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ADHD, Autism, and Psychopathy as Life Strategies:

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The Role of Optimal Stimulation Level on Evolutionary Fitness

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Abstract

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

17

Keywords: ADHD, psychopathy, autism, conduct disorder, testosterone, cortisol

18 ADHD, Autism, and Psychopathy as Life Strategies: The Role of Optimal
19 Stimulation Level on Evolutionary Fitness
20 Attention deficit and hyperactivity disorder (ADHD), autism spectrum disorders
21 (ASD) and antisocial personality disorder/psychopathy (ASPD) are strongly related in
22 terms of symptomatology, epidemiology, and comorbidity. The symptoms and
23 comorbidities of ADHD diverge in two different directions. The symptoms of ADHD,
24 especially the inattentive subtype of ADHD (ADHD-i), are highly overlapping with those
25 of ASD. On the other hand, symptoms of the combined subtype of ADHD (ADHD-c),
26 overlap with those of antisocial disorders (conduct disorder, oppositional defiant disorder,
27 and antisocial personality disorder). Moreover, the symptoms of ADHD that are shared
28 with ASD correlate negatively with the symptoms shared with ASPD, suggesting that
29 autism and ASPD are two ends of a spectrum. The current essay will argue that all three
30 represent masculine life strategies to maximize evolutionary fitness, and are distinguished
31 by their relative competitive success, as illustrated by their optimal stimulation level and
32 sexual behaviors. Behavioral traits that indicate high tolerance to risk would be an
33 indicator of reproductive fitness, in a vertical hierarchy of intra-sexual competitive
34 outcomes.

35 **Attention Deficit and Hyperactivity Disorder**

36 The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders
37 (DSM-5) defines the attention deficit and hyperactivity disorder (ADHD) as a persistent
38 pattern of inattention and/or hyperactivity that impairs daily functioning, particularly in
39 school and work settings. Three subtypes have been identified; the inattentive subtype,
40 the hyperactive subtype, and the combined type. Most features associated with ADHD

41 seem to converge two directions. The symptoms of ADHD-i resemble a milder form of
42 autism, including poorer cognitive empathy, and a lower optimal stimulation level. On
43 the other hand, the symptoms of ADHD-c and ADHD-h resemble the under-stimulated
44 aspect of psychopathy, along with its absence of severe cognitive impairment. The
45 scientific literature about ADHD is unforgivably problematic, however, since few articles
46 specify which subtype of ADHD their sample is based on. This is especially upsetting
47 since there does not seem to be any justification to include a non-hyperactive subtype in a
48 so-called hyperactivity disorder (Milich, Balentine, & Lynam, 2001). The term ADHD
49 will be arbitrarily interpreted as the classical ADHD-c and ADHD-h subtypes, which
50 include the hyperactivity component.

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

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

59 People with antisocial disorders or ADHD show similar patterns in interpersonal
60 relationships. As a general rule, people with ADHD and antisocial disorders show
61 stronger affective empathy deficits (problems with appropriate emotional response to
62 others) relative to lesser cognitive empathy problems (problems with perspective taking).
63 People with ADHD do not report more difficulties making or keeping friendships

64 themselves (Marton, Wiener, Rogers, & Moore, 2012), but they are somewhat
65 uninterested in other people's needs. Some children with ADHD may prioritize personal
66 goals such as sensation seeking and fun rather than complying with rules and equity
67 (Melnick & Hinshaw, 1996). They describe their friendships in egoistic terms rather than
68 emotional ones, such as "he is entertaining". Social skills training for ADHD has proven
69 largely ineffective, apparently because it focused on cognitive empathy rather than
70 impulsivity (Mikami, 2014). Children and adolescents with ADHD are often perpetrators
71 of bullying in school (Bacchini, Affuso, & Trotta, 2008), are particularly reactive to
72 provocation from peers (King et al., 2009), and tend to lack appropriate social skills, such
73 as sharing, cooperation, and turn taking (Cordier, Bundy, Hocking, & Einfeld, 2010;
74 Wehmeier, Schacht, & Barkley, 2010). Likewise, psychopaths and children with
75 psychopathic tendencies have an intact Theory of Mind (Blair, 1999; Blair, 2007), but
76 severely ignore the well-being of their peers. Children with CD, as opposed to those with
77 ASD, show amygdala hypo-reaction in empathy tests. In children with both ASD and CD
78 this results in lack of attention to the eyes (Bons et al., 2013). This propensity of those
79 with ADHD to be impulsive, bullying, hostile and unable to form relationships based on
80 the needs of both parties are a milder form of the interpersonal traits defining
81 psychopathy, namely their instrumental and manipulative use of others, which denotes
82 unidirectional benefits in interpersonal relationships. Psychopaths show superficial
83 charm, and may appear charming to employers or potential romantic partners, but
84 typically use this charm highly selectively. Furthermore, their appeal rapidly vanes when
85 incentives are gone. Indeed, people with ADHD show psychopathic personality traits but
86 are not within the range of clinical psychopathy (Fowler et al., 2009; Piatigorsky &

