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Executive functions in psychopathy: a meta-analysis of inhibition, planning, shifting, and working memory performance

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Review Article

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Abstract

Much research has focused on executive function (EF) impairments in psychopathy, a severe personality disorder characterized by a lack of empathy, antisocial behavior, and a disregard for social norms and moral values. However, it is still unclear to what extent EF deficits are present across psychopathy factors and, more importantly, which EF domains are impaired. The current meta-analysis answers these questions by synthesizing the results of 50 studies involving 5,694 participants from 12 different countries. Using multilevel random-effects models, we pooled effect sizes (Cohen's *d*) for five different EF domains: overall EF, inhibition, planning, shifting, and working memory. Moreover, differences between psychopathy factors were evaluated. Our analyses revealed *small* deficits in overall EF, inhibition, and planning performance. However, a closer inspection of psychopathy factors indicated that EF deficits were specific to lifestyle/antisocial traits, such as disinhibition. Conversely, interpersonal/affective traits, such as boldness, showed no deficits and in some cases even improved EF performance. These findings suggest that EF deficits are *not* a key feature of psychopathy per se, but rather are related to antisociality and disinhibitory traits. Potential brain correlates of these findings as well as implications for future research and treatment are discussed.

Executive dysfunctions have been linked to antisocial behavior. However, despite a large number of publications in recent decades, it is still unclear whether executive functions are also impaired in psychopathy. The present meta-analysis seeks to present a neuropsychological profile of executive functions in psychopathy and its factors.

Psychopathy is a severe personality disorder characterized by a constellation of affective, interpersonal, and behavioral symptoms (Burghart & Mier, 2022; De Brito et al., 2021; Vitacco & Kosson, 2010). These symptoms are typically manifested by a lack of empathy or remorse, manipulativeness, and impulsivity, promoting a pervasive pattern of disregard for the rights of others (De Brito et al., 2021). While sharing similarities with antisocial personality disorder (ASPD; American Psychiatric Association, 2013), they differ conceptually. ASPD is broader in scope, with a strong focus on criminal conduct, whereas psychopathy emphasizes interpersonal and affective characteristics (De Brito et al., 2021). This is complemented by a general tendency towards fearlessness and boldness in the face of risks and stressful situations, which has been shown to be a distinguishing trait of psychopathy (Venables, Hall, & Patrick, 2014). Most individuals with a diagnosis of psychopathy therefore also meet the diagnostic criteria for ASPD, but not vice versa (Hildebrand & de Ruiter, 2004). Thus, psychopathy is no less devastating to society than ASPD and, in fact, has been referred to as one of the most important constructs in forensic psychology (Gillespie, Jones, & Garofalo, 2023).

A diagnosis of psychopathy is generally made using the Psychopathy Checklist-Revised (PCL-R; Hare, 2003), a semi-structured interview that divides psychopathy into two factors (Factor 1: Interpersonal/Affective; Factor 2: Chronic Antisocial Lifestyle) or four facets (interpersonal, affective, lifestyle, antisocial; De Brito et al., 2021). Although considered the gold standard, more economical self-report measures of psychopathy have been developed in recent decades. Most notable are the Self-Report Psychopathy Scale-4 (SRP-4; Paulhus, Neumann, & Hare, 2017), the Levenson Self-Report Psychopathy Scale (LSRP; Levenson, Kiehl, & Fitzpatrick, 1995), the Psychopathic Personality Inventory-Revised (PPI-R; Lilienfeld & Widows, 2005), and the Triarchic Psychopathy Measure (TriPM; Patrick, Fowles, & Krueger, 2009). While these scales differ to varying degrees in their underlying conceptualization of psychopathy, they all view it as a constellation of personality traits that fall on a continuum, rather than a dichotomous construct (Sellbom, Lilienfeld, Fowler, & McCary, 2018). This is an important distinction as it allows for the expansion of psychopathy research

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in community samples by not strictly categorizing individuals as either psychopathic or non-psychopathic (Hare & Neumann, 2008).

The etiology of psychopathy is still not fully understood (De Brito et al., 2021), but is likely the result of a complex interplay of genetic (Frazier, Ferreira, & Gonzales, 2019) and environmental influences (de Ruiter et al., 2022; Mariz, Cruz, & Moreira, 2022). These, in turn, are believed to influence healthy brain functioning, particularly in prefrontal regions (Nummenmaa et al., 2021). An important task of the prefrontal lobe is the control of executive functions (EFs; Yuan & Raz, 2014). EF comprise a set of cognitive processes essential for adaptive and goal-oriented human behavior (Jurado & Rosselli, 2007; Kramer & Stephens, 2014). Yet, the exact scope of these cognitive processes remains a matter of debate, with little agreement on the 'core domains' of EF. Baggetta and Alexander (2016) reviewed the EF literature and found considerable heterogeneity among studies. They identified a total of 39 different EF domains, many of which were mentioned only once. The two most influential models that emerged from the literature were those proposed by Miyake et al. (2000) and Diamond (2013). Both conceptualize EF as a multidimensional construct with three core domains: Inhibition, Shifting, and Working Memory. *Inhibition* is the ability to 'control one's attention, behavior, thoughts or emotions to override a strong internal predisposition or external lure, and instead do what's more appropriate or needed' (Diamond, 2013, p. 137). *Shifting* describes the ability to 'change perspectives or approaches to a problem, flexibly adjusting to new demands, rules or priorities' (Diamond, 2013, p. 137). *Working Memory* involves the ability to hold information in memory and process it mentally (Diamond, 2013). Where Miyake et al. (2000) and Diamond (2013) differ is in their conceptualization of higher-order EF. Only the former postulates the additional existence of a common underlying EF factor that captures interindividual differences in other domains (Baggetta & Alexander, 2016; Miyake et al., 2000). While this three-factor unity-diversity perspective has significantly influenced EF research for two decades, its validity compared to other models has only more recently been systematically examined. Karr et al. (2018) conducted a re-analysis of latent variable studies testing seven different models. Their findings indicate that none of the tested models converged consistently across all samples. Still, they found strong evidence supporting a unity-diversity perspective, although the specific number of core EF domains remains uncertain. It is therefore recommended to explore additional models beyond those frequently reported in the literature, provided that they address individual EF domains along with a common EF factor (Karr et al., 2018). While it is neither feasible nor practical to consider all EF domains that have ever been proposed in the literature, one domain that seems crucial to also examine in the context of psychopathy is *Planning* (Maes & Brazil, 2013), as it is critical for identifying goals and the steps necessary to achieve them (Kramer & Stephens, 2014).

It can be expected that frontal lobe impairments and the resulting executive dysfunctions explain some of the symptoms observed in psychopathy. Acquired damages in these areas were found to lead to recklessness, violence, emotional outbursts, and other behaviors that resemble those of antisocial and psychopathic individuals (Anderson, Bechara, Damasio, Tranel, & Damasio, 2013; Barrash, Tranel, & Anderson, 2000; Eslinger, Flaherty-Craig, & Benton, 2004). Moreover, previous research has linked psychopathy to functional and structural deficits in prefrontal areas (Alegria, Radua, & Rubia, 2016; Deming & Koenigs, 2020; Poeppl et al., 2019). However, the wealth of prior neuropsychological research examining EF deficits in psychopathy is inconsistent. While some studies found an association between psychopathy and poor EFs (e.g. Bagshaw, Gray, & Snowden, 2014; Snowden, Gray, Pugh, & Atkinson, 2013), others found no association (e.g. Dolan, 2012; Hart, Forth, & Hare, 1990; Smith, Arnett, & Newman, 1992) or even improved EF performance (e.g. Sellbom & Verona, 2007).

Previous meta-analyses that sought to clarify these contradictory findings have not been entirely successful, either because they focused on antisocial behavior in general or were restricted to certain EF tasks. For instance, Morgan & Lilienfeld's (2000) influential meta-analysis explored the relationship between EF deficits and antisocial behavior, which was operationalized by including ASPD, conduct disorder, and psychopathy. Although the authors also performed subgroup analyses specifically for psychopathy, the focus on a broad concept of antisociality makes it challenging to generalize the findings to psychopathic individuals (Ogloff, Campbell, & Shepherd, 2016). More importantly, only psychopathy total scores were considered, which may limit conclusions since research has shown that the individual factors of psychopathy have distinct developmental pathways and neurobiological correlates (Patrick & Drislane, 2015). Similar constraints are found in Ogilvie, Stewart, Chan, and Shum (2011). Despite being an update of Morgan and Lilienfeld (2000) that includes a broader range of EFs and more recent measures of psychopathy, the focus remained on antisocial behavior and psychopathy total scores. In response, Maes and Brazil (2013) conducted a systematic review aimed at examining EF performance between psychopathy factors. However, the interpretability of their findings is constrained by a small sample of only eleven studies and a narrative summary of the included articles. The two most recent meta-analyses were performed by Gillespie, Lee, Williams, and Jones (2022) and Jansen and Franse (2024). The former yielded a statistically significant but small negative relationship between psychopathy and performance on go/no-go and stop signal tasks. Although including many different psychopathy measures and a reasonable number of studies ($n = 17$), it is limited to only one EF domain, namely inhibition. Jansen and Franse (2024), on the other hand, focused on antisocial personality disorder. Psychopathy was only considered as part of a moderator analysis in the form of a total score and aggregated with CU traits.

The present meta-analysis

In view of the inconclusive findings on psychopathy and EF performance and the limits of previous attempts to clarify these discrepancies, we considered it crucial to conduct a comprehensive meta-analysis that comprises not only psychopathy total and factor scores but also a wide range of EF domains. In doing so, we aimed to answer the following questions: (1) is psychopathy related to executive dysfunction; (2) is this association specific to certain psychopathy factors and/or EF domains; and (3) are these effects moderated by other variables?

Methods

Literature search

A systematic literature search was conducted in October 2022 using three online databases (PsycInfo, PubMed, Web of

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Science; see online Supplementary Table S1 for our search terms). In addition, previous reviews and Google Scholar were manually searched for relevant references.

