ADHD, Autism, and Psychopathy as Life Strategies:
The Role of Optimal Stimulation Level on Evolutionary Fitness
Abstract

This literature review suggests that autism spectrum disorders (ASD), attention deficit and hyperactivity disorder (ADHD), and antisocial personality disorder/psychopathy (ASPD) represent life strategies to fulfill masculine evolutionary needs. The diagnostic criteria of ADHD overlap with ASD and ASPD, both of which are often diagnosed alongside of ADHD. Additionally, all three are mostly diagnosed in males and related to brain masculinity. Males with masculinized brains would be distinguished by their optimal stimulation level and empathy, which is conceptualized here as different competitive outcomes. Individuals with the least empathy impairments and highest optimal stimulation levels represent fitter individuals, from an evolutionary perspective.

Keywords: ADHD, psychopathy, autism, conduct disorder, testosterone, cortisol
ADHD, Autism, and Psychopathy as Life Strategies: The Role of Optimal Stimulation Level on Evolutionary Fitness

Attention deficit and hyperactivity disorder (ADHD), autism spectrum disorders (ASD) and antisocial personality disorder/psychopathy (ASPD) are strongly related in terms of symptomatology, epidemiology, and comorbidity. The symptoms and comorbidities of ADHD diverge in two different directions. The symptoms of ADHD, especially the inattentive subtype of ADHD (ADHD-i), are highly overlapping with those of ASD. On the other hand, symptoms of the combined subtype of ADHD (ADHD-c), overlap with those of antisocial disorders (conduct disorder, oppositional defiant disorder, and antisocial personality disorder). Moreover, the symptoms of ADHD that are shared with ASD correlate negatively with the symptoms shared with ASPD, suggesting that autism and ASPD are two ends of a spectrum. The current essay will argue that all three represent masculine life strategies to maximize evolutionary fitness, and are distinguished by their relative competitive success, as illustrated by their optimal stimulation level and sexual behaviors. Behavioral traits that indicate high tolerance to risk would be an indicator of reproductive fitness, in a vertical hierarchy of intra-sexual competitive outcomes.

Attention Deficit and Hyperactivity Disorder

The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) defines the attention deficit and hyperactivity disorder (ADHD) as a persistent pattern of inattention and/or hyperactivity that impairs daily functioning, particularly in school and work settings. Three subtypes have been identified; the inattentive subtype, the hyperactive subtype, and the combined type. Most features associated with ADHD
seem to converge two directions. The symptoms of ADHD-i resemble a milder form of autism, including poorer cognitive empathy, and a lower optimal stimulation level. On the other hand, the symptoms of ADHD-c and ADHD-h resemble the under-stimulated aspect of psychopathy, along with its absence of severe cognitive impairment. The scientific literature about ADHD is unforgivably problematic, however, since few articles specify which subtype of ADHD their sample is based on. This is especially upsetting since there does not seem to be any justification to include a non-hyperactive subtype in a so-called hyperactivity disorder (Milich, Balentine, & Lynam, 2001). The term ADHD will be arbitrarily interpreted as the classical ADHD-c and ADHD-h subtypes, which include the hyperactivity component.

**Common features of ASPD and ADHD-c/ADHD-h**

Antisocial disorders resemble the symptoms of ADHD in many ways (e.g., Herpertz et al, 2001). Many are diagnosed with both ADHD and antisocial disorders—oppositional defiant disorder (ODD), conduct disorder (CD), or ASPD, or progress from one to another (Barkley, 1997; Campbell, Shaw, & Gilliom, 2000; Loeber, Burke, & Pardini, 2009; Salisbury, 2013). Hyperactive individuals are seven times more likely to develop antisocial disorders than controls (Mannuzza, Klein, Bessler, Malloy, & LaPadula, 1993).

People with antisocial disorders or ADHD show similar patterns in interpersonal relationships. As a general rule, people with ADHD and antisocial disorders show stronger affective empathy deficits (problems with appropriate emotional response to others) relative to lesser cognitive empathy problems (problems with perspective taking). People with ADHD do not report more difficulties making or keeping friendships
themselves (Marton, Wiener, Rogers, & Moore, 2012), but they are somewhat uninterested in other people’s needs. Some children with ADHD may prioritize personal goals such as sensation seeking and fun rather than complying with rules and equity (Melnick & Hinshaw, 1996). They describe their friendships in egoistic terms rather than emotional ones, such as “he is entertaining”. Social skills training for ADHD has proven largely ineffective, apparently because it focused on cognitive empathy rather than impulsivity (Mikami, 2014). Children and adolescents with ADHD are often perpetrators of bullying in school (Bacchini, Affuso, & Trotta, 2008), are particularly reactive to provocation from peers (King et al., 2009), and tend to lack appropriate social skills, such as sharing, cooperation, and turn taking (Cordier, Bundy, Hocking, & Einfeld, 2010; Wehmeier, Schacht, & Barkley, 2010). Likewise, psychopaths and children with psychopathic tendencies have an intact Theory of Mind (Blair, 1999; Blair, 2007), but severely ignore the well-being of their peers. Children with CD, as opposed to those with ASD, show amygdala hypo-reaction in empathy tests. In children with both ASD and CD this results in lack of attention to the eyes (Bons et al., 2013). This propensity of those with ADHD to be impulsive, bullying, hostile and unable to form relationships based on the needs of both parties are a milder form of the interpersonal traits defining psychopathy, namely their instrumental and manipulative use of others, which denotes unidirectional benefits in interpersonal relationships. Psychopaths show superficial charm, and may appear charming to employers or potential romantic partners, but typically use this charm highly selectively. Furthermore, their appeal rapidly vanes when incentives are gone. Indeed, people with ADHD show psychopathic personality traits but are not within the range of clinical psychopathy (Fowler et al., 2009; Piatigorsky &
Hinshaw, 2004). While people with ADHD and psychopaths can be sociable and make new friendships, but become rapidly bored from them.