87 Hinshaw, 2004). While people with ADHD and psychopaths can be sociable and make
88 new friendships, but become rapidly bored from them.

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

105 ADHD has many symptoms related to under-arousal, often resulting in excessive
106 sensation-seeking tendencies. Examples include: dangerous driving behavior (Barkley,
107 Murphy, Dupaul, & Bush, 2002) resulting in increased number of traffic accidents
108 (Swensen et al., 2004), criminality (Mannuzza, Klein, Abikoff, & Moulton III, 2004),
109 higher probability of physical injury, substance and alcohol abuse (Lee, Humphreys,

110 Flory, Liu, & Glass, 2011; Rooney, Chronis-Tuscano, & Yoon, 2012) as well as risky
111 sexual behaviors (Flory, Molina, Pelham, Gnagy, & Smith, 2006).

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

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

126 Children with ADHD-c/ADHD-h tend to be more aggressive and disinhibited,
127 whereas ADHD-i children tend to be more passive and shy (Hodgens et al., 2000),
128 similarly to children with ASD. ASD and ADHD, especially the inattentive subtype,
129 share numerous symptoms (Rommelse, Geurts, Franke, Buitelaar, & Hartman, 2011;
130 Salisbury, 2013; Taurines et al., 2012; Taylor, Charman, & Ronald, 2015). The first
131 striking resemblance between ADHD-i and autism is the similarity of their classroom
132 behaviors. They are often distracted, unorganized, do not seem to listen when spoken to

133 and have trouble following instructions. For autism, these symptoms are typically
134 believed to be the result of their narrow interests and difficulties attending to social
135 stimuli. In the case of ADHD-i, the causes remain unclear. People with ADHD-i also
136 have narrow interests and difficulties with communication, which indicates that the
137 source of their difficulties might be the same than the difficulties of those with autism.

138 Those with ADHD, similar to those with ASD, have persistent deficits in social
139 interaction. They both have a weak Theory of Mind (ADHD: Uekermann et al., 2010;
140 ASD: Baron-Cohen, Leslie, & Frith, 1985). Enduring symptoms include difficulties with
141 understanding others, knowing implicit social norms and having conversations made of
142 reciprocal turn taking. Individuals with either condition drift off during conversation and
143 pay little to no attention to social cues. People with ADHD have trouble understanding a
144 social situation from someone else's perspective (Marton, Wiener, Rogers, Moore, &
145 Tannock, 2009). These difficulties frequently result in poor peer relationships and few
146 friendships for both individuals with ADHD and ASD. While people with autism are less
147 often rejected, they are more likely to be ignored and usually have only one friend or no
148 friends at all. The rejection patterns of those with the inattentive subtype of ADHD
149 resemble those of autism; being neglected rather than rejected (Hodgens, Cole, &
150 Boldizar, 2000). Miller, Hanford, Fassbender, Duke, and Schweitzer (2011) found that
151 emotion recognition was poorer in the inattentive subtype than in the combined subtype,
152 indicating that ADHD-i more closely resembles social cognition deficits of ASD than
153 ADHD-c. Social anxiety is prevalent in both conditions (ADHD: Matson & Nebel-
154 Schwalm, 2007; ASD: Bejerot, Eriksson, & Mörtberg, 2014). Some researchers have
155 explored autistic traits in people with ADHD specifically. Reiersen, Constantino, Volk,

156 and Todd (2007) found that those with ADHD had more severe communication
157 impairment than controls. People with the inattentive subtype of ADHD are two to five
158 times more likely than their ADHD-c counterparts to be referred for speech and language
159 problems (Weiss, Worling, & Wasdell, 2003). The communication and social
160 impairments in ADHD suggest that the inattention problems in ADHD, especially
161 ADHD-i, might partly stem from their little interest for social cues, which is similar to
162 autism.