Eligibility criteria and study selection

To be included, the following criteria had to be met. First, studies needed to assess the association between psychopathy and EF performance using validated measures for both constructs (see below) in either an offender or community sample. Second, sufficient data for effect size calculation had to be reported or sent to us upon request. Third, the samples studied had to be over the age of 18. Gray literature, such as dissertations, was included, while single case studies or articles that did not report primary data were not.

Screening was conducted in pairs of two in accordance with the Preferred Reporting Items of Systematic Reviews and Meta-Analyses guidelines (PRISMA; Page et al., 2021). The eligible literature was first manually screened at the abstract level and subsequently assessed in full. Data extraction was also performed by two independent reviewers.

Included measures

Executive functions

All neuropsychological tests that could be assigned to one of the following four EF domains were included: Inhibition, shifting, planning, and working memory. Assignment to an EF domain was done by manual annotation and was based on previous literature (e.g. Baliousis, Duggan, McCarthy, Huband, & Völlm, 2019; Diamond, 2013; Jurado & Rosselli, 2007; Maes & Brazil, 2013; Pennington & Ozonoff, 1996). The EF domain to which each task was assigned is shown in Table 1. We acknowledge that the grouping of specific tasks into a single domain is debatable, as many tests likely require multiple EFs simultaneously (Friedman & Miyake, 2017; Karr et al., 2018; Miyake et al., 2000). However, in the absence of a clear definition, we addressed this issue in three ways. First, we also combined all tasks into a single common EF domain. Second, we performed supplementary analyses for the EF tasks separately. While this reduces statistical power, it avoids the 'over-lumping' of tasks (Snyder, Miyake, & Hankin, 2015). Third, we performed sensitivity analyses using the GOSH approach (Olkin, Dahabreh, & Trikalinos, 2012), which allows us to examine the robustness of the results by simulating alternative meta-analyses (see below).

Also debatable is the question of which test score of a particular neuropsychological task best reflects EF performance. In case of the Wisconsin Card Sorting Test (WCST), for example, some researchers consider only the Preservative Error Score to be representative of shifting performance and ignore all other test scores produced by the WCST (e.g. Categories Achieved). However, since there is no consensus in the scientific community and test results reported in each article vary widely, we chose to extract all available data and perform our analyses incorporating all performance scores.

Moreover, only cold EF tasks were included to assess EF performance without the potentially influencing affective and reward/punishment components of hot EF tasks (Salehinejad, Ghanavati, Rashid, & Nitsche, 2021).

Psychopathy

Both semi-structured interviews, such as the PCL-R, as well as self-report measures were considered eligible. When available, total and factor/facet scores were extracted. However, given the large heterogeneity in the factor structure of different psychopathy measures, we followed the approach of Gillespie et al. (2022) and assigned each psychopathy factor/facet to one of two overarching factors: Interpersonal/Affective (I/A) and Lifestyle/Antisocial (L/A; for more details, see online Supplementary Table S2). These were then used to examine differences in EF performance across psychopathy factors. Importantly, although this approach increases statistical power, it has drawbacks that must be addressed. Grouping different dimensions of psychopathy into overarching factors may bias the results, especially in relation to the TriPM and the PPI-R. Both emphasize boldness and fearlessness in their conceptualization of psychopathy. While these traits are captured by Factor 1 of the PCL-R, this is only true to some extent (Venables et al., 2014). Moreover, boldness has been shown to have adaptive features and often displays opposite relationships with various outcomes compared to other psychopathy traits (e.g. Burghart, Sahm, Schmidt, Bulla, & Mier, 2024; Segarra, Poy, Branchadell, Ribes-Guardiola, & Moltó, 2022). It is therefore crucial not only to rely on the approach of Gillespie et al. (2022), but also to present results for 2-factor and 3-factor solutions separately. Given the reduced power associated with this approach, interpretation should prioritize effect sizes over statistical significance.

Synthesis of results

Cohen's d (Cohen, 1988) was chosen as the effect size index, with $d < 0$ indicating poorer EF performance in psychopathic individuals. In cases where a correlation coefficient was reported, it was converted following the formula recommended by Borenstein, Hedges, Higgins, and Rothstein (2009). Effect sizes were pooled separately for overall EF (i.e. including all effect sizes), inhibition, shifting, planning, and working memory using multilevel random-effects models. This allows for non-independence across effect sizes (e.g. due to studies providing more than one effect size) by decomposing heterogeneity within (σ_2^2) and between samples (σ_1^2; Cheung, 2014). All analyses were performed in R with the metafor package (Viechtbauer, 2010). Our data can be found online: https://osf.io/fv8d5/.

Multilevel mixed-effects models were used to test whether the results were influenced by a range of potential moderators previously examined in other meta-analyses on psychopathy (Gillespie et al., 2022). These included sample type (community *v.* offenders), percentage of women in a sample (ranging from 0 to 100%), mean age of a sample, literature status (peer reviewed *v.* gray), publication year, and country. The type of psychopathy measure (PCL-R *v.* self-report) was confounded with sample type and could therefore not be investigated.

To examine the robustness of our results, additional sensitivity analyses were performed and the presence of publication bias was investigated. The former involved GOSH analyses for overall EF and the four domains, in which one million meta-analyses were simulated based on random subsets of effect sizes (Olkin et al., 2012). The produced distribution of meta-analytical results was then plotted and visually examined. Our findings were considered robust when unimodal distributions were observed, indicating that there is no specific combination of effect sizes that drive the results in a particular direction. Conversely, multimodal distributions would suggest that certain combinations of effect sizes significantly influence the results. Lastly, the presence of

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Table 1. Study characteristics of all included articles

Study	Psychopathy measure	Sample	*N*	% Women	Age (mean)	EF domain	EF task	Country
Bagshaw et al. (2014)	PCL-R	Offenders	27	0	35.14	Inhibition	Hayling Sentence Completion Test	UK
							Brixton Spatial Anticipation Test	
						Planning	Tower of London	
						Shifting	Brixton Spatial Anticipation Test	
Baliousis et al. (2019)	PCL-R	Offenders	82	0	32.42	Planning	Stockings of Cambridge	UK
						Shifting	ID/ED Set Shifting	
						WM	Spatial Span	
							Spatial Working Memory	
Bare (2005)	SRP-2	Community	92	54	21.90	Shifting	WCST	USA
Baskin-Sommers et al. (2015)	PCL-R	Offenders	374	0	30.97	Inhibition	D-KEFS Color-Word	USA
						Planning	D-KEFS Tower	
Blair et al. (2006)	PCL-R	Offenders	37	0	33.54	Inhibition	Number-Stroop Task	UK
De Brito, Viding, Kumari, Blackwood, and Hodgins (2013)	PCL-R	Offenders	45	0	37.39	WM	Digit Span-Backwards	UK
Delfin, Andiné, Hofvander, Billstedt, and Wallinius (2018)	PCL-R	Offenders	214	0	21.94	Inhibition	Stop-Signal Task	Sweden
						Planning	Stockings of Cambridge	
						Shifting	ID/ED Set Shifting	
						WM	Spatial Working Memory	
Dinn and Harris (2000)	PCL:SV	Community	22	0	28.30	Inhibition	Go/No-Go Task	USA
							Color-Word Stroop Task	
Dolan (2012)	PCL:SV	Offenders	68	0	38.28	Inhibition	Go/No-Go Task	UK
						Planning	Stockings of Cambridge	
						Shifting	ID/ED Set Shifting	
Ducro, Vicenzutto, Suinen, and Pham (2014)	PCL-R	Offenders	22	100	42.77	Planning	Tower of London	Belgium
							Porteus Maze	
Dvorak-Bertsch, Sadeh, Glass, Thornton, and Newman (2007)	PCL-R	Offenders	97	0	–	Inhibition	Color-Word Stroop Task	USA
Friedman, Rhee, Ross, Corley, and Hewitt (2021)	LSRP	Community	765	53	22.80	Inhibition	Antisaccade Task	USA
							Stop-Signal Task	
							Stroop Task	
						Shifting	Number-Letter Task	
							Color-Shape Task	
							Category-Switch Task	

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						WM	Keep-Track Task	
							Letter Memory Task	
							Spatial n-Back Task	
Goodwin (2014)	TriPM	Community	240	42	26.91	Inhibition	Go/No-Go Task	USA
						Planning	Porteus Maze	
						Shifting	Trail Making Test	
Hare (1984)	PCL	Offenders	30	0	32.60	Shifting	WCST	Canada
						WM	Sequential Matching Memory Task	
Hart et al. (1990)	PCL-R	Offenders	121	0	30.15	Shifting	Trail Making Test	Canada
Hiatt, Schmitt, and Newman (2004)	PCL-R	Offenders	75	0	28.27	Inhibition	Color-Word Stroop Task	USA
							Picture-Word Stroop Task	
Ishikawa, Raine, Lencz, Bihrle, and Lacasse (2001)	PCL-R	Community	39	0	28.82	Shifting	WCST	USA
Kalinian and Wisniewski (2006)	PCL:SV	Offenders	54	100	37.85	Shifting	D-KEFS Sorting Task	USA
Kiehl, Smith, Hare, and Liddle (2000)	PCL-R	Offenders	24	0	27.54	Inhibition	Go/No-Go Task	Canada
Kim and Jung (2014)	PPI-R	Community	30	67	20.20	Shifting	WCST	South Korea
Krakowski et al. (2015)	PCL:SV	Offenders	38	16	41.53	Inhibition	Go/No-Go Task	USA
						Shifting	Task-Switching Paradigm	
Lantrip, Towns, Roth, and Giancola (2016)	PPI	Community	501	51	23.07	Inhibition	BRIEF-A: Inhibition	USA
						Planning	BRIEF-A: Planning	
						Shifting	BRIEF-A: Shifting	
						WM	BRIEF-A: Working Memory	
Lapierre, Braun, and Hodgins (1995)	PCL	Offenders	60	0	32.97	Inhibition	Go/No-Go Task	Canada
						Planning	Porteus Maze	
						Shifting	WCST	
Mahmut, Homewood, and Stevenson (2008)	SRP-3	Community	101	73	22.99	Shifting	Trail Making Test	Australia
Malesza and Ostaszewski (2016)	SRP-3	Community	298	54	21.80	Inhibition	Stop-Signal Task	Germany
Maurer et al. (2016)	PCL-R	Offenders	44	100	33.94	Inhibition	Go/No-Go Task	USA
Michałowski, Droździel, and Harciarek (2015)	PPI	Community	26	81	–	Inhibition	Go/No-Go Task	Poland
							Stop-Signal Task	
Mitchell, Colledge, Leonard, and Blair (2002)	PCL-R	Offenders	42	0	33.24	Shifting	ID/ED Set Shifting	UK
Mol, Van Den Bos, Derks, and Egger (2009)	PCL-R	Offenders	53	0	38.60	Shifting	WCST	Netherlands
Monaghan (2020)	LSRP	Community	126	63	19.60	WM	n-Back Task	USA
Morgan, Gray, and Snowden (2011)	PPI-R	Community	80	63	21.16	Inhibition	GoStop Impulsivity Paradigm	UK
O'Connell (2019)	TriPM	Community	118	57	19.90	Inhibition	Stop-Signal Task	USA
							Stroop Task	