People with ADHD and antisocial disorders share a general tendency to use approach mechanisms, especially marked in the hyperactive/impulsive and combined subtypes. People using approach mechanism have an increased sensitivity to rewards, and decreased sensitivity to punishment (Keltner, Anderson, & Gruenfeld, 2003). As such, their sensory feedback is somewhat attenuated. Using the Sensitivity to Punishment and Sensitivity to Reward Questionnaire for children (SPSRQ-C), Luman, van Meel, Oosterlaan, and Geurts (2012) found that all their ADHD groups (ADHD+ASD, ADHD, and ADHD+ODD) had higher reward sensitivity than controls. Additionally, those with a comorbid diagnosis of autism showed the most punishment sensitivity compared to other experimental groups. Becker and colleagues (2013) found that those with sluggish cognitive tempo (SCT), a cluster of symptoms that is not very different from ADHD-i, had an increased sensitivity to punishment, fear and shyness, compared to those with undifferentiated ADHD, who had an increased sensitivity to rewards and had traits of impulsivity. In conclusion, the closer the symptoms of ADHD are to psychopathy, the higher the sensitivity to rewards. Increased reward sensitivity has been studied quite extensively in psychopaths (Wallace, Malterer, & Newman, 2009).

ADHD has many symptoms related to under-arousal, often resulting in excessive sensation-seeking tendencies. Examples include: dangerous driving behavior (Barkley, Murphy, Dupaul, & Bush, 2002) resulting in increased number of traffic accidents (Swensen et al., 2004), criminality (Mannuzza, Klein, Abikoff, & Moulton III, 2004), higher probability of physical injury, substance and alcohol abuse (Lee, Humphreys,
Flory, Liu, & Glass, 2011; Rooney, Chronis-Tuscano, & Yoon, 2012) as well as risky sexual behaviors (Flory, Molina, Pelham, Gnagy, & Smith, 2006).

Psychological traits characterizing the symptoms of psychopathy and ADHD are highly overlapping, namely in regards to attention. In vigilance tasks, in which subjects must endure long periods of low stimuli, people with ASPD become quickly under-aroused. They become bored when they are unable to seek stimulation and they have difficulties paying attention (Orris, 1969). Moreover, just like individuals with ADHD, they are constantly seeking excitement from dangerous experiences and engage in more impulsive sensation seeking than controls (Ruch & Zuckerman, 2001). In a meta-analysis of 38 studies, Gao and Raine (2009) found that psychopaths have reduced P3 amplitudes on encephalographs, which are a measure of brain activity and an indicator of the extent to which the brain is engaged. These results have been replicated with participants with ADHD (Szuromi, Czobor, Komlosi, & Bitter, 2011). This indicates that the hyperkinetic tendencies of people with ADHD might originate in the traits that they share with psychopaths: a high need for stimulation and excitement.

**Common features of ASD and ADHD-i**

Children with ADHD-c/ADHD-h tend to be more aggressive and disinhibited, whereas ADHD-i children tend to be more passive and shy (Hodgens et al., 2000), similarly to children with ASD. ASD and ADHD, especially the inattentive subtype, share numerous symptoms (Rommelse, Geurts, Franke, Buitelaar, & Hartman, 2011; Salisbury, 2013; Taurines et al., 2012; Taylor, Charman, & Ronald, 2015). The first striking resemblance between ADHD-i and autism is the similarity of their classroom behaviors. They are often distracted, unorganized, do not seem to listen when spoken to
and have trouble following instructions. For autism, these symptoms are typically believed to be the result of their narrow interests and difficulties attending to social stimuli. In the case of ADHD-i, the causes remain unclear. People with ADHD-i also have narrow interests and difficulties with communication, which indicates that the source of their difficulties might be the same than the difficulties of those with autism.

Those with ADHD, similar to those with ASD, have persistent deficits in social interaction. They both have a weak Theory of Mind (ADHD: Uekermann et al., 2010; ASD: Baron-Cohen, Leslie, & Frith, 1985). Enduring symptoms include difficulties with understanding others, knowing implicit social norms and having conversations made of reciprocal turn taking. Individuals with either condition drift off during conversation and pay little to no attention to social cues. People with ADHD have trouble understanding a social situation from someone else’s perspective (Marton, Wiener, Rogers, Moore, & Tannock, 2009). These difficulties frequently result in poor peer relationships and few friendships for both individuals with ADHD and ASD. While people with autism are less often rejected, they are more likely to be ignored and usually have only one friend or no friends at all. The rejection patterns of those with the inattentive subtype of ADHD resemble those of autism; being neglected rather than rejected (Hodgens, Cole, & Boldizar, 2000). Miller, Hanford, Fassbender, Duke, and Schweitzer (2011) found that emotion recognition was poorer in the inattentive subtype than in the combined subtype, indicating that ADHD-i more closely resembles social cognition deficits of ASD than ADHD-c. Social anxiety is prevalent in both conditions (ADHD: Matson & Nebel-Schwalm, 2007; ASD: Bejerot, Eriksson, & Mörtberg, 2014). Some researchers have explored autistic traits in people with ADHD specifically. Reiersen, Constantino, Volk,
and Todd (2007) found that those with ADHD had more severe communication impairment than controls. People with the inattentive subtype of ADHD are two to five times more likely than their ADHD-c counterparts to be referred for speech and language problems (Weiss, Worling, & Wasdell, 2003). The communication and social impairments in ADHD suggest that the inattention problems in ADHD, especially ADHD-i, might partly stem from their little interest for social cues, which is similar to autism.