163 Narrow interests, one of the two core components of autism (APA, 2013), are
164 often observed in people with ADHD, although often overlooked. Recent theories have
165 suggested that inattentive symptoms are a result of poor motivation (e.g., Sonuga-Barke,
166 2003) rather than a generalized inability to concentrate. People with ADHD-i maybe be
167 dreamy, bored and distracted in class, but they do not spend their leisure time stationary
168 and daydreaming. They are very capable of pursuing hobbies, which happen to be
169 different than the school curriculum. Accordingly, people with a diagnosis of ADHD
170 show good concentration for activities they find interesting (Walitza, Drechsler, & Ball,
171 2012). For instance, video game use is often linked to autism and ADHD (Gentile,
172 Swing, Lim, & Khoo, 2012), most pronounced in autism and the inattentive portion of
173 ADHD (Mazurek & Engelhardt, 2013). The fact that “inattentive” people can play video
174 games for long intervals challenges the assumption that they are unable to pay attention,
175 and suggests that people with ADHD show a certain selectivity in their interests. Their
176 lack of motivation in school settings might be partly explained by narrow interests, one of
177 the two core components of autism.

178 ADHD and ASD are highly comorbid, have high co-heritability rates and have
179 similar patterns of comorbidity. The comorbidity rates are between 14% and 78%
180 (Gargaro, Rinehart, Bradshaw, Tonge, & Sheppard, 2011). ADHD is the second most
181 common comorbid disorder in people with autism (Simonoff et al., 2008). One could
182 argue that ADHD deserves the first place, which is currently held by social anxiety, as it
183 is somewhat redundant since autism is defined by severe social communication
184 impairments. ADHD and ASD have similar comorbidities. Within those diagnosed with
185 Tourette's syndrome, 60% are also diagnosed with ADHD (Barkley, 1993). Of all those
186 with ADHD, 20% will be diagnosed with a tic disorder (Leckman, 2002). Similarly,
187 among individuals with ASD, 22% had tic disorders (Canitano & Vivanti, 2007).
188 Moreover, ASD and ADHD are highly heritable, ASD often being considered as the most
189 heritable mental disorder. Lichtenstein, Carlström, Råstam, Gillberg, and Anckarsäter
190 (2010) found that genetic effects accounted for 80% of the variation in ASD and 79% in
191 ADHD. It has been suggested that this indicates a common genetic or environmental
192 cause (Taylor et al., 2015). This hypothesis has been tested multiple times, resulting in
193 reports of moderate degrees of genetic overlap in middle childhood to adulthood
194 (Lichtenstein et al., 2010; Lundström et al., 2011; Reiersen, Constantino, Grimmer,
195 Martin, & Todd, 2008; Ronald, Simonoff, Kuntsi, Asherson, & Plomin, 2008; Taylor et
196 al., 2013).

197 ADHD also includes symptoms that seem related to ASD, namely in terms of
198 poor Theory of Mind and lower optimal stimulation levels. The second cluster of
199 characteristics, grouping antisocial symptoms, includes a weak Theory of Mind (Farrant,
200 Fletcher, & Maybery, 2014), drifting off in conversation, lack of social skills, impulsivity

201 in interpersonal relationships, ODD and CD (McBurnett & Pfiffner, 2009), difficulties
202 with friendships (Coleman, 2008), delayed language acquirement (Bellani, Moretti,
203 Perlini, & Brambilla, 2011) and problems following instructions. Interestingly (but
204 unsurprisingly), ADHD has been theorized to be disproportionately present in athletes.
205 For instance, the holder of the record of the most Olympic medals (doubling the number
206 of medals of the second highest record holder),

207 **Autism Spectrum Disorders**

208 Many who are diagnosed with ADHD fit the criteria for autism. The DSM-5
209 defines autism in terms of two patterns of behavior. The first is persistent deficits in
210 social communication, such as a lack of reciprocity, poor verbal and nonverbal
211 interaction and deficits in developing, maintaining and understanding relationships.
212 Individuals with autism typically have abnormal eye-contact patterns, difficulties using
213 gestures, a lack of facial expressions and fail to respond appropriately to social
214 interactions. It is generally said that autism is characterized by a weakened Theory of
215 Mind (ToM; Baron-Cohen et al., 1985). ToM is the ability to attribute emotional states,
216 motivations and intentions to others and to understand that others have inner states that
217 differ from one's own. The second pattern is stereotyped and repetitive behaviors,
218 interests and activities. People with ASD commonly have extremely narrow interests,
219 abnormal in their intensity and focus, such as fixating on a specific part of an object,
220 fictional character or subject. They insist on sameness, have specific routines and show
221 considerable distress when routines need to be changed. Approximately 90% of
222 individuals diagnosed with ASD have an auditory hypersensitivity (Gomes, Pedroso, &
223 Wagner, 2008). There are fields in which people with autism excel. There is a higher rate