(*Continued*)

Table 1. (*Continued.*)

Study	Psychopathy measure	Sample	*N*	% Women	Age (mean)	EF domain	EF task	Country
						Shifting	Plus-Minus Task	
							Number-Letter Task	
						WM	Keep-Track Task	
							Letter-Memory Task	
Pasion, Cruz, and Barbosa (2018)	TriPM	Mixed	104	0	35.78	Inhibition	Stroop Task	Portugal
						Shifting	Trail Making Test	
						WM	n-Back Task	
Pauli, Liljeberg, Gustavsson, Kristiansson, and Howner (2019)	PCL-R; TriPM	Offenders	105	0	38.80	Inhibition	D-KEFS Color-Word	Sweden
							Stop-Signal Task	
						WM	Digit Span	
Pera-Guardiola et al. (2016)	PCL-R	Offenders	44	0	35.36	Shifting	WCST	Spain
Pham, Vanderstukken, Philippot, and Vanderlinden (2003)	PCL-R	Offenders	36	0	30.50	Inhibition	Color-Word Stroop Task	Belgium
						Planning	Porteus Maze	
							Tower of London	
						Shifting	Trail Making Test	
							WCST	
Ribes-Guardiola, Poy, Patrick, and Moltó (2020)	TriPM	Community	142	71	20.58	Inhibition	Go/No-Go Task	Spain
							Flanker Task	
Ross, Benning, and Adams (2007)	PPI; LSRP	Mixed	293	55	28.94	Inhibition	Frontal Systems and Behavior Scale: Inhibition	USA
Sellbom et al. (2022)	TriPM	Community	212	42	26.60	Inhibition	Go/No-Go Task	USA
						Planning	Porteus Maze	
Sellbom and Verona (2007)	PPI	Community	95	47	20.20	Inhibition	COWAT	USA
							Flanker Task	
						Planning	WISC-Mazes	
						Shifting	Trail Making Test	
							WCST	
						WM	Digit Span-Backwards	
Smith (1999)	PCL-R	Offenders	16	0	35.51	Inhibition	Go/No-Go Task	Canada
Smith et al. (1992)	PCL-R	Offenders	69	0	25.95	Inhibition	Stroop Task	USA
						Shifting	Trail Making Test	
						WM	Digit Span-Backwards	
Snowden et al. (2013)	PPI-R	Community	60	80	–	Planning	Porteus Maze	UK

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Steele, Maurer, Bernat, Calhoun, and Kiehl (2016)	PCL-R	Offenders	93	0	34.53	Inhibition	Go/No-Go Task	USA
Suchy and Kosson (2006)	PCL-R	Offenders	44	0	25.98	Shifting	Verbal Task	USA
							Non-Verbal Task	
Tonnaer, Cima, and Arntz (2016)	PCL-R	Offenders	87	0	37.90	Inhibition	GoStop Impulsivity Paradigm	Netherlands
Varlamov, Khalifa, Liddle, Duggan, and Howard (2011)	PCL-R	Offenders	49	0	32.78	Inhibition	Visual Go/No-Go Task	UK
Zeier, Baskin-Sommers, Hiatt Racer, and Newman (2012)	PCL-R	Offenders	98	0	28.25	Inhibition	Flanker Task	USA
Zeier and Newman (2013)	PCL:SV; PPI	Offenders	127	0	–	Inhibition	Picture-Word Stroop Task	USA
Zimak, Suhr, and Bolinger (2014)	PPI-SF	Community	75	0	19.32	Inhibition	Stop-Signal Task	USA

Note: BRIEF-A, Behavior Rating Inventory of Executive Function; D-KEFS, Delis-Kaplan Executive Function System; EF, executive function; LSRP, Levenson Self-Report Psychopathy Scale; N, number of participants; PCL-R, Psychopathy Checklist – Revised; PCL:SV, Psychopathy Checklist: Screening Version; PPI, Psychopathic Personality Inventory; PPI-R, Psychopathic Personality Inventory – Revised; PPI-SF, Psychopathic Personality Inventory – Short Form; SRP, Self Report Psychopathy Scale; TriPM, Triarchic Psychopathy Measure; WCST, Wisconsin Card Sorting Test; WM, working memory.

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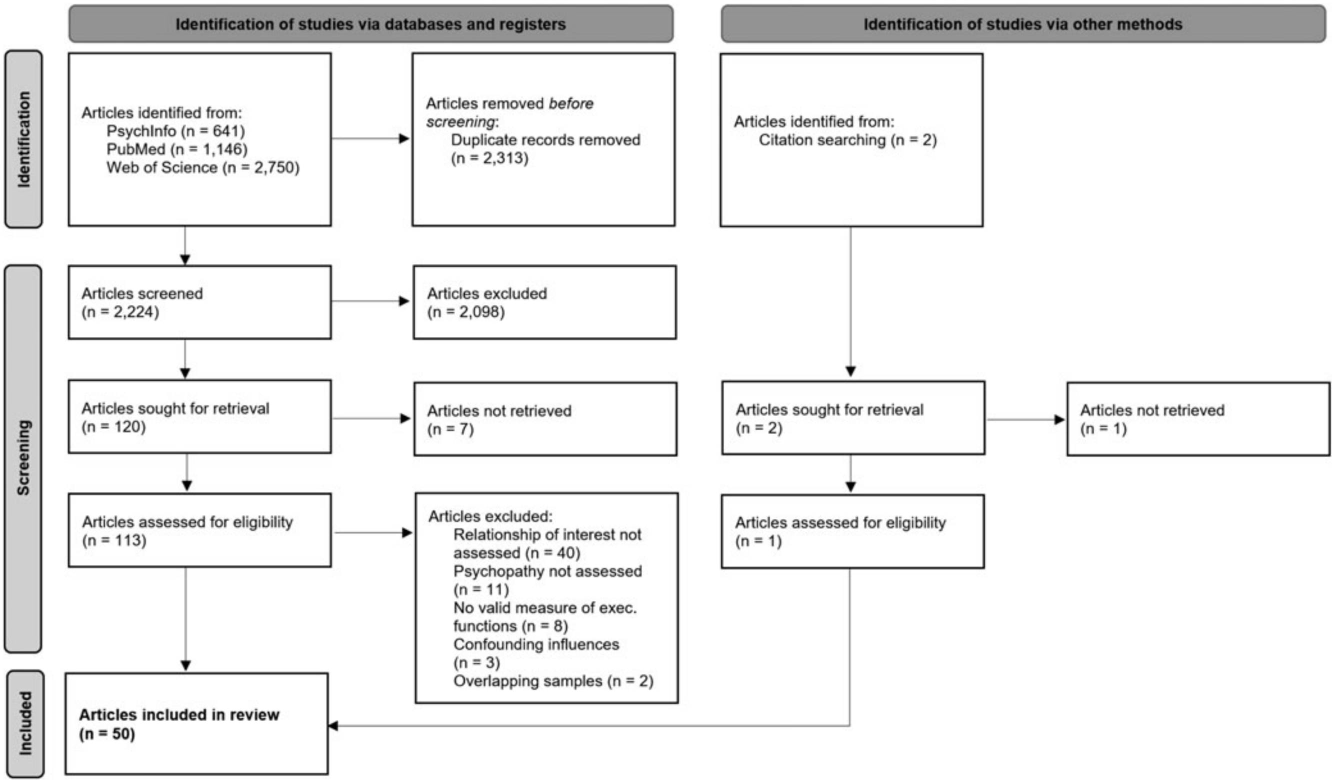

Figure 1. PRISMA flowchart of our study selection process.

publication bias was evaluated by visually inspecting colored funnel plots for asymmetry (Nakagawa et al., 2022) and by performing adjusted Egger's regression tests for dependent effect sizes (Rodgers & Pustejovsky, 2021).

Results

Description of included studies

The literature search yielded 789 articles, of which 50 were included in our meta-analysis (Fig. 1). These were published between the years of 1984 and 2021 and comprised a total of 5694 participants (range = 16 to 765) from 12 countries. Most studies examined men, and only about a quarter of all participants were women. While 30 articles were based on individuals who offended, 20 included community samples. Detailed information on all included articles is provided in Table 1.

Meta-analytical results

Psychopathic individuals showed statistically significant impairments in their overall EF, inhibition, and planning performance. The pooled effect sizes for shifting and working memory also indicated deficits but did not reach statistical significance. All multilevel models revealed substantial levels of heterogeneity across studies, suggesting the presence of moderators. Results are presented in Table 2 (results for individual EF tasks are shown in online Supplementary Table S3).