Narrow interests, one of the two core components of autism (APA, 2013), are often observed in people with ADHD, although often overlooked. Recent theories have suggested that inattentive symptoms are a result of poor motivation (e.g., Sonuga-Barke, 2003) rather than a generalized inability to concentrate. People with ADHD-i maybe be dreamy, bored and distracted in class, but they do not spend their leisure time stationary and daydreaming. They are very capable of pursuing hobbies, which happen to be different than the school curriculum. Accordingly, people with a diagnosis of ADHD show good concentration for activities they find interesting (Walitza, Drechsler, & Ball, 2012). For instance, video game use is often linked to autism and ADHD (Gentile, Swing, Lim, & Khoo, 2012), most pronounced in autism and the inattentive portion of ADHD (Mazurek & Engelhardt, 2013). The fact that “inattentive” people can play video games for long intervals challenges the assumption that they are unable to pay attention, and suggests that people with ADHD show a certain selectivity in their interests. Their lack of motivation in school settings might be partly explained by narrow interests, one of the two core components of autism.
ADHD and ASD are highly comorbid, have high co-heritability rates and have similar patterns of comorbidity. The comorbidity rates are between 14% and 78% (Gargaro, Rinehart, Bradshaw, Tonge, & Sheppard, 2011). ADHD is the second most common comorbid disorder in people with autism (Simonoff et al., 2008). One could argue that ADHD deserves the first place, which is currently held by social anxiety, as it is somewhat redundant since autism is defined by severe social communication impairments. ADHD and ASD have similar comorbidities. Within those diagnosed with Tourette’s syndrome, 60% are also diagnosed with ADHD (Barkley, 1993). Of all those with ADHD, 20% will be diagnosed with a tic disorder (Leckman, 2002). Similarly, among individuals with ASD, 22% had tic disorders (Canitano & Vivanti, 2007).

Moreover, ASD and ADHD are highly heritable, ASD often being considered as the most heritable mental disorder. Lichtenstein, Carlström, Råstam, Gillberg, and Anckarsäter (2010) found that genetic effects accounted for 80% of the variation in ASD and 79% in ADHD. It has been suggested that this indicates a common genetic or environmental cause (Taylor et al., 2015). This hypothesis has been tested multiple times, resulting in reports of moderate degrees of genetic overlap in middle childhood to adulthood (Lichtenstein et al., 2010; Lundström et al., 2011; Reiersen, Constantino, Grimmer, Martin, & Todd, 2008; Ronald, Simonoff, Kuntsi, Asherson, & Plomin, 2008; Taylor et al., 2013).

ADHD also includes symptoms that seem related to ASD, namely in terms of poor Theory of Mind and lower optimal stimulation levels. The second cluster of characteristics, grouping antisocial symptoms, includes a weak Theory of Mind (Farrant, Fletcher, & Maybery, 2014), drifting off in conversation, lack of social skills, impulsivity,
in interpersonal relationships, ODD and CD (McBurnett & Pfiffner, 2009), difficulties with friendships (Coleman, 2008), delayed language acquirement (Bellani, Moretti, Perlini, & Brambilla, 2011) and problems following instructions. Interestingly (but unsurprisingly), ADHD has been theorized to be disproportionately present in athletes. For instance, the holder of the record of the most Olympic medals (doubling the number of medals of the second highest record holder),

**Autism Spectrum Disorders**

Many who are diagnosed with ADHD fit the criteria for autism. The DSM-5 defines autism in terms of two patterns of behavior. The first is persistent deficits in social communication, such as a lack of reciprocity, poor verbal and nonverbal interaction and deficits in developing, maintaining and understanding relationships. Individuals with autism typically have abnormal eye-contact patterns, difficulties using gestures, a lack of facial expressions and fail to respond appropriately to social interactions. It is generally said that autism is characterized by a weakened Theory of Mind (ToM; Baron-Cohen et al., 1985). ToM is the ability to attribute emotional states, motivations and intentions to others and to understand that others have inner states that differ from one’s own. The second pattern is stereotyped and repetitive behaviors, interests and activities. People with ASD commonly have extremely narrow interests, abnormal in their intensity and focus, such as fixating on a specific part of an object, fictional character or subject. They insist on sameness, have specific routines and show considerable distress when routines need to be changed. Approximately 90% of individuals diagnosed with ASD have an auditory hypersensitivity (Gomes, Pedroso, & Wagner, 2008). There are fields in which people with autism excel. There is a higher rate...
of autism in families of people talented in physics, engineering and mathematics (Baron-Cohen et al., 1998), and people with autism are disproportionately present in science, technology, engineering, and mathematics (STEM; Wei, Yu, Shattuck, McCracken, & Blackorby, 2013). To put it more concisely, autism is defined by selectivity in interests, low tolerance for stress originating from environmental stimuli and difficulties with social cognition, but are disproportionately present in the hard sciences.

