using the clinical tool PCL-YV reported markedly lower heritable influences and higher non-shared environmental factors than the other studies using measures developed to assess psychopathic personality traits and measures used to assess general traits.

Informant, on the other hand, that is who reports the information, such as a caregiver, a teacher or if the information is provide via self-report, seems to effect the findings, showing that report by others, parent ratings or teacher ratings, gave higher estimates on additive genetic factors compared to self-reports. Teacher ratings reported remarkably higher additive genetic factors than self-reports, but only for females (Fontaine et al., 2010). Important to

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remember is that different informants are used to rate psychopathic personality traits, or general personality traits, depending on the age of the participants (Tuvblad & Baker, 2011).

Informant and age are closely linked since the age of the participant partly decides who will report the assessment. A young person is more likely to have an adult assessing them, such as a caregiver or teacher, compared to an adolescent or adult person. Another logical result is that shared environmental influences explain more of the variance in psychopathic personality traits when a person is young, the young person being more dependent on his or her environment for their well-being. The results showed an interesting difference between young boys and girls who were assessed by teachers, where shared environmental factors explained a large part of the total variance in psychopathic personality traits in girls but for boys it explained only a small part of the variance, nor were the results significant. Only one adult sample reported that shared environmental factors explained a small part of the variance in psychopathic personality (Vernon et al., 2008), and that estimate was not significant either.

Previous behavioral genetic research has reported higher genetic and unique environmental influences, but lower shared environmental influences as part of the ageing process (Plomin et al., 2001). That is, as individuals age, the shared or family environment is of less importance, whereas the impact of genetic influences increases in importance with increasing age. Our findings that shared environmental influences on psychopathic personality traits are diminishing as age increases are in line with previous behavioral genetic research.

As expected the results showed no overall support for sex differences concerning genetic and environmental influences on psychopathic personality traits. Only at a young age, 7-12 years, did sex seem to have an impact and only if reported by others, not via self-report. Important to remember is that less than half of the included studies tested for sex differences

and therefore examined males and females separately, while the majority of the studies did not test for sex differences or they examined males and females as one group or included only males in the study, making it impossible to detect sex differences.

### **Strengths and limitations of the present meta-analysis**

A first limitation is whether the fundamental assumption of twin studies, that of equal environments (EEA, equal environment assumption), is sound or not. The idea is that because MZ twins are assumed to have identical genes, the only thing that can be different for each twin will be the social environment, both the upbringing and probably foremost each twin's unique experiences. DZ twins differ genetically from each other, just like any other siblings, but being born at the same time the idea is that they will be exposed to more or less the same environment, so any differences between them should depend on their genetic disposition and of course, their unique experiences (Jorde, Carey, Bamshad, & White, 2003).

If the equal environment assumption is violated, this will result in biased estimates. Nevertheless, previous research has shown convincing evidence that the equal environment assumption holds for various traits and behaviors (Plomin et al., 2001; Tuvblad & Baker 2011).

A second limitation is related to generalizability, can these results be generalized to singletons? Previous research on antisocial behavior (cited in Moffitt, 2005) has shown that the prevalence rate and behavioral distribution of antisocial behavior among twins compared to the general population is similar, and therefore it can be assumed that the conclusions drawn from research conducted on twin samples can be generalized to the general population, at least when it comes to antisocial behavior. A related issue concerns the fact that these findings are based on data from non-forensic samples, that is, samples from the general

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population and our findings can therefore not be generalized to forensic settings like prison populations and psychiatric populations.

A strength with the present meta-analysis is that it has exclusively included articles that examine the interpersonal-affective factor, which is considered to be the core feature of psychopathic personality traits. In the only other meta-analysis conducted on genetic and environmental influences on psychopathy (Waldman & Rhee, 2006), the majority of the articles included focused on the behavioral aspect of psychopathic personality traits. Another strength is that studies included are published after 1990 when new ways of measuring psychopathic personality traits had been developed and twin studies were larger. Further, since including only twin studies to estimate the genetic and environmental influences on psychopathic personality traits this gave the unique possibility of disentangling the genetic and environmental influences, and to estimate the magnitude of both simultaneously (Rhee & Waldman, 2002). A general strength using a meta-analytical design is that it summarizes the results of several studies which increase the sample size, which in turn adds power to the study (Rhee & Waldman, 2002). To the best of our knowledge, the present meta-analysis is up to date the most comprehensive study that has been conducted on the genetic and environmental influences on psychopathic personality traits.

Why do we want to estimate the relative magnitude of genetic and environmental influences on psychopathic personality traits? It is general agreed that revealing the underlying genetic and environmental etiology of psychopathy will be beneficial for intervention and prevention efforts, and that it is a step toward the search for specific candidate genes and environmental risk factors which underlie psychopathic personality traits.

Are psychopaths and people with psychopathic personality traits incurable? Or maybe the correct term would be 'untreatable'? That is at least a common opinion in clinical circles. According to a recent meta-analysis on treatment of psychopathy, there is no reason for this

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'pessimism', evidence shows on the contrary support for that cognitive-behavioral, psychodynamic and eclectic intervention methods work (Salekin, 2002). The financial costs that this very small group of people inflicts on fellow beings and society as a whole are enormous (Beaver et al., 2012) and treatment, although costly, might show in the long run to be less expensive than incarceration, where they, if not given appropriate treatment, continue to cause havoc with further cost as a consequence.

### **Conclusions and future directions**

The conclusions of this meta-analysis are that the genetic make-up and what makes twins different from each other, that is, the heritable factors and non-shared environmental influences, together explain the variance in the development of psychopathic personality traits. The implications of these findings are that preventive work needs to focus on strengthening potential protective factors and identifying specific environmental factors that contribute to the development of psychopathic personality traits, but since environmental factors only explain half of the variance, future research need also to focus on the molecular genetic and brain imaging fields which can help discover biological mechanisms and neural circuitry pathways underlying psychopathic personality traits.

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