Analyses of differences in EF performance across psychopathy factors yielded statistically significant results for overall EF, inhibition, planning, and working memory (Table 3). Across four domains, L/A was associated with significantly greater deficits than I/A. The contrary was found for shifting, although the *Q*-test was only marginally significant ($p = 0.05$; Table 3). Here, I/A was associated with improved shifting performance, whereas L/A resulted in a null effect. When the psychopathy factors

Table 2. Results of multilevel models (Cohen's *d*) for each executive function domain

EF domain	*n*	*k*	*d* [95% CI]	σ_1^2	σ_2^2	*Q*
Overall EF	45	215	−0.23 [−0.36 to −0.11]***	0.133	0.049	829.59***
Inhibition	29	99	−0.20 [−0.34 to −0.06]**	0.087	0.080	491.24***
Planning	11	35	−0.50 [−0.79 to −0.21]***	0.160	0.101	103.16***
Shifting	24	65	−0.12 [−0.28 to 0.04]	0.122	0.000	161.71***
Working memory	10	16	−0.13 [−0.28 to 0.01]	0.031	0.000	25.72*

Note: EF, executive function; *n*, number of studies; *k*, number of effect sizes; *d*, Cohen's *d*; CI, confidence interval; σ_1^2, between-study heterogeneity; σ_2^2, within-study heterogeneity; *Q*, test for heterogeneity.
*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

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Table 3. Differences in executive function performance (Cohen's *d*) across psychopathy factors (grouped to two overarching factors)

EF domain	*n*	*k*	*Q*	*d* [95% CI]
Overall EF	24	265	9.37**	
I/A				−0.06 [−0.18 to 0.07]
L/A				−0.25 [−0.37 to −0.12]***
Inhibition	20	138	5.48*	
I/A				−0.07 [−0.22 to 0.08]
L/A				−0.23 [−0.39 to −0.08]**
Planning	8	43	5.87*	
I/A				−0.12 [−0.29 to 0.05]
L/A				−0.44 [−0.64 to −0.25]***
Shifting	11	45	3.70†	
I/A				0.15 [0.01–0.30]*
L/A				−0.06 [−0.22 to 0.10]
Working memory	9	39	5.74*	
I/A				0.02 [−0.12 to 0.17]
L/A				−0.24 [−0.40 to −0.08]**

Note: EF, executive function; *n*, number of studies; *k*, number of effect sizes; *d*, Cohen's *d*; CI, confidence interval; I/A, Interpersonal/Affective; L/A, Lifestyle/Antisocial; *Q*, test for heterogeneity (indicates whether the difference between I/A and L/A is statistically significant).
*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; † $p = 0.05$.

were further disentangled, the PCL-like 2-factor model (i.e. excluding TriPM and PPI-R) resulted in less clear differences for factor 1 and factor 2 than the overarching factor model for L/A and I/A. Nevertheless, factor 2 generally displayed larger negative effect sizes than factor 1 (Table 4). In contrast, in the 3-factor model, disinhibition was consistently associated with deficits across all EF domains, whereas boldness exhibited either no deficits (overall EF, inhibition, planning) or even improved performance (shifting and working memory; Table 4). Due to low statistical power, the confidence intervals were large (Table 4).

Moderator analyses

The proportion of women in a sample significantly moderated overall EF ($Q = 17.62$, $p < 0.05$, $\beta = -0.72$ [−1.05 to −0.38]), inhibition ($Q = 3.86$, $p < 0.05$, $\beta = -0.52$ [−1.04 to −0.001]), planning ($Q = 4.59$, $p < 0.05$, $\beta = -0.78$ [−1.50 to −0.07]), and shifting ($Q = 4.70$, $p < 0.05$, $\beta = -0.52$ [−1.00 to −0.05]), with more women producing greater performance deficits in psychopathy. However, this was not observed for working memory ($Q = 0.84$, $p = 0.36$, $\beta = -0.26$ [−0.81 to 0.30]). All other tested moderators (i.e. sample type, age, literature status, publication year, and country) were statistically non-significant.

Sensitivity analyses and publication bias

Except for working memory, our GOSH sensitivity analyses identified unimodal distributions for all EF domains, indicating that no combination of effect sizes biases the results in any particular direction (Fig. 2). The distribution for working memory was

Table 4. Differences in executive function performance (Cohen's *d*) across psychopathy factors (using 2-factor and 3-factor models)

	d [95% CI]				
Model	Overall EF	Inhibition	Planning	Shifting	Working memory
2-Factor model	*n* = 13	*n* = 10	*n* = 3	*n* = 5	*n* = 4
Factor 1	−0.18 [−0.39 to 0.03]	−0.19 [−046 to 0.08]	−0.39 [−0.77 to −0.02]*	0.05 [−0.06 to 0.17]	−0.15 [−0.27 to −0.04]**
Factor 2	−0.23 [−0.34 to −0.02]*	−0.23 [−0.50 to 0.04]	−0.52 [−0.89 to 0.15]**	0.02 [−0.09 to 0.13]	−0.21 [−0.32 to −0.10]***
3-Factor model	*n* = 14	*n* = 13	*n* = 5	*n* = 6	*n* = 6
Boldness	0.06 [−0.12 to 0.24]	0.01 [−0.22 to 0.24]	0.09 [−0.15 to 0.34]	0.25 [−0.02 to 0.52]	0.27 [0.01–0.52]*
Disinhibition	−0.29 [−0.47 to −0.11]**	−0.29 [−0.51 to −0.06]*	−0.46 [−0.70 to −0.22]***	−0.15 [−0.42 to 0.12]	−0.34 [−0.59 to −0.08]**
Meanness	−0.05 [−0.26 to 0.15]	−0.06 [−0.32 to 0.20]	−0.11 [−0.42 to 0.20]	0.09 [−0.26 to 0.43]	−0.05 [−0.38 to 0.28]

Note: EF, executive function; *n*, number of studies; *d*, Cohen's *d*; CI, confidence interval. The 2-factor model includes all PCL-like measures, while the 3-factor model includes only the TriPM and the PPI-R. For the sake of brevity, the factors presented in the table are named Boldness, Disinhibition, and Meanness, but these also represent the PPI-R's Fearless Dominance, Self-Centered Impulsivity, and Coldheartedness, respectively. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

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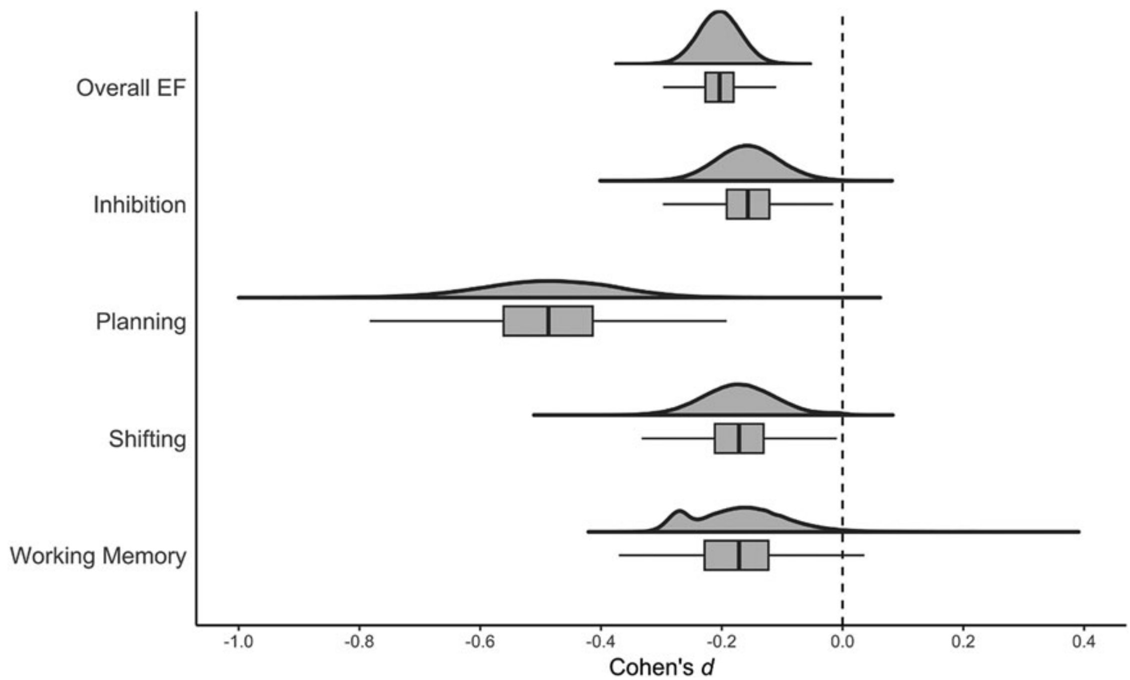

Figure 2. Distribution of summary effect sizes based on meta-analyses with randomly drawn subsets of effect sizes.
Note: The results are based on a graphical display of study heterogeneity (GOSH) approach, in which separate meta-analyses are performed on 1 000 000 randomly drawn subsets of effect sizes. Due to the smaller number of effect sizes for working memory ($k = 16$), all possible combinations were fitted ($2^{16}-1 = 65\,535$). It is important to emphasize that this method does not account for dependencies between effect sizes and should therefore only be interpreted in terms of the robustness of the results, rather than providing information about the true summary effect size of each EF domain.

bimodal, with the effects reported by Baliousis et al. (2019) having the largest influence. Specifically, meta-analyses that include them generally yield smaller summary effect sizes (i.e. the right peak; Figure 2). However, the proximity of the two peaks suggests that the differences are negligible.

Online Supplementary Fig. S1 shows a colored funnel plot for each EF domain. A visual inspection of these funnel plots reveals a clear pattern of asymmetry for overall EF and planning. This is supported by statistically significant Egger's regression tests indicating the presence of small study effects. Consequently, the true pooled effect size for overall EF and planning are likely smaller.