**Antisocial Personality Disorder**

ADHD is often comorbid with or precursor of antisocial behavior. Antisocial personality disorder (ASPD) is defined as impairments in personality functioning and pathological personality traits. ASPD was one of the first disorders ever identified, commonly known under the name psychopathy. These terms will be used interchangeably. Impaired personality functioning in psychopathy is characterized by a long-term pattern of manipulating, exploiting and violating the rights of others. Individuals with ASPD have a diminished capacity to feel remorse and empathy, and use deceit, coercion as well as dominance to control others. Pathological personality traits in the category of antagonism are manipulativeness, deceitfulness, callousness, and hostility. In the case of disinhibition: irresponsibility, impulsivity, and risk taking (APA, 2013). Robert D. Hare, author of the Hare Psychopathy Checklist, believes that psychopaths are especially present in the corporate culture, as their manipulative and fearless tendencies might be adaptive in these settings (Hare & Babiak, 2006). Conduct disorder (CD) is characterized by behavior that violates either the rights of others or major societal norms and is normally diagnosed before adulthood. Symptoms include provoking others, lying, bullying, destructing property, deceiving, and violating rules.
The DSM-5 defines oppositional defiant disorder (ODD) as a pattern of angry/irritable mood, argumentative/defiant behavior, or vindictiveness lasting at least six months (APA, 2013). Typical symptoms include arguing with adults, blaming others for one’s own actions, being irritable and losing one’s temper, and deliberately provoking others. Only children and adolescents are eligible for an ODD diagnosis. Although the DSM-IV forbade a dual diagnosis, clinical studies have demonstrated that 60 to 95% of CD cases have a comorbid ODD diagnosis (Rowe, Costello, Angold, Copeland, & Maughan, 2010). This exclusion criterion has been removed in the DSM-5.

Diagnoses of ASD, ADHD, and ASPD in Females

Even though this review concerns the expression of disorders in males, it needs to be addressed that there is a substantial number of girls diagnosed with the highlighted disorders. The existing literature demonstrates that girls diagnosed with either of them rarely meet the specified criteria, and suggests that they are clusters of symptoms almost exclusively seen in males.

ASD, as it is currently defined, is virtually non-existent in females. The male to female ratio in Asperger’s Syndrome (high functioning autism) is greater than 10:1 (Baron-Cohen, 2002). Although there is an overall male to female ratio of 4:1 or 5:1 in ASD (Shin Kim et al., 2011), females with autism do not show the typical autism phenotype. Females with autism have repeatedly scored lower than males on restricted interests and behaviors (Van Wijngaarden-Cremers et al., 2014), which constitute one of the two families of symptoms of autism. Although these results are revealing, a comparison with control groups of neurotypical males and females would be of greater significance. The behavioral profile of girls with autism is not consistent with the widely...
accepted model of autism as an extremely low social motivation, as introduced by Chevallier, Kohls, Troiani, Brodkin, and Schultz (2012). Severe deficits in pretend play, compared to mild deficits in non-pretence play, is oftentimes considered to be the earliest behavioral manifestation in boys with autism, and girls with autism do not show this tendency (Knickmeyer, Wheelwright, & Baron-Cohen, 2008). This finding is especially meaningful as pretend play requires the inference of mental states to others, to understand the implicit rules that guide imaginative play in groups. Girls with autism show more interest in social relations, and have even been reported to be misdiagnosed as borderline personality disorder, which is characterized by an extreme sensitivity in interpersonal relationships (Attwood, 2007). The social impairment of females with autism, although substantial compared to normal females, is still lesser than that of normal males (Head, McGillivray, & Stokes, 2014). Intellectual disability occurs twice more often in females diagnosed with autism (Mandy et al., 2012), which indicates that the cause of their impairments might stem from their intellectual disability rather than other specified causes. Furthermore, narrow interests and repetitive behaviors are often seen in those with intellectual disability, which might increase their occurrence in girls with autism, even though they are seldom observed (Van Wijngaarden-Cremers et al., 2014). For these reasons, many studies exclude autistic females altogether, resulting in an average ratio of 15:1 for fMRI studies on autism (Philip et al., 2012). It seems that the traditional phenotype of autism is seen in males only. Psychological categorization is always subject to change, and impaired social cognition in some females deserves consideration (or not, since autistic females score higher than normal males on friendship measures); however,
females do not appear to experience autism as is presently described. Autism will be
referred to as a male-only condition.