224 of autism in families of people talented in physics, engineering and mathematics (Baron-
225 Cohen et al., 1998), and people with autism are disproportionately present in science,
226 technology, engineering, and mathematics (STEM; Wei, Yu, Shattuck, McCracken, &
227 Blackorby, 2013). To put it more concisely, autism is defined by selectivity in interests,
228 low tolerance for stress originating from environmental stimuli and difficulties with
229 social cognition, but are disproportionately present in the hard sciences.

230 **Antisocial Personality Disorder**

231 ADHD is often comorbid with or precursor of antisocial behavior. Antisocial
232 personality disorder (ASPD) is defined as impairments in personality functioning and
233 pathological personality traits. ASPD was one of the first disorders ever identified,
234 commonly known under the name *psychopathy*. These terms will be used
235 interchangeably. Impaired personality functioning in psychopathy is characterized by a
236 long-term pattern of manipulating, exploiting and violating the rights of others.
237 Individuals with ASPD have a diminished capacity to feel remorse and empathy, and use
238 deceit, coercion as well as dominance to control others. Pathological personality traits in
239 the category of antagonism are manipulateness, deceitfulness, callousness, and
240 hostility. In the case of disinhibition: irresponsibility, impulsivity, and risk taking (APA,
241 2013). Robert D. Hare, author of the Hare Psychopathy Checklist, believes that
242 psychopaths are especially present in the corporate culture, as their manipulative and
243 fearless tendencies might be adaptive in these settings (Hare & Babiak, 2006). Conduct
244 disorder (CD) is characterized by behavior that violates either the rights of others or
245 major societal norms and is normally diagnosed before adulthood. Symptoms include
246 provoking others, lying, bullying, destructing property, deceiving, and violating rules.

247 The DSM-5 defines oppositional defiant disorder (ODD) as a pattern of angry/irritable
248 mood, argumentative/defiant behavior, or vindictiveness lasting at least six months
249 (APA, 2013). Typical symptoms include arguing with adults, blaming others for one's
250 own actions, being irritable and losing one's temper, and deliberately provoking others.
251 Only children and adolescents are eligible for an ODD diagnosis. Although the DSM-IV
252 forbade a dual diagnosis, clinical studies have demonstrated that 60 to 95% of CD cases
253 have a comorbid ODD diagnosis (Rowe, Costello, Angold, Copeland, & Maughan,
254 2010). This exclusion criterion has been removed in the DSM-5.

255 **Diagnoses of ASD, ADHD, and ASPD in Females**

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

261 ASD, as it is currently defined, is virtually non-existent in females. The male to
262 female ratio in Asperger's Syndrome (high functioning autism) is greater than 10:1
263 (Baron-Cohen, 2002). Although there is an overall male to female ratio of 4:1 or 5:1 in
264 ASD (Shin Kim et al., 2011), females with autism do not show the typical autism
265 phenotype. Females with autism have repeatedly scored lower than males on restricted
266 interests and behaviors (Van Wijngaarden-Cremers et al., 2014), which constitute one of
267 the two families of symptoms of autism. Although these results are revealing, a
268 comparison with control groups of neurotypical males and females would be of greater
269 significance. The behavioral profile of girls with autism is not consistent with the widely