Discussion

This meta-analysis shows statistically significant impairments in overall EF, inhibition, and planning performance among individuals with psychopathic traits. These deficits are consistent with current conceptualizations of psychopathy that emphasize symptoms of poor behavioral control and difficulty planning ahead (Hare, 2020). Both are likely to foster socially distressing and inappropriate behaviors such as aggression and violence (Hare, 2020; Moffitt et al., 2011). However, it is important to highlight that the effects in our meta-analysis can only be considered small. Although the pooled effect size for planning is of medium size, it was clearly influenced by publication bias and thus is likely smaller in reality (Thornton, 2000). Together with the lack of statistically significant effects for working memory and shifting performance, it can be concluded that psychopathy is *not* characterized by severe global EF dysfunction and that EF impairments are *not* a key feature of this disorder.

Instead, it can be assumed that EF dysfunctions are related to antisociality and not to psychopathic personality traits *per se* (O'Connell, 2019). This is supported by Jansen and Franse (2024), who meta-analyzed EF deficits in ASPD. Their summary effect sizes were approximately twice as large as those identified in our own meta-analysis, suggesting that EF deficits play a greater role in ASPD than they do in psychopathy. Our findings regarding differences in EF performance across psychopathy factors further support this conclusion. We found statistically significant EF impairments for L/A, but not for I/A. This is also true for working memory performance, which did not appear to be impaired in psychopathy when only total scores were considered. While such a clear distinction between the two psychopathy factors was not readily apparent when only PCL-like scales were examined, the results for the 3-factor model of psychopathy (i.e. TriPM and PPI-R) showed a clear pattern. Disinhibition (and meanness) was consistently related to deficits in all EF domains, whereas boldness exhibited either no relationship or even positive associations with EF performance. Crucially, traits of disinhibition are highly shared between ASPD and psychopathy. Boldness, on the other hand, is unique to psychopathy and serves as a key distinguishing factor from ASPD (Venables et al., 2014; Wall, Wygant, & Sellbom, 2015). It is therefore likely that the additional presence of boldness in psychopathy attenuates EF impairments, thereby making them less pronounced than in ASPD.

Our moderator analyses suggest that overall EF, inhibition, planning, and shifting deficits in psychopathy are greater among women than men. Although no such influence of sex was found for working memory performance, this should not be taken as evidence for the absence of this moderating effect. Especially because the sample of studies that examined working memory performance was small and included few women. Female psychopathy differs from male psychopathy (Guay, Knight, Ruscio, & Hare, 2018) with differences particularly

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evident in greater emotional instability (Beryl, Chou, & Völlm, 2014). This instability may manifest in more EF impairments and thus explain the findings of our moderator analyses. Further research is needed to test this hypothesis.

Integration of neuroimaging studies

Integrating neuroimaging studies in our findings can provide additional insight into why EF impairments do not appear to be a prominent feature of psychopathy per se, but rather are related to the disinhibitory and antisocial aspects of this disorder. For example, a meta-analysis by Wong et al. (2019) explored the neural network of aggression, a behavior closely tied to disinhibition. Their findings revealed a link between aggression and aberrant precuneus activity, which is assumed to further disrupt the larger cognitive control network and in turn negatively impacts EF performance. Similarly, Dugré et al. (2020) conducted a meta-analysis of neurofunctional abnormalities within the antisocial spectrum across five different neurocognitive domains. One of these domains was cognitive control (i.e. EF performance), with studies primarily using Stroop and Go/No-Go tasks. Their results again indicated reduced activation in regions within (and outside) the cognitive control network, including the premotor cortex, anterior insula, ventrolateral PFC, and cerebellar regions.

Considering these findings, alongside the fact that most individuals with psychopathy also meet diagnostic criteria for ASPD (Hildebrand & de Ruiter, 2004), the question arises as to why psychopathy does not appear to be characterized by substantial EF impairments. Another meta-analysis by Alegria et al. (2016) may provide answers. The authors aggregated whole-brain fMRI studies involving youths with disruptive behavior disorder or conduct problems. Consistent with Wong et al. (2019) and Dugré et al. (2020), they identified deficiencies in a broader network of prefrontal and other regions (i.e. rostro-dorsomedial, fronto-cingulate, and ventral-striatal cortices). More importantly, however, a subgroup analysis focusing specifically on youths with additional psychopathic traits revealed a different pattern of results. They displayed hypoactivity in the ventromedial PFC and limbic system, but *hyper*activity in dorsal and fronto-striatal regions, which might lead to unimpaired executive control. It follows that while psychopathy shares many neurobiological features with ASPD as well as with disruptive or aggressive behavior, it is related to additional unique adaptive aspects that are observable on a neural level and seem to mitigate EF impairments otherwise prevalent in related conditions. This mirrors our own findings. Specifically, poor EF performance correlated strongly with psychopathic traits that are also highly prevalent in ASPD (i.e. L/A or disinhibition), but showed weaker relationships with traits more distinctive of psychopathy (i.e. I/A or boldness) and potentially adaptive under certain conditions (Bronchain, Raynal, & Chabrol, 2020). This likely accounts for the overall minor role of EF impairments within psychopathy itself. That said, to truly advance our understanding of the underlying roots of these adaptive traits, future neuroimaging studies need to disentangle psychopathy into its factors instead of treating it as a single construct.

Limitations

A few limitations must be considered when interpreting our results. First and foremost, although we drew on previous research to assign neuropsychological tasks to specific EF domains, we cannot rule out that these tasks actually reflect performance in more than one domain (Niendam et al., 2012). This is known as the impurity problem of EFs (Baggetta & Alexander, 2016; Miyake et al., 2000). There have been attempts in the past to resolve this issue by using so-called process pure measures of EFs, which are assumed to be uniquely associated with a single EF domain (Miyake et al., 2000; O'Connell, 2019). However, the current state of evidence for this assumption is weak. We therefore applied several strategies to mitigate the potential influence of our task-domain assignment. These included exploring results based on a common EF domain as well as for individual tasks independently, and using GOSH sensitivity analyses. All of which support the robustness of our findings and provide strong evidence that our conclusions are not biased by the assumptions we made.

Another limitation arises from the fact that the vast majority of studies included in this meta-analysis focused on men. This is particularly troublesome in view of the results of our moderator analyses, but unfortunately a common theme in the literature that has already affected the generalizability of other meta-analyses (e.g. Burghart et al., 2023; de Ruiter et al., 2022). Future studies in the field should therefore prioritize the inclusion of women.

Implications

The present findings have implications for both future research and treatment efforts. First, it should become standard practice in psychopathy research to investigate and report psychopathy factors, not just total scores. As shown in our meta-analysis, this may help to clarify conflicting results. Second, neuroimaging studies that map the neural correlates of EFs for different psychopathy factors are needed, as are studies that directly compare psychopathic individuals' performance on hot and cold EF tasks. Particularly in regard of the known aberrations in structural connectivity between the orbital parts of the prefrontal cortex and medial temporal lobe in psychopathy (Craig et al., 2009), it could be predicted that hot EF tasks result in stronger impairments in psychopathy. Further, the inhibition impairments should be associated by dysfunctional activation in prefrontal regions and might be related to emotion regulation deficits. However, studies on emotion regulation in psychopathy are still rather scarce and findings on fractional anisotropy in psychopathy vary between psychopathy factors and between studies with conduct disorder and adult psychopathy (e.g. Maurer, Paul, Anderson, Nyalakanti, & Kiehl, 2020; Wolf et al., 2015), hampering clear hypotheses on the direction of change.

Finally, although there is ample evidence that poor EF performance can be improved with treatment (Stamenova & Levine, 2019), our results suggest that EF training should not be blindly administered to psychopathic individuals. Rather, it should be reserved for those who score high on antisocial factors (e.g. disinhibition). Especially with regard to the importance of cost-efficient therapy, this can help to allocate resources more effectively.

Conclusion

With the present meta-analysis, we showed that EF deficits are rather small and may not represent a central aspect of general psychopathy. That is, performance impairments on various EF tasks seem specific to the antisocial and disinhibitory traits of psychopathy, whereas the affective traits that are more distinctive

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of psychopathy, such as boldness, relate to no or even enhanced EF performance. Our findings have clear implications for future research on EFs in psychopathy and highlight the necessity to address psychopathy not as a single construct, but to systematically differentiate between the affective and the antisocial dimensions of this disorder.

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References

References marked with an asterisk indicate studies included in the meta-analysis.

Alegria, A. A., Radua, J., & Rubia, K. (2016). Meta-analysis of fMRI studies of disruptive behavior disorders. *American Journal of Psychiatry*, *173*(11), 1119–1130. https://doi.org/10.1176/appi.ajp.2016.15081089

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: American Psychiatric Association.

Anderson, S. W., Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (2013). Impairment of social and moral behavior related to early damage in human prefrontal cortek. In G. G. Berntson, & J. T. Cacioppo (Eds.), *Social neuroscience key readings* (1st ed., pp. 29–39). New York: Psychology Press.