Females do not seem to embody the ADHD criteria often. An astonishing 92% of
girls are diagnosed with the inattentive subtype (Weiler, Bellinger, Marmor, Rancier, &
Waber, 1999). To put it more boldly, 92% of girls diagnosed with ADHD do not fit the
behavioral criteria of ADHD. Girls with ADHD have increased internalizing problems,
although externalizing problems is one of the defining characteristic of ADHD
(Rucklidge, 2010). When actual symptoms need to be observed, such as in clinical
studies, boys have outnumbered females up to 10:1 (Biederman et al., 2002). When
ADHD is pervasive, ratios go up to 16:1 (Rutter, Caspi, & Moffitt, 2003). Females are
rarely diagnosed with the combined subtype, and their impulsivity symptoms rarely reach
conduct disorder. Females are outnumbered from 10 to 15 times in the persistent type of
conduct disorder (Moffitt, 2006). The difficulties of girls with ADHD might originate
from elsewhere than those of boys with ADHD. In a meta-analytic review, Gaub and
Carlson (1997) compared individual variables in boys and girls with ADHD, and found
statistically significant medium effect sizes disfavoring girls in terms of three different
intelligence measures. These results were replicated by Gershon (2002). Their classroom
difficulties might also originate from eating disorders (Biederman et al., 2007) or lower
socio-economic status compared to control females (Gaub & Carlson, 1997). In short,
females do not embody what the academia has communally termed “ADHD”, and their
difficulties in the classroom might not have the same causes than males. Since girls
diagnosed with ADHD have a fundamentally different behavioral profile than their male
counterparts, the burden of proof is in the hands of those who claim that the male and
female presentation are based on a common causal mechanism. As we are not even remotely close to establish objective distinguishing characteristics between people with and without ADHD, phenotypic expression is the only diagnostic tool, and it differs fundamentally between boys and girls with ADHD. Henceforth, ADHD will be described as a behavioral pattern that is seen in males only.

Females do not appear to reach the clinical criteria for psychopathy, which was mostly specified based on males. This is because males and females differ in their expression of psychopathy (Wynn, Hoiseth, & Pettersen, 2012). Male psychopaths tend to be aggressive, engage in criminal behavior and substance abuse. Female psychopaths tend to flirt, manipulate and exhibit self-injury (Forouzan & Cooke, 2005), which fit more accurately in the criteria of histrionic and borderline personality disorder, which tend to be diagnosed alongside of ASPD in women (Warren et al., 2003). There is only a slight sex difference in the prevalence of ODD, but there is a major one in the case of CD (Loeber et al., 2009), a better predictor of adulthood psychopathy. Boys are 10 to 15 times more likely than girls to develop the life-course-persistent type of conduct disorder. Accordingly, Moffitt (2006) argues that it is an exclusively male phenomenon. This sex difference is one of the most stable finding in all of antisocial behavior research (Rutter et al., 2003). Regardless of diagnoses, the large sex gap is seen is violent juvenile crime and physical aggression (Eme, 2007).

**Theoretical Accounts for the Male Bias**

There is a major sex bias in favor of males in disorders that are characterized by a deficient empathy and the disregard for the rights of others. In this way, cognitive and
affective empathy impairments define male-biased disorders. A lack of empathy as the extreme form of a male brain has been investigated by Baron-Cohen.

**The Extreme Male Brain Theory of Autism**

In 2002, Baron-Cohen introduced the extreme male brain (EMB) theory of autism. The rationale behind this theory is that people with ASD behave in ways that are congruent with normal sex differences, but to an abnormal extent. Males generally outperform females in systemizing measures. By systemizing, Baron-Cohen means:

Anything that takes inputs and deliver outputs. When you systemise, you use ‘if–then’ (correlation) rules. The brain focuses in on a detail or parameter of the system, and observes how this varies. That is, it treats a feature as a variable. Or a person actively manipulates this variable (hence the English word, systematically). They note the effect(s) of this one input elsewhere in the system (i.e. the output). ‘If I do x, then y happens’


Males outperform females on systemizing tests, such as tests of intuitive physics or map reading. As a result, fields that comprise the most inflexible manipulation of systems are almost entirely composed of males, such as chess players, symphony composers, physicists, and computer programmers. On the other hand, females outperform males on empathy measures, such as *Reading the Mind in the Eyes* test or emotion recognition tests, and people with autism score significantly lower than normal males. The most promising evidence brought forward by Baron-Cohen is that people with autism carry the biological marker of pronounced brain masculinization, which is prenatal testosterone (Auyeung et al., 2012).
There are numerous shortcomings to the Extreme Male Brain theory. The most fundamental flaw is that the reasoning that led to autism being the extreme male brain, could be used to nominate other disorders as the extreme male brain. Namely, a few other conditions have been linked to similar high prenatal testosterone levels, but their phenotypes are different. ADHD is an example. Based on 2D:4D ratios, de Bruin, Verheij, Wiegman, and Ferdinand (2006) found no significant differences between the autism group and the ADHD group, indicating that a more pronounced brain masculinization in autism, compared to ADHD, could not be empirically demonstrated. Most importantly, many behaviors that are stereotypically masculine are not shown by those with ASD, such as spatial abilities, athletic abilities (see Hönekopp & Schuster, 2010 for a review), aggression and sensation seeking, which are all correlates of prenatal testosterone, an indicator of brain masculinity (Liu, Portnoy, & Raine, 2012). This indicates that autism is a form of the extreme male brain, but that it only represents one type of expression.

The EMB theory does not account for many findings about ASD, such as that 90% of those diagnosed with ASD have an auditory hypersensitivity (Gomes et al., 2008), or that people with ASD have poor motor coordination (Gowen & Hamilton, 2012), which do not fall under the criteria of repetitive behaviors and lack of responsivity to social cues. This suggests that the clinical definition of hypermasculinity should include disorders characterized by aggression and stimulus seeking, in addition to a lack of sociability.