270 accepted model of autism as an extremely low social motivation, as introduced by
271 Chevallier, Kohls, Troiani, Brodtkin, and Schultz (2012). Severe deficits in pretend play,
272 compared to mild deficits in non-pretence play, is oftentimes considered to be the earliest
273 behavioral manifestation in boys with autism, and girls with autism do not show this
274 tendency (Knickmeyer, Wheelwright, & Baron-Cohen, 2008). This finding is especially
275 meaningful as pretend play requires the inference of mental states to others, to understand
276 the implicit rules that guide imaginative play in groups. Girls with autism show more
277 interest in social relations, and have even been reported to be misdiagnosed as borderline
278 personality disorder, which is characterized by an extreme sensitivity in interpersonal
279 relationships (Attwood, 2007). The social impairment of females with autism, although
280 substantial compared to normal females, is still lesser than that of normal males (Head,
281 McGillivray, & Stokes, 2014). Intellectual disability occurs twice more often in females
282 diagnosed with autism (Mandy et al., 2012), which indicates that the cause of their
283 impairments might stem from their intellectual disability rather than other specified
284 causes. Furthermore, narrow interests and repetitive behaviors are often seen in those
285 with intellectual disability, which might increase their occurrence in girls with autism,
286 even though they are seldom observed (Van Wijngaarden-Cremers et al., 2014). For these
287 reasons, many studies exclude autistic females altogether, resulting in an average ratio of
288 15:1 for fMRI studies on autism (Philip et al., 2012). It seems that the traditional
289 phenotype of autism is seen in males only. Psychological categorization is always subject
290 to change, and impaired social cognition in some females deserves consideration (or not,
291 since autistic females score higher than normal males on friendship measures); however,

292 females do not appear to experience autism as is presently described. Autism will be
293 referred to as a male-only condition.

294 Females do not seem to embody the ADHD criteria often. An astonishing 92% of
295 girls are diagnosed with the inattentive subtype (Weiler, Bellinger, Marmor, Rancier, &
296 Waber, 1999). To put it more boldly, 92% of girls diagnosed with ADHD do not fit the
297 behavioral criteria of ADHD. Girls with ADHD have increased internalizing problems,
298 although externalizing problems is one of the defining characteristic of ADHD
299 (Rucklidge, 2010). When actual symptoms need to be observed, such as in clinical
300 studies, boys have outnumbered females up to 10:1 (Biederman et al., 2002). When
301 ADHD is pervasive, ratios go up to 16:1 (Rutter, Caspi, & Moffitt, 2003). Females are
302 rarely diagnosed with the combined subtype, and their impulsivity symptoms rarely reach
303 conduct disorder. Females are outnumbered from 10 to 15 times in the persistent type of
304 conduct disorder (Moffitt, 2006). The difficulties of girls with ADHD might originate
305 from elsewhere than those of boys with ADHD. In a meta-analytic review, Gaub and
306 Carlson (1997) compared individual variables in boys and girls with ADHD, and found
307 statistically significant medium effect sizes disfavoring girls in terms of three different
308 intelligence measures. These results were replicated by Gershon (2002). Their classroom
309 difficulties might also originate from eating disorders (Biederman et al., 2007) or lower
310 socio-economic status compared to control females (Gaub & Carlson, 1997). In short,
311 females do not embody what the academia has communally termed “ADHD”, and their
312 difficulties in the classroom might not have the same causes than males. Since girls
313 diagnosed with ADHD have a fundamentally different behavioral profile than their male
314 counterparts, the burden of proof is in the hands of those who claim that the male and

315 female presentation are based on a common causal mechanism. As we are not even
316 remotely close to establish objective distinguishing characteristics between people with
317 and without ADHD, phenotypic expression is the only diagnostic tool, and it differs
318 fundamentally between boys and girls with ADHD. Henceforth, ADHD will be described
319 as a behavioral pattern that is seen in males only.

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

334 **Theoretical Accounts for the Male Bias**

335 There is a major sex bias in favor of males in disorders that are characterized by a
336 deficient empathy and the disregard for the rights of others. In this way, cognitive and

337 affective empathy impairments define male-biased disorders. A lack of empathy as the
338 extreme form of a male brain has been investigated by Baron-Cohen.

339 **The Extreme Male Brain Theory of Autism**

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

344 Anything that takes inputs and deliver outputs. When you systemise, you
345 use 'if-then' (correlation) rules. The brain focuses in on a detail or
346 parameter of the system, and observes how this varies. That is, it treats a
347 feature as a variable. Or a person actively manipulates this variable (hence
348 the English word, systematically). They note the effect(s) of this one input
349 elsewhere in the system (i.e. the output). 'If I do x, then y happens'
350 (Baron-Cohen, 2002, p.248).