Baggetta, P., & Alexander, P. A. (2016). Conceptualization and operationalization of executive function. *Mind, Brain, and Education*, *10*(1), 10–33. https://doi.org/10.1111/mbe.12100

*Bagshaw, R., Gray, N. S., & Snowden, R. J. (2014). Executive function in psychopathy: The tower of London, Brixton spatial anticipation and the Hayling sentence completion tests. *Psychiatry Research*, *220*(1–2), 483–489. https://doi.org/10.1016/j.psychres.2014.07.031

*Baliousis, M., Duggan, C., McCarthy, L., Huband, N., & Völlm, B. (2019). Executive function, attention, and memory deficits in antisocial personality disorder and psychopathy. *Psychiatry Research*, *278*, 151–161. https://doi.org/10.1016/j.psychres.2019.05.046

*Bare, R. L. (2005). *Psychopathic traits in college students: Electrodermal reactivity, anxiety, disinhibition, risk-taking, and executive functioning* [Doctoral dissertation]. University of Tennessee, Knoxville. https://trace.tennessee.edu/utk_graddiss/657

Barrash, J., Tranel, D., & Anderson, S. W. (2000). Acquired personality disturbances associated with bilateral damage to the ventromedial prefrontal region. *Developmental Neuropsychology*, *18*(3), 355–381. https://doi.org/10.1207/S1532694205Barrash

*Baskin-Sommers, A. R., Brazil, I. A., Ryan, J., Kohlenberg, N. J., Neumann, C. S., & Newman, J. P. (2015). Mapping the association of global executive functioning onto diverse measures of psychopathic traits. *Personality Disorders: Theory, Research, and Treatment*, *6*(4), 336–346. https://doi.org/10.1037/per0000125

Beryl, R., Chou, S., & Völlm, B. (2014). A systematic review of psychopathy in women within secure settings. *Personality and Individual Differences*, *71*, 185–195. https://doi.org/10/f6ktmf

*Blair, K. S., Newman, C., Mitchell, D. G. V., Richell, R. A., Leonard, A., Morton, J., & Blair, R. J. R. (2006). Differentiating among prefrontal substrates in psychopathy: Neuropsychological test findings. *Neuropsychology*, *20*(2), 153–165. https://doi.org/10.1037/0894-4105.20.2.153

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to meta-analysis*. Chichester, UK: John Wiley & Sons, Ltd. https://doi.org/10.1002/9780470743386

Bronchain, J., Raynal, P., & Chabrol, H. (2020). Heterogeneity of adaptive features among psychopathy variants. *Personality Disorders: Theory, Research, and Treatment*, *11*(1), 63–68. https://doi.org/10.1037/per0000366

Burghart, M., de Ruiter, C., Hynes, S. E., Krishnan, N., Levtova, Y., & Uyar, A. (2023). The structured assessment of protective factors for violence risk (SAPROF): A meta-analysis of its predictive and incremental validity. *Psychological Assessment*, *35*(1), 56–67. https://doi.org/10.1037/pas0001184

Burghart, M., & Mier, D. (2022). No feelings for me, no feelings for you: A meta-analysis on alexithymia and empathy in psychopathy. *Personality and Individual Differences*, *194*, 111658. https://doi.org/10.1016/j.paid.2022.111658

Burghart, M., Sahm, A. H. J., Schmidt, S., Bulla, J., & Mier, D. (2024). Understanding empathy deficits and emotion dysregulation in psychopathy: The mediating role of alexithymia. *PLoS ONE*, *19*(5), e0301085. https://doi.org/10.1371/journal.pone.0301085

Cheung, M. W.-L. (2014). Modeling dependent effect sizes with three-level meta-analyses: A structural equation modeling approach. *Psychological Methods*, *19*(2), 211–229. https://doi.org/10/gcz6v4

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Erlbaum.

Craig, M. C., Catani, M., Deeley, Q., Latham, R., Daly, E., Kanaan, R., … Murphy, D. G. M. (2009). Altered connections on the road to psychopathy. *Molecular Psychiatry*, *14*(10), 946–953. https://doi.org/10.1038/mp.2009.40

De Brito, S. A., Forth, A. E., Baskin-Sommers, A., Brazil, I. A., Kimonis, E. R., Pardini, D., … Viding, E. (2021). Psychopathy. *Nature Reviews Disease Primers*, *7*(1), 1–21. https://doi.org/10/gk49ff

*De Brito, S. A., Viding, E., Kumari, V., Blackwood, N., & Hodgins, S. (2013). Cool and hot executive function impairments in violent offenders with antisocial personality disorder with and without psychopathy. *PLoS ONE*, *8*(6), e65566. https://doi.org/10.1371/journal.pone.0065566

*Delfin, C., Andiné, P., Hofvander, B., Billstedt, E., & Wallinius, M. (2018). Examining associations between psychopathic traits and executive functions in incarcerated violent offenders. *Frontiers in Psychiatry*, *9*, 310. https://doi.org/10.3389/fpsyt.2018.00310

Deming, P., & Koenigs, M. (2020). Functional neural correlates of psychopathy: A meta-analysis of MRI data. *Translational Psychiatry*, *10*(1), 133. https://doi.org/10.1038/s41398-020-0816-8

de Ruiter, C., Burghart, M., De Silva, R., Griesbeck Garcia, S., Mian, U., Walshe, E., & Zouharova, V. (2022). A meta-analysis of childhood maltreatment in relation to psychopathic traits. *PLOS ONE*, *17*(8), e0272704. https://doi.org/10.1371/journal.pone.0272704

Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, *64*(1), 135–168. https://doi.org/10.1146/annurev-psych-113011-143750

*Dinn, W. M., & Harris, C. L. (2000). Neurocognitive function in antisocial personality disorder. *Psychiatry Research*, *97*(2–3), 173–190. https://doi.org/10.1016/S0165-1781(00)00224-9

*Dolan, M. (2012). The neuropsychology of prefrontal function in antisocial personality disordered offenders with varying degrees of psychopathy. *Psychological Medicine*, *42*(8), 1715–1725. https://doi.org/10.1017/S0033291711002686

*Ducro, C., Vicenzutto, A., Suinen, P., & Pham, T. (2014). Relationship between neuropsychological characteristics of attention, planning, impulsivity and decision making in female psychopathic forensic patients. *Acta Psychiatrica Belgica*, *114*(4), 33–40.

Dugré, J. R., Radua, J., Carignan-Allard, M., Dumais, A., Rubia, K., & Potvin, S. (2020). Neurofunctional abnormalities in antisocial spectrum: A meta-analysis of fMRI studies on five distinct neurocognitive research domains. *Neuroscience & Biobehavioral Reviews*, *119*, 168–183. https://doi.org/10.1016/j.neubiorev.2020.09.013

*Dvorak-Bertsch, J. D., Sadeh, N., Glass, S. J., Thornton, D., & Newman, J. P. (2007). Stroop tasks associated with differential activation of anterior cingulate do not differentiate psychopathic and non-psychopathic offenders. *Personality and Individual Differences*, *42*(3), 585–595. https://doi.org/10.1016/j.paid.2006.07.023

Eslinger, P. J., Flaherty-Craig, C. V., & Benton, A. L. (2004). Developmental outcomes after early prefrontal cortex damage. *Brain and Cognition*, *55*(1), 84–103. https://doi.org/10.1016/S0278-2626(03)00281-1

Frazier, A., Ferreira, P. A., & Gonzales, J. E. (2019). Born this way? A review of neurobiological and environmental evidence for the etiology of psychopathy. *Personality Neuroscience*, *2*, e8. https://doi.org/10/gjtsd6

Friedman, N. P., & Miyake, A. (2017). Unity and diversity of executive functions: Individual differences as a window on cognitive structure. *Cortex*, *86*, 186–204. https://doi.org/10.1016/j.cortex.2016.04.023

*Friedman, N. P., Rhee, S. H., Ross, J. M., Corley, R. P., & Hewitt, J. K. (2021). Genetic and environmental relations of executive functions to antisocial personality disorder symptoms and psychopathy. *International Journal of Psychophysiology*, *163*, 67–78. https://doi.org/10.1016/j.ijpsycho.2018.12.007

Gillespie, S. M., Jones, A., & Garofalo, C. (2023). Psychopathy and dangerousness: An umbrella review and meta-analysis. *Clinical Psychology Review*, *100*, 102240. https://doi.org/10.1016/j.cpr.2022.102240

Gillespie, S. M., Lee, J., Williams, R., & Jones, A. (2022). Psychopathy and response inhibition: A meta-analysis of go/no-go and stop signal task performance. *Neuroscience & Biobehavioral Reviews*, *142*, 104868. https://doi.org/10.1016/j.neubiorev.2022.104868

*Goodwin, B. E. (2014). *A nomological network of psychopathy: Elaborating on the construct validity of the triarchic model* [Doctoral dissertation]. The University of Alabama, Tuscaloosa, AL.

Guay, J.-P., Knight, R. A., Ruscio, J., & Hare, R. D. (2018). A taxometric investigation of psychopathy in women. *Psychiatry Research*, *261*, 565–573. https://doi.org/10/gc7cjk

*Hare, R. D. (1984). Performance of psychopaths on cognitive tasks related to frontal lobe function. *Journal of Abnormal Psychology*, *93*(2), 133–140. https://doi.org/10.1037/0021-843X.93.2.133

Hare, R. D. (2003). *Hare psychopathy checklist-revised: PCL-R* (2nd ed.). Toronto: Multi-Health Systems.

Hare, R. D. (2020). The PCL-R assessment of psychopathy. In A. R. Felthous, & H. Saß (Eds.), *The Wiley international handbook on psychopathic disorders and the law* (1st ed., pp. 63–106). Hoboken, NJ: Wiley. https://doi.org/10.1002/9781119159322.ch4

Hare, R. D., & Neumann, C. S. (2008). Psychopathy as a clinical and empirical construct. *Annual Review of Clinical Psychology*, *4*(1), 217–246. https://doi.org/10.1146/annurev.clinpsy.3.022806.091452

*Hart, S. D., Forth, A. E., & Hare, R. D. (1990). Performance of criminal psychopaths on selected neuropsychological tests. *Journal of Abnormal Psychology*, *99*(4), 374–379. https://doi.org/10.1037/0021-843X.99.4.374

*Hiatt, K. D., Schmitt, W. A., & Newman, J. P. (2004). Stroop tasks reveal abnormal selective attention among psychopathic offenders. *Neuropsychology*, *18*(1), 50–59. https://doi.org/10.1037/0894-4105.18.1.50

Hildebrand, M., & de Ruiter, C. (2004). PCL-R psychopathy and its relation to DSM-IV Axis I and II disorders in a sample of male forensic psychiatric patients in the Netherlands. *International Journal of Law and Psychiatry*, *27*(3), 233–248. https://doi.org/10.1016/j.ijlp.2004.03.005