Zentall and Zentall’s Optimal Stimulation Theory
In 1983, Zentall and Zentall theorized that hyperactivity was a homeostatic mechanism to regulate activity level. Healthy individuals, when experiencing a sensory overload, usually tend to avoid stimuli. They become disorganized and withdraw socially. Repetitive movements, such as tics, are found in normal individuals when over-aroused. Furthermore, stimulus overload shrinks the focus of attention (see Hockey, 1970 for a review). This shrinking of the focus of attention contrasts with the wide attentional focus of people with ADHD, who are often said to be unable to focus without attending to other surrounding distracting stimuli. Low levels of arousal decrease discrimination of inutile peripheral stimuli (Callaway & Stone, 1960), as if the mind was seeking arousing stimuli. When normal individuals are deprived of their senses, they typically seek stimuli. When healthy subjects were not allowed to move in an experiment, they experienced reduced intellectual ability and inability to concentrate. Similar results have been found in rats and monkeys in sensory deprivation studies. In this way, it appears that the difference between hyperactive individuals and the neurotypical population is that hyperactive individuals have a greater need for stimulation, which results in a faster boredom of non-exciting stimuli. For high stimuli settings, such as a film or game, no difference was found between hyperactive and non-hyperactive individuals.

Zentall and Zentall’s Optimal Stimulation Level theory is interesting because it suggests that the difference between someone with autism and someone with antisocial disorders is caused by the same underlying mechanism. Different individuals have different level of risk tolerance or stimulation needs, and this shapes their personality permanently.
The main weakness of this model is that it does not account for the impaired social cognition that is a central aspect of autism. A weak Theory of Mind, however, is unlikely to be a result of the male brain. Fetal testosterone levels, indicator of the brain’s masculinity, do not differ significantly between those with autism and ADHD (de Bruin et al., 2006), and Theory of Mind of people with ADHD is much less impaired. The male to female ratio for autism has been shown to converge towards 2:1, and impaired social cognition is arguably the only autistic trait that is the basis for autism diagnoses in females. Most importantly, girls with borderline personality disorder are the current candidate for the extreme female brain (Larson et al., 2015), and they are impaired in all three aspects of social cognition: executive functioning, Theory of Mind and emotion recognition (Baez et al., 2015). Deficits in ToM are neither always permanent nor exclusive to people with autism. It is impaired in many conditions that involve anxiety and distress. For instance, those who are depressed or psychotic have a weaker Theory of Mind (Wang, Wang, Chen, Zhu, and Wang, 2008; Zobel et al., 2010). This means that an impaired Theory of Mind is not exclusive to neither autism nor the male brain, but is better explained by distress. As a matter of fact, over-arousal decreases cognitive performance (Zentall & Zentall, 1983). Cognitive empathy deficits in autism might be better explained by the combination of a typically masculine disinterest in social relationships, and over-arousal (Bal et al., 2010; Hirstein, Iversen, & Ramachandran, 2001), which impedes social skills (Richard, French, Nash, Hadwin, & Donnelly, 2007).

Autistic people, compared to those with ADHD or ASPD, have a lower stress tolerance level. Hypersensitivity is an intricate part of the ASD clinical presentation (Kern et al., 2007), such as auditory hypersensitivity (Gomes et al., 2008). There is a high
correlation between all forms of hypersensitivity and autism severity in children. In fact, physical clumsiness increases with autistic symptoms (Hilton et al., 2007). Next, we have ADHD-i, which has lower rates of injury compared to controls, ADHD-c and ADHD-h groups (Lahey et al., 1998). People with an ADHD diagnosis score significantly higher than controls on measures of risk-taking, resulting in dangerous driving behavior (Barkley et al., 2002), more traffic accidents (Swensen et al., 2004), criminality (Mannuzza et al., 2004), increased substance abuse (Rooney et al., 2012) and risky sexual behavior (Flory et al., 2006). The combined subtype is more strongly linked to risky, impulsive behaviors, notably drug use (Wilens, Faraone, & Biederman, 2004). The combined subtype of ADHD is also more strongly correlated with ODD (66%), CD (47%; Freitag & Retz, 2010) and externalizing disorders (Acosta et al., 2008). Lastly, antisocial personality disorder, commonly known as psychopathy, is by distal definition extreme risk taking. Psychopaths need extreme stimulation, which they receive through drug use, alcohol consumption, risky sexual behaviors, and multiple sexual partners. Furthermore, they are responsible for about half of the violent crimes (Hare & Babiak, 2006). Importantly, psychopathic traits in people with ADHD correlate negatively with autistic traits. Farrant and colleagues (2014) have found that deficits in social cognition were inversely correlated with hyperactivity in a typically developing sample. This indicates that autism spectrum disorders and psychopathy represent two ends of a spectrum.

This increase in risky behaviors from autism to ADHD, and then psychopathy indicates that their risk tolerance inclines them to different patterns of behavior and activities. The idea that people differ in regards to excitement seeking needs has been
investigated before. Zentall and Zentall (1983) have suggested that humans differ fundamentally in regards to their optimal stimulation levels, and put ASD, ADHD and psychopathy in this framework.