351 Males outperform females on systemizing tests, such as tests of intuitive physics
352 or map reading. As a result, fields that comprise the most inflexible manipulation of
353 systems are almost entirely composed of males, such as chess players, symphony
354 composers, physicists, and computer programmers. On the other hand, females
355 outperform males on empathy measures, such as *Reading the Mind in the Eyes* test or
356 emotion recognition tests, and people with autism score significantly lower than normal
357 males. The most promising evidence brought forward by Baron-Cohen is that people with
358 autism carry the biological marker of pronounced brain masculinization, which is
359 prenatal testosterone (Auyeung et al., 2012).

360 There are numerous shortcomings to the Extreme Male Brain theory. The most
361 fundamental flaw is that the reasoning that led to autism being the extreme male brain,
362 could be used to nominate other disorders as the extreme male brain. Namely, a few other
363 conditions have been linked to similar high prenatal testosterone levels, but their
364 phenotypes are different. ADHD is an example. Based on 2D:4D ratios, de Bruin,
365 Verheij, Wiegman, and Ferdinand (2006) found no significant differences between the
366 autism group and the ADHD group, indicating that a more pronounced brain
367 masculinization in autism, compared to ADHD, could not be empirically demonstrated.

368 Most importantly, many behaviors that are stereotypically masculine are not
369 shown by those with ASD, such as spatial abilities, athletic abilities (see Hönekopp &
370 Schuster, 2010 for a review), aggression and sensation seeking, which are all correlates of
371 prenatal testosterone, an indicator of brain masculinity (Liu, Portnoy, & Raine, 2012).
372 This indicates that autism is a form of the extreme male brain, but that it only represents
373 one type of expression.

374 The EMB theory does not account for many findings about ASD, such as that
375 90% of those diagnosed with ASD have an auditory hypersensitivity (Gomes et al.,
376 2008), or that people with ASD have poor motor coordination (Gowen & Hamilton,
377 2012), which do not fall under the criteria of repetitive behaviors and lack of responsivity
378 to social cues. This suggests that the clinical definition of hypermasculinity should
379 include disorders characterized by aggression and stimulus seeking, in addition to a lack
380 of sociability.

381 **Zentall and Zentall's Optimal Stimulation Theory**

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

399 Zentall and Zentall's Optimal Stimulation Level theory is interesting because it
400 suggests that the difference between someone with autism and someone with antisocial
401 disorders is caused by the same underlying mechanism. Different individuals have
402 different level of risk tolerance or stimulation needs, and this shapes their personality
403 permanently.

404 The main weakness of this model is that it does not account for the impaired
405 social cognition that is a central aspect of autism. A weak Theory of Mind, however, is
406 unlikely to be a result of the male brain. Fetal testosterone levels, indicator of the brain's
407 masculinity, do not differ significantly between those with autism and ADHD (de Bruin
408 et al., 2006), and Theory of Mind of people with ADHD is much less impaired. The male
409 to female ratio for autism has been shown to converge towards 2:1, and impaired social
410 cognition is arguably the only autistic trait that is the basis for autism diagnoses in
411 females. Most importantly, girls with borderline personality disorder are the current
412 candidate for the extreme female brain (Larson et al., 2015), and they are impaired in all
413 three aspects of social cognition: executive functioning, Theory of Mind and emotion
414 recognition (Baez et al., 2015). Deficits in ToM are neither always permanent nor
415 exclusive to people with autism. It is impaired in many conditions that involve anxiety
416 and distress. For instance, those who are depressed or psychotic have a weaker Theory of
417 Mind (Wang, Wang, Chen, Zhu, and Wang, 2008; Zobel et al., 2010). This means that an
418 impaired Theory of Mind is not exclusive to neither autism nor the male brain, but is
419 better explained by distress. As a matter of fact, over-arousal decreases cognitive
420 performance (Zentall & Zentall, 1983). Cognitive empathy deficits in autism might be
421 better explained by the combination of a typically masculine disinterest in social
422 relationships, and over-arousal (Bal et al., 2010; Hirstein, Iversen, & Ramachandran,
423 2001), which impedes social skills (Richard, French, Nash, Hadwin, & Donnelly, 2007).