*Ishikawa, S. S., Raine, A., Lencz, T., Bihrle, S., & Lacasse, L. (2001). Autonomic stress reactivity and executive functions in successful and unsuccessful criminal psychopaths from the community. *Journal of Abnormal Psychology*, *110*(3), 423–432. https://doi.org/10.1037//0021-843X.I10.3.423

Jansen, J. M., & Franse, M. E. (2024). Executive functioning in antisocial behavior: A multi-level systematic meta-analysis. *Clinical Psychology Review*, *109*, 102408. https://doi.org/10.1016/j.cpr.2024.102408

Jurado, M. B., & Rosselli, M. (2007). The elusive nature of executive functions: A review of our current understanding. *Neuropsychology Review*, *17*(3), 213–233. https://doi.org/10.1007/s11065-007-9040-z

*Kalinian, H., & Wisniewski, A. W. (2006). Abnormal findings revealed in female criminal psychopaths using the sorting test. *Journal of Forensic Neuropsychology*, *4*(4), 33–48. https://doi.org/10.1300/J151v04n04_03

Karr, J. E., Areshenkoff, C. N., Rast, P., Hofer, S. M., Iverson, G. L., & Garcia-Barrera, M. A. (2018). The unity and diversity of executive functions: A systematic review and re-analysis of latent variable studies. *Psychological Bulletin*, *144*(11), 1147–1185. https://doi.org/10.1037/bul0000160

*Kiehl, K. A., Smith, A. M., Hare, R. D., & Liddle, P. F. (2000). An event-related potential investigation of response inhibition in schizophrenia and psychopathy. *Biological Psychiatry*, *48*(3), 210–221. https://doi.org/10.1016/S0006-3223(00)00834-9

*Kim, Y. Y., & Jung, Y. S. (2014). Reduced frontal activity during response inhibition in individuals with psychopathic traits: An sLORETA study. *Biological Psychology*, *97*, 49–59. https://doi.org/10.1016/j.biopsycho.2014.02.004

*Krakowski, M. I., Foxe, J., de Sanctis, P., Nolan, K., Hoptman, M. J., Shope, C., … Czobor, P. (2015). Aberrant response inhibition and task switching in psychopathic individuals. *Psychiatry Research*, *229*(3), 1017–1023. https://doi.org/10.1016/j.psychres.2015.06.018

Kramer, J. H., & Stephens, M. L. (2014). Executive function. In M. J. Aminoff, & R. B. Daroff (Eds.), *Encyclopedia of the neurological sciences* (2nd ed., pp. 236–238). London, UK: Elsevier. https://doi.org/10.1016/B978-0-12-385157-4.00451-6

*Lantrip, C., Towns, S., Roth, R. M., & Giancola, P. R. (2016). Psychopathy traits are associated with self-report rating of executive functions in the everyday life of healthy adults. *Personality and Individual Differences*, *101*, 127–131. https://doi.org/10.1016/j.paid.2016.05.051

*Lapierre, D., Braun, C. M. J., & Hodgins, S. (1995). Ventral frontal deficits in psychopathy: Neuropsychological test findings. *Neuropsychologia*, *33*(2), 139–151. https://doi.org/10.1016/0028-3932(94)00110-B

Levenson, M. R., Kiehl, K. A., & Fitzpatrick, C. M. (1995). Assessing psychopathic attributes in a noninstitutionalized population. *Journal of Personality and Social Psychology*, *68*(1), 151–158. https://doi.org/10/b4957p

Lilienfeld, S. O., & Widows, M. (2005). *Professional manual for the psychopathic personality inventory-revised* (*PPI-R*). Lutz, FL: Psychological Assessment Resources.

Maes, J. H. R., & Brazil, I. A. (2013). No clear evidence for a positive association between the interpersonal-affective aspects of psychopathy and executive functioning. *Psychiatry Research*, *210*(3), 1265–1274. https://doi.org/10.1016/j.psychres.2013.09.028

*Mahmut, M. K., Homewood, J., & Stevenson, R. J. (2008). The characteristics of non-criminals with high psychopathy traits: Are they similar to criminal psychopaths? *Journal of Research in Personality*, *42*(3), 679–692. https://doi.org/10.1016/j.jrp.2007.09.002

*Malesza, M., & Ostaszewski, P. (2016). Dark side of impulsivity – associations between the Dark Triad, self-report and behavioral measures of impulsivity. *Personality and Individual Differences*, *88*, 197–201. https://doi.org/10.1016/j.paid.2015.09.016

Mariz, C., Cruz, O. S., & Moreira, D. (2022). The influence of environmental and genetic factors on the development of psychopathy: A systematic review. *Aggression and Violent Behavior*, *62*, 101715. https://doi.org/10/gnm7bn

Maurer, J. M., Paul, S., Anderson, N. E., Nyalakanti, P. K., & Kiehl, K. A. (2020). Youth with elevated psychopathic traits exhibit structural integrity deficits in the uncinate fasciculus. *NeuroImage: Clinical*, *26*, 102236. https://doi.org/10.1016/j.nicl.2020.102236

*Maurer, J. M., Steele, V. R., Edwards, B. G., Bernat, E. M., Calhoun, V. D., & Kiehl, K. A. (2016). Dysfunctional error-related processing in female psychopathy. *Social Cognitive and Affective Neuroscience*, *11*(7), 1059–1068. https://doi.org/10.1093/scan/nsv070

*Michałowski, J. M., Droździel, D., & Harciarek, M. (2015). Impulsive antisociality and executive control problems: Evidence from go/no-go and stop-signal tasks. *Current Issues in Personality Psychology*, *3*(1), 36–41. https://doi.org/10.5114/cipp.2015.49939

*Mitchell, D. G. V., Colledge, E., Leonard, A., & Blair, R. J. R. (2002). Risky decisions and response reversal: Is there evidence of orbitofrontal cortex dysfunction in psychopathic individuals? *Neuropsychologia*, *40*(12), 2013–2022. https://doi.org/10.1016/S0028-3932(02)00056-8

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex 'frontal lobe' tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49–100. https://doi.org/10.1006/cogp.1999.0734

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., … Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences*, *108*(7), 2693–2698. https://doi.org/10.1073/pnas.1010076108

*Mol, B., Van Den Bos, P., Derks, Y., & Egger, J. (2009). Executive functioning and the two-factor model of psychopathy: No differential relation? *International Journal of Neuroscience*, *119*(1), 124–140. https://doi.org/10.1080/00207450802324861

https://doi.org/10.1017/S0033291724001259 Published online by Cambridge University Press

*Monaghan, K. (2020). *Emotion experience to expression: Influence of psychopathy, expression suppression, and working memory* [Undergraduate thesis]. University of Central Florida, Florida, USA. https://stars.library.ucf.edu/honorstheses/844

Morgan, A. B., & Lilienfeld, S. O. (2000). A meta-analytic review of the relation between antisocial behavior and neuropsychological measures of executive function. *Clinical Psychology Review*, *20*(1), 113–136. https://doi.org/10.1016/S0272-7358(98)00096-8

*Morgan, J. E., Gray, N. S., & Snowden, R. J. (2011). The relationship between psychopathy and impulsivity: A multi-impulsivity measurement approach. *Personality and Individual Differences*, *51*(4), 429–434. https://doi.org/10.1016/j.paid.2011.03.043

Nakagawa, S., Lagisz, M., Jennions, M. D., Koricheva, J., Noble, D. W. A., Parker, T. H., … O'Dea, R. E. (2022). Methods for testing publication bias in ecological and evolutionary meta-analyses. *Methods in Ecology and Evolution*, *13*(1), 4–21. https://doi.org/10.1111/2041-210X.13724

Niendam, T. A., Laird, A. R., Ray, K. L., Dean, Y. M., Glahn, D. C., & Carter, C. S. (2012). Meta-analytic evidence for a superordinate cognitive control network subserving diverse executive functions. *Cognitive, Affective, & Behavioral Neuroscience*, *12*(2), 241–268. https://doi.org/10.3758/s13415-011-0083-5

Nummenmaa, L., Lukkarinen, L., Sun, L., Putkinen, V., Seppälä, K., Karjalainen, T., … Tiihonen, J. (2021). Brain basis of psychopathy in criminal offenders and general population. *Cerebral Cortex*, *31*(9), 4104–4114. https://doi.org/10.1093/cercor/bhab072

*O'Connell, D. C. (2019). *The association between psychopathic personality traits and executive functions* [Doctoral dissertation]. Washington State University, Washington, USA.

Ogilvie, J. M., Stewart, A. L., Chan, R. C. K., & Shum, D. H. K. (2011). Neuropsychological measures of executive function and antisocial behavior: A meta-analysis. *Criminology*, *49*(4), 1063–1107. https://doi.org/10.1111/j.1745-9125.2011.00252.x

Ogloff, J. R. P., Campbell, R. E., & Shepherd, S. M. (2016). Disentangling psychopathy from antisocial personality disorder: An Australian analysis. *Journal of Forensic Psychology Practice*, *16*(3), 198–215. https://doi.org/10.1080/15228932.2016.1177281

Olkin, I., Dahabreh, I. J., & Trikalinos, T. A. (2012). GOSH – a graphical display of study heterogeneity. *Research Synthesis Methods*, *3*(3), 214–223. https://doi.org/10/ggwk9v

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *Systematic Reviews*, *10*(1), 89. https://doi.org/10.1186/s13643-021-01626-4

*Pasion, R., Cruz, A. R., & Barbosa, F. (2018). Dissociable effects of psychopathic traits on executive functioning: Insights from the triarchic model. *Frontiers in Psychology*, *9*, 1713. https://doi.org/10.3389/fpsyg.2018.01713

Patrick, C. J., & Drislane, L. E. (2015). Triarchic model of psychopathy: Origins, operationalizations, and observed linkages with personality and general psychopathology. *Journal of Personality*, *83*(6), 627–643. https://doi.org/10/dvxf

Patrick, C. J., Fowles, D. C., & Krueger, R. F. (2009). Triarchic conceptualization of psychopathy: Developmental origins of disinhibition, boldness, and meanness. *Development and Psychopathology*, *21*(3), 913–938. https://doi.org/10/d43r7p

Paulhus, D. L., Neumann, C. S., & Hare, R. D. (2017). *SRP-4: Self-report psychopathy scale* (4th ed.). Toronto: Multi-Health Systems.