Hence, if masculinity is the common component in autism, ADHD and psychopathy, we would expect biomarkers to support this reasoning. Likewise, if they are distinguished by their sensation seeking needs, we would expect them to have hormonal profiles corroborating this theory. If autistic individuals, people with ADHD and psychopaths are chronically above or below their threshold of excitement, their stress hormone levels and their approach hormone levels should reflect their behavioral tendencies.

**Testosterone and Cortisol**

Testosterone influences behavior in two major ways throughout a male’s life. First, testosterone has organizational effects on the brain. Organizational effects influence childhood play behavior, sexual orientation and identity and other differences between men and women in the normal population. Studies of amniotic fluids have suggested that prenatal testosterone levels determine the extent to which a brain is masculinized. Prenatal testosterone levels are often based on measuring the length of the second digit (“pointing finger”) compared to the fourth digit (“ring finger”). Individuals exposed to higher level of prenatal androgens have lower ratios, and men and women have been repeatedly found to have contrasting ratios. 2D:4D ratios are the preferred biological marker to measure prenatal testosterone (see Manning, Kilduff, Cook, Crewther, & Fink, 2014 for a review). ADHD, ASD, and ASPD were suggested to be a result of highly
masculinized brains. We would therefore expect them to be linked to lower 2D:4D ratios, indicating hyper masculinization.

Second, testosterone affects reproductive behavior postnatally. Testosterone facilitates competitive behavior and reproductive behavior, and is produced in higher quantities posterior to successful encounters (Archer, 2006). On the other hand, those who “lose” the interaction have a decrease in their testosterone levels, triggering inhibition tendencies. In this way, testosterone is the “reward” that successful males receive, that will encourage subsequent competitive behaviors. These results are not found in chance-based competition. Conversely, a decrease in testosterone levels will discourage further competitiveness. The higher the stakes are, the higher the testosterone surge will be, such as physical vs non-physical competition (there is no data comparing physical confrontation and psychopath-like competitive behavior). Therefore, we should expect autistic individuals to show low testosterone levels, as they are extremely risk averse relative to their environmental expectations. In the case of psychopaths and people with ADHD, we would expect high levels.

Cortisol is a steroid hormone produced in the adrenal cortex. Often called the hormone of stress, cortisol regulates changes in the body in response to stress. Cortisol levels are commonly used to operationalize stress levels. The risk tolerance is the dimension on which autism spectrum disorders, hyperactive disorders and antisocial disorders vary. One would then expect higher cortisol levels in people with autism and lower levels in those with antisocial disorders.

What kind of prenatal hormonal profiles do people with autism, ADHD and psychopathy show? People with autism had lower (more masculine) finger length ratios
than controls (Al-Zaid, Alhader, & Al-Ayadhi, 2015; Auyeung et al., 2012; Manning, Baron-Cohen, Wheelwright, & Sanders, 2001).

People with ADHD have been consistently shown to have lower 2D:4D ratios, indicating a masculinized brain (de Bruin et al., 2006; Martel, Gobrogge, Breedlove, & Nigg, 2008; Martel, 2009; McFadden, Westhafer, Pasanen, Carlson, & Tucker, 2005; Stevenson et al., 2007). Indeed, 2D:4D ratios are inversely correlated to ADHD symptoms (Romero-Martinez, Polderman, Gonzalez-Bono, & Moya-Albiol, 2013).

Portnoy, Raine, Seigerman, and Gao (2011) found that 2D:4D ratios were inversely correlated to the fearlessness, impulsive nonconformity and cold-heartedness subscales of psychopathy. Liu and colleagues (2012) have found increased aggression (and attention) problems in children with lower finger length ratio. When comparing offenders and non-offenders, the former has significantly more masculinized ratios (Hanoch, Gummerum, & Rolison, 2012). Moreover, impulsivity (not 2D:4D ratios) significantly predicts low educational achievement, which strongly predicts criminal behavior. In this way, these results suggest that 2D:4D ratios lead to criminality only if it is paired with impulsivity. The bottom line is that psychopaths (as illustrated by offenders) have a masculinized brain, but those with a masculinized brain do not necessarily become psychopaths.

In short, studies of prenatal androgen exposure converge towards the conclusion that 2D:4D ratios spawn different types of behavioral patterns. As hypothesized, psychopathy, ADHD, and autism have masculinized finger length ratios, indicating a masculine brain.
What kind of postnatal hormonal profiles do people with autism, ADHD and psychopathy show? Auyeung and colleagues (2012) did not find a link between Quantitative Checklist for Autism in Toddlers scores and postnatal testosterone. Takagishi and colleagues (2010) did not find a significant relationship between Autism Quotient and salivary testosterone. Furthermore, Croonenberghs and colleagues (2010) found lower testosterone levels in individuals with autism. In low functioning autism, cortisol was found to be higher than in controls and in those with Asperger’s (Putnam, Lopata, Thomeer, Volker, & Rodgers, 2015). Likewise, individuals with autism show a significantly higher increase in cortisol when stressed, compared to controls (Spratt et al., 2012).

Testosterone levels predict sensation seeking behavior in adolescents with ADHD (Martin et. al, 2006). People with ADHD have lower cortisol levels relative to controls, especially the hyperactive/impulsive type (Blomqvist et al., 2007). Maldonado, Trianes, Cortés, Moreno, and Escobar (2009) found decreasing cortisol levels from controls, to ADHD-i to ADHD-h. Ma, Chen, Chen, Liu, and Wang (2011) found the same pattern in plasma cortisol levels.