424 Autistic people, compared to those with ADHD or ASPD, have a lower stress
425 tolerance level. Hypersensitivity is an intricate part of the ASD clinical presentation
426 (Kern et al., 2007), such as auditory hypersensitivity (Gomes et al., 2008). There is a high

427 correlation between all forms of hypersensitivity and autism severity in children. In fact,
428 physical clumsiness increases with autistic symptoms (Hilton et al., 2007). Next, we have
429 ADHD-i, which has lower rates of injury compared to controls, ADHD-c and ADHD-h
430 groups (Lahey et al., 1998). People with an ADHD diagnosis score significantly higher
431 than controls on measures of risk-taking, resulting in dangerous driving behavior
432 (Barkley et al., 2002), more traffic accidents (Swensen et al., 2004), criminality
433 (Mannuzza et al., 2004), increased substance abuse (Rooney et al., 2012) and risky sexual
434 behavior (Flory et al., 2006). The combined subtype is more strongly linked to risky,
435 impulsive behaviors, notably drug use (Wilens, Faraone, & Biederman, 2004). The
436 combined subtype of ADHD is also more strongly correlated with ODD (66%), CD
437 (47%; Freitag & Retz, 2010) and externalizing disorders (Acosta et al., 2008). Lastly,
438 antisocial personality disorder, commonly known as *psychopathy*, is by distal definition
439 extreme risk taking. Psychopaths need extreme stimulation, which they receive through
440 drug use, alcohol consumption, risky sexual behaviors, and multiple sexual partners.
441 Furthermore, they are responsible for about half of the violent crimes (Hare & Babiak,
442 2006). Importantly, psychopathic traits in people with ADHD correlate negatively with
443 autistic traits. Farrant and colleagues (2014) have found that deficits in social cognition
444 were inversely correlated with hyperactivity in a typically developing sample. This
445 indicates that autism spectrum disorders and psychopathy represent two ends of a
446 spectrum.

447 This increase in risky behaviors from autism to ADHD, and then psychopathy
448 indicates that their risk tolerance inclines them to different patterns of behavior and
449 activities. The idea that people differ in regards to excitement seeking needs has been

450 investigated before. Zentall and Zentall (1983) have suggested that humans differ
451 fundamentally in regards to their optimal stimulation levels, and put ASD, ADHD and
452 psychopathy in this framework.

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

460 **Testosterone and Cortisol**

461 Testosterone influences behavior in two major ways throughout a male's life.
462 First, testosterone has organizational effects on the brain. Organizational effects influence
463 childhood play behavior, sexual orientation and identity and other differences between
464 men and women in the normal population. Studies of amniotic fluids have suggested that
465 prenatal testosterone levels determine the extent to which a brain is masculinized.
466 Prenatal testosterone levels are often based on measuring the length of the second digit
467 ("pointing finger") compared to the fourth digit ("ring finger"). Individuals exposed to
468 higher level of prenatal androgens have lower ratios, and men and women have been
469 repeatedly found to have contrasting ratios. 2D:4D ratios are the preferred biological
470 marker to measure prenatal testosterone (see Manning, Kilduff, Cook, Crewther, & Fink,
471 2014 for a review). ADHD, ASD, and ASPD were suggested to be a result of highly

472 masculinized brains. We would therefore expect them to be linked to lower 2D:4D ratios,
473 indicating hyper masculinization.

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

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

493 What kind of prenatal hormonal profiles do people with autism, ADHD and
494 psychopathy show? People with autism had lower (more masculine) finger length ratios

495 than controls (Al-Zaid, Alhader, & Al-Ayadhi, 2015; Auyeung et al., 2012; Manning,
496 Baron-Cohen, Wheelwright, & Sanders, 2001).

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

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

513 In short, studies of prenatal androgen exposure converge towards the conclusion
514 that 2D:4D ratios spawn different types of behavioral patterns. As hypothesized,
515 psychopathy, ADHD, and autism have masculinized finger length ratios, indicating a
516 masculine brain.

517 What kind of postnatal hormonal profiles do people with autism, ADHD and
518 psychopathy show? Auyeung and colleagues (2012) did not find a link between
519 Quantitative Checklist for Autism in Toddlers scores and postnatal testosterone.
520 Takagishi and colleagues (2010) did not find a significant relationship between Autism
521 Quotient and salivary testosterone. Furthermore, Croonenberghs and colleagues (2010)
522 found lower testosterone levels in individuals with autism. In low functioning autism,
523 cortisol was found to be higher than in controls and in those with Asperger's (Putnam,
524 Lopata, Thomeer, Volker, & Rodgers, 2015). Likewise, individuals with autism show a
525 significantly higher increase in cortisol when stressed, compared to controls (Spratt et al.,
526 2012).