*Pauli, M., Liljeberg, J., Gustavsson, P., Kristiansson, M., & Howner, K. (2019). Assessing the relevance of self-reported ADHD symptoms and cognitive functioning for psychopathy using the PCL-R and the TriPM. *The Journal of Forensic Psychiatry & Psychology*, *30*(4), 642–657. https://doi.org/10.1080/14789949.2018.1560489

Pennington, B. F., & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry*, *37*(1), 51–87. https://doi.org/10.1111/j.1469-7610.1996.tb01380.x

*Pera-Guardiola, V., Batalla, I., Bosque, J., Kosson, D., Pifarré, J., Hernández-Ribas, R., … Cardoner, N. (2016). Modulatory effects of psychopathy on Wisconsin Card Sorting Test performance in male offenders with Antisocial Personality Disorder. *Psychiatry Research*, *235*, 43–48. https://doi.org/10.1016/j.psychres.2015.12.003

*Pham, T. H., Vanderstukken, O., Philippot, P., & Vanderlinden, M. (2003). Selective attention and executive functions deficits among criminal psychopaths. *Aggressive Behavior*, *29*(5), 393–405. https://doi.org/10.1002/ab.10051

Poeppl, T. B., Donges, M. R., Mokros, A., Rupprecht, R., Fox, P. T., Laird, A. R., … Eickhoff, S. B. (2019). A view behind the mask of sanity: Meta-analysis of aberrant brain activity in psychopaths. *Molecular Psychiatry*, *24*(3), 463–470. https://doi.org/10.1038/s41380-018-0122-5

*Ribes-Guardiola, P., Poy, R., Patrick, C. J., & Moltó, J. (2020). Electrocortical measures of performance monitoring from go/no-go and flanker tasks: Differential relations with trait dimensions of the triarchic model of psychopathy. *Psychophysiology*, *57*(6), e13573. https://doi.org/10.1111/psyp.13573

Rodgers, M. A., & Pustejovsky, J. E. (2021). Evaluating meta-analytic methods to detect selective reporting in the presence of dependent effect sizes. *Psychological Methods*, *26*(2), 141–160. https://doi.org/10.1037/met0000300

*Ross, S. R., Benning, S. D., & Adams, Z. (2007). Symptoms of executive dysfunction are endemic to secondary psychopathy: An examination in criminal offenders and noninstitutionalized young adults. *Journal of Personality Disorders*, *21*(4), 384–399. https://doi.org/10.1521/pedi.2007.21.4.384

Salehinejad, M. A., Ghanavati, E., Rashid, M. H. A., & Nitsche, M. A. (2021). Hot and cold executive functions in the brain: A prefrontal-cingular network. *Brain and Neuroscience Advances*, *5*, 1–19. https://doi.org/10.1177/23982128211007769

Segarra, P., Poy, R., Branchadell, V., Ribes-Guardiola, P., & Moltó, J. (2022). Psychopathy and heart rate variability: A new physiological marker for the adaptive features of boldness. *Personality Disorders: Theory, Research, and Treatment*, *13*(5), 557–562. https://doi.org/10.1037/per0000573

*Sellbom, M., Anderson, J. L., Goodwin, B. E., Kastner, R. M., Rock, R. C., Johnson, A. K., … Salekin, R. T. (2022). Evaluation of the moderated-expression and differential configuration hypotheses in the context of 'successful' or 'noncriminal' psychopathy. *Personality Disorders: Theory, Research, and Treatment*, *13*(5), 542–556. https://doi.org/10.1037/per0000498

Sellbom, M., Lilienfeld, S. O., Fowler, K. A., & McCary, K. L. (2018). The self-report assessment of psychopathy: Challenges, pitfalls, and promises. In C. J. Patrick (Ed.), *Handbook of psychopathy* (2nd ed., pp. 211–258). New York: The Guilford Press.

*Sellbom, M., & Verona, E. (2007). Neuropsychological correlates of psychopathic traits in a non-incarcerated sample. *Journal of Research in Personality*, *41*(2), 276–294. https://doi.org/10.1016/j.jrp.2006.04.001

*Smith, A. M. (1999). *An fMRI investigation of frontal lobe functioning in psychopathy and schizophrenia during a Go/No-Go Task* [Doctoral dissertation]. The University of British Columbia, Vancouver, Canada.

*Smith, S. S., Arnett, P. A., & Newman, J. P. (1992). Neuropsychological differentiation of psychopathic and nonpsychopathic criminal offenders. *Personality and Individual Differences*, *13*(11), 1233–1243. https://doi.org/10.1016/0191-8869(92)90259-R

*Snowden, R. J., Gray, N. S., Pugh, S., & Atkinson, G. (2013). Executive function as a function of sub-clinical psychopathy. *Personality and Individual Differences*, *55*(7), 801–804. https://doi.org/10.1016/j.paid.2013.06.016

Snyder, H. R., Miyake, A., & Hankin, B. L. (2015). Advancing understanding of executive function impairments and psychopathology: Bridging the gap between clinical and cognitive approaches. *Frontiers in Psychology*, *6*, 328. https://doi.org/10.3389/fpsyg.2015.00328

Stamenova, V., & Levine, B. (2019). Effectiveness of goal management training® in improving executive functions: A meta-analysis. *Neuropsychological Rehabilitation*, *29*(10), 1569–1599. https://doi.org/10.1080/09602011.2018.1438294

*Steele, V. R., Maurer, J. M., Bernat, E. M., Calhoun, V. D., & Kiehl, K. A. (2016). Error-related processing in adult males with elevated psychopathic traits. *Personality Disorders: Theory, Research, and Treatment*, *7*(1), 80–90. https://doi.org/10.1037/per0000143

*Suchy, Y., & Kosson, D. S. (2006). Forming, switching, and maintaining mental sets among psychopathic offenders during verbal and nonverbal tasks: Another look at the left-hemisphere activation hypothesis. *Journal of the International Neuropsychological Society*, *12*(4), 538–548. https://doi.org/10.1017/S135561770606070X

https://doi.org/10.1017/S0033291724001259 Published online by Cambridge University Press

Thornton, A. (2000). Publication bias in meta-analysis its causes and consequences. *Journal of Clinical Epidemiology*, *53*(2), 207–216. https://doi.org/10.1016/S0895-4356(99)00161-4

*Tonnaer, F., Cima, M., & Arntz, A. (2016). Modeling impulsivity in forensic patients: A three-dimensional model of impulsivity. *The American Journal of Psychology*, *129*(4), 429–441. https://doi.org/10.5406/amerjpsyc.129.4.0429

*Varlamov, A., Khalifa, N., Liddle, P., Duggan, C., & Howard, R. (2011). Cortical correlates of impaired self-regulation in personality disordered patients with traits of psychopathy. *Journal of Personality Disorders*, *25*(1), 75–88. https://doi.org/10.1521/pedi.2011.25.1.75

Venables, N. C., Hall, J. R., & Patrick, C. J. (2014). Differentiating psychopathy from antisocial personality disorder: A triarchic model perspective. *Psychological Medicine*, *44*(5), 1005–1013. https://doi.org/10/f53zdv

Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software*, *36*(3), 1–48.

Vitacco, M. J., & Kosson, D. S. (2010). Understanding psychopathy through an evaluation of interpersonal behavior: Testing the factor structure of the interpersonal measure of psychopathy in a large sample of jail detainees. *Psychological Assessment*, *22*(3), 638–649. https://doi.org/10.1037/a0019780

Wall, T. D., Wygant, D. B., & Sellbom, M. (2015). Boldness explains a key difference between psychopathy and antisocial personality disorder. *Psychiatry, Psychology and Law*, *22*(1), 94–105. https://doi.org/10/gddc5n

Wolf, R. C., Pujara, M. S., Motzkin, J. C., Newman, J. P., Kiehl, K. A., Decety, J., … Koenigs, M. (2015). Interpersonal traits of psychopathy linked to reduced integrity of the uncinate fasciculus: Neural correlates of psychopathy. *Human Brain Mapping*, *36*(10), 4202–4209. https://doi.org/10.1002/hbm.22911

Wong, T. Y., Sid, A., Wensing, T., Eickhoff, S. B., Habel, U., Gur, R. C., & Nickl-Jockschat, T. (2019). Neural networks of aggression: ALE meta-analyses on trait and elicited aggression. *Brain Structure and Function*, *224*(1), 133–148. https://doi.org/10.1007/s00429-018-1765-3

Yuan, P., & Raz, N. (2014). Prefrontal cortex and executive functions in healthy adults: A meta-analysis of structural neuroimaging studies. *Neuroscience & Biobehavioral Reviews*, *42*, 180–192. https://doi.org/10.1016/j.neubiorev.2014.02.005

*Zeier, J. D., Baskin-Sommers, A. R., Hiatt Racer, K. D., & Newman, J. P. (2012). Cognitive control deficits associated with antisocial personality disorder and psychopathy. *Personality Disorders: Theory, Research, and Treatment*, *3*(3), 283–293. https://doi.org/10.1037/a0023137

*Zeier, J. D., & Newman, J. P. (2013). Both self-report and interview-based measures of psychopathy predict attention abnormalities in criminal offenders. *Assessment*, *20*(5), 610–619. https://doi.org/10.1177/1073191111415364

*Zimak, E. H., Suhr, J., & Bolinger, E. M. (2014). Psychophysiological and neuropsychological characteristics of non-incarcerated adult males with higher levels of psychopathic personality traits. *Journal of Psychopathology and Behavioral Assessment*, *36*(4), 542–554. https://doi.org/10.1007/s10862-014-9430-5

https://doi.org/10.1017/S0033291724001259 Published online by Cambridge University Press