Terburg, Morgan, and van Honk (2009) identify low cortisol and high testosterone as the hormonal marker for psychopathic tendencies and violent social aggression, which has been supported empirically by Glenn, Raine, Schug, Gao, and Granger (2011).

The 2D:4D ratios are lower than controls in all male-biased disorders, indicating that they are indeed varying expressions of the male brain. The decreasing levels of cortisol and increasing levels of testosterone from autism to ADHD, and then
psychopathy indicate that individuals are less and less stressed and more and more successfully competitive as they approach psychopathic tendencies. This is consistent with Zentall and Zentall’s reasoning, which suggested that people with autism, ADHD and psychopathy have an optimal stimulation level that does not match their environment (Zentall & Zentall, 1983).

Different Behavioral Profiles and Intra-Sexual Competition

A fundamental assumption in evolutionary reasoning is that all forms of life compete with their conspecifics to transmit their genes. In humans, it has been generally accepted that males compete more fiercely, and are therefore wired for competition. Archer (2006) showed that intra-sexual competition had bidirectional relationship with hormonal levels. When an individual successfully defeats an opponent, the former has a surge in testosterone, while the latter has a decrease in testosterone levels. An increase promotes further competitive and approach behaviors, such as disinhibition and mating efforts. In contrast, diminished testosterone levels discourage competitive behavior, or the sought for safer forms of competition. The testosterone surge is more pronounced in physical confrontations. In this way, successful confrontation promotes psychopathic traits, and unsuccessful confrontation promotes autistic traits.

As males strive to reach higher tiers of competition, we would expect success in riskier systems to represent a more attractive outcome, namely in regards to reproductive fitness. Accordingly, psychopathy and impulsivity conditions are therefore expressions of relative fitness. Psychopathy has been argued to represent a life strategy rather than a disorder (Krupp, Sewall, Lalumière, Sheriff, & Harris, 2013). For instance, facial symmetry is often considered as the best predictor of physical attraction, as it indicates
healthy development (Penton-Voak et al., 2001). People with autism have pronounced facial asymmetry compared to controls (Hammond et al., 2008), in contrast to psychopathic offenders, who have better facial symmetry compared to both non-psychopathic male offenders and non-offenders (Lalumière, Harris, & Rice, 2001). People with ADHD have earlier sexual experiences, more casual sex, and more short-term sexual partners (Flory et al., 2006). Similarly, multiple short-term sexual encounters are one of the main behavioral symptom of psychopathy. Ellis and Walsh (2007) have reviewed 51 studies, 50 of which reported a positive association between number of sexual partners and antisocial behavior. Anecdotally, in a large forensic hospital, among psychopathic patients who were acquitted due to (malingered) insanity, 39% had a consensual sexual relationship with female staff members (Gacono, Meloy, Sheppard, Speth, & Roske, 1995). More generally, positive correlations between sensation-seeking and sexual success has been extensively studied (Bogaert & Fisher, 1995; Cyders, Dzemidzic, Eiler, & Kareken, 2016; Eisenberg, Campbell, MacKillop, Lum, & Wilson, 2007; Lalasz-Weigel, 2011; Victor, Sansosti, Bowman, & Hariri, 2015; Webster & Crysel, 2012). In contrast, people with autism have shown to be intrusive, stalking, persisting for months and to engage in inappropriate courting behavior towards ex-partners, celebrities and colleagues (Stokes, Newton, & Kaur, 2007), representing desperate strategies. To conclude, psychopaths and people with ADHD represent the evolutionary successful version of the male brain.

Conclusion

The present review aimed to demonstrate that attention deficit hyperactivity disorder shares traits with ASD and ASPD. These conditions represent the male brain, as
they are all highly male-biased, linked to brain masculinization, and they all share a
classical characteristic: a lack of empathy, which is the defining element of the female brain
(Baron-Cohen, 2002). There are differences in how this lack of empathy is expressed.
Autistic individuals tend to avoid social interactions, people with attention deficits can be
somewhat rude and misunderstand others, and those with antisocial disorders may
provoke and aggress others repeatedly. The increase of risky social behavior shows a
parallel with overall tendencies of those diagnosed with male-biased disorders.
Individuals with autism are especially sensitive to sounds and changes of routines, and
people with impulsive disorders show increasingly dangerous behavior as the severity of
their psychopathic traits increases. This is illustrated by lower levels of stress hormones
and higher levels of testosterone in psychopaths, and the opposite pattern in autistic
individuals.
Different patterns of behavior indicate how the environment shapes one’s
behavior and personality in a permanent fashion. Autistic symptoms are the behavioral
patterns of chronically overstimulated males, and psychopathy is how a male acts when
consistently under-aroused. When over-aroused, males withdraw and seek safer forms of
competition, and when under-aroused, seek higher, riskier forms of competition and use
approach mechanisms. As people with autism, ADHD and psychopathy are
overrepresented in systems, sports and criminal activities respectively, they all engage in
intra-sexual competition based on their optimal level of stimulation. Males who engage in
the highest tiers of intra-sexual competition have increased evolutionary fitness.

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doi:10.1111/j.1469–7610.2007.01857.x

doi:10.1177/1087054710392536

doi:10.1037/a0020798


doi:10.1097/CHI.0b013e318179964f