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

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

537 The 2D:4D ratios are lower than controls in all male-biased disorders, indicating
538 that they are indeed varying expressions of the male brain. The decreasing levels of
539 cortisol and increasing levels of testosterone from autism to ADHD, and then

540 psychopathy indicate that individuals are less and less stressed and more and more
541 successfully competitive as they approach psychopathic tendencies. This is consistent
542 with Zentall and Zentall's reasoning, which suggested that people with autism, ADHD
543 and psychopathy have an optimal stimulation level that does not match their environment
544 (Zentall & Zentall, 1983).

545 **Different Behavioral Profiles and Intra-Sexual Competition**

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

557 As males strive to reach higher tiers of competition, we would expect success in
558 riskier systems to represent a more attractive outcome, namely in regards to reproductive
559 fitness. Accordingly, psychopathy and impulsivity conditions are therefore expressions of
560 relative fitness. Psychopathy has been argued to represent a life strategy rather than a
561 disorder (Krupp, Sewall, Lalumière, Sheriff, & Harris, 2013). For instance, facial
562 symmetry is often considered as the best predictor of physical attraction, as it indicates

563 healthy development (Penton-Voak et al., 2001). People with autism have pronounced
564 facial asymmetry compared to controls (Hammond et al., 2008), in contrast to
565 psychopathic offenders, who have better facial symmetry compared to both non-
566 psychopathic male offenders and non-offenders (Lalumière, Harris, & Rice, 2001).
567 People with ADHD have earlier sexual experiences, more casual sex, and more short
568 term sexual partners (Flory et al., 2006). Similarly, multiple short-term sexual encounters
569 are one of the main behavioral symptom of psychopathy. Ellis and Walsh (2007) have
570 reviewed 51 studies, 50 of which reported a positive association between number of
571 sexual partners and antisocial behavior. Anecdotally, in a large forensic hospital, among
572 psychopathic patients who were acquitted due to (malingered) insanity, 39% had a
573 consensual sexual relationship with female staff members (Gacono, Meloy, Sheppard,
574 Speth, & Roske, 1995). More generally, positive correlations between sensation-seeking
575 and sexual success has been extensively studied (Bogaert & Fisher, 1995; Cyders,
576 Dzemidzic, Eiler, & Kareken, 2016; Eisenberg, Campbell, MacKillop, Lum, & Wilson,
577 2007; Lalasz Weigel, 2011; Victor, Sansosti, Bowman, & Hariri, 2015; Webster &
578 Crysel, 2012). In contrast, people with autism have shown to be intrusive, stalking,
579 persisting for months and to engage in inappropriate courting behavior towards ex-
580 partners, celebrities and colleagues (Stokes, Newton, & Kaur, 2007), representing
581 desperate strategies. To conclude, psychopaths and people with ADHD represent the
582 evolutionary successful version of the male brain.

583 **Conclusion**

584 The present review aimed to demonstrate that attention deficit hyperactivity
585 disorder shares traits with ASD and ASPD. These conditions represent the male brain, as

586 they are all highly male-biased, linked to brain masculinization, and they all share a
587 characteristic: a lack of empathy, which is the defining element of the female brain
588 (Baron-Cohen, 2002). There are differences in how this lack of empathy is expressed.
589 Autistic individuals tend to avoid social interactions, people with attention deficits can be
590 somewhat rude and misunderstand others, and those with antisocial disorders may
591 provoke and aggress others repeatedly. The increase of risky social behavior shows a
592 parallel with overall tendencies of those diagnosed with male-biased disorders.
593 Individuals with autism are especially sensitive to sounds and changes of routines, and
594 people with impulsive disorders show increasingly dangerous behavior as the severity of
595 their psychopathic traits increases. This is illustrated by lower levels of stress hormones
596 and higher levels of testosterone in psychopaths, and the opposite pattern in autistic
597 individuals.

598 Different patterns of behavior indicate how the environment shapes one's
599 behavior and personality in a permanent fashion. Autistic symptoms are the behavioral
600 patterns of chronically overstimulated males, and psychopathy is how a male acts when
601 consistently under-aroused. When over-aroused, males withdraw and seek safer forms of
602 competition, and when under-aroused, seek higher, riskier forms of competition and use
603 approach mechanisms. As people with autism, ADHD and psychopathy are
604 overrepresented in systems, sports and criminal activities respectively, they all engage in
605 intra-sexual competition based on their optimal level of stimulation. Males who engage in
606 the highest tiers of intra-sexual competition have increased evolutionary fitness.

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