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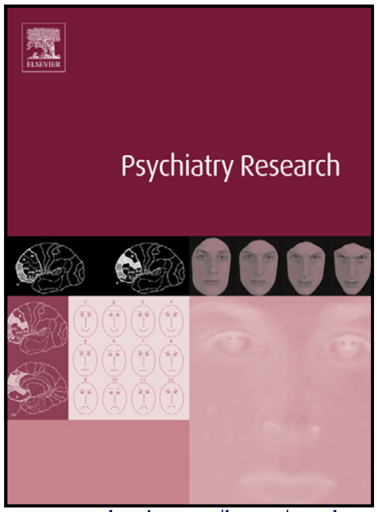

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No clear evidence for a positive association between the interpersonal-affective aspects of psychopathy and executive functioning

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Abstract

Common psychopathy rating instruments distinguish between an interpersonal-affective and an antisocial dimension. The suggestion that the interpersonal-affective dimension, often considered to be the core feature of psychopathy, is positively associated with executive functioning is occasionally made in the literature, without reporting objective empirical data. The primary aim of the present paper was to search for empirical studies reporting relevant data, focussing on four aspects of ‘cold’ executive functioning: inhibition, attentional shifting, working memory, and planning. Eleven published articles were identified, reporting data of 721 individuals from incarcerated and non-incarcerated, male and female, and adult and non-adult samples. Using a heterogeneous set of tests and dependent measures across studies, the inhibition and attentional shifting components were assessed in eight and five studies, respectively; the working memory and planning components each in two studies. A small majority of the studies found positive associations with the different executive functions, although the associations were mostly non-significant. Given the scarcity of studies and the use of heterogeneous populations, tests and statistical analyses, no robust conclusions can be drawn at this stage. Therefore, caution is needed when claiming a positive association between the interpersonal-affective features of psychopathy and executive functioning. Clearly more research is needed to further validate and specify the suggested association.

Keywords: psychopathy; interpersonal-affective dimension; inhibition; shifting; working memory; planning

1. Introduction

1.1. Psychopathy and underlying dimensions

Psychopathy is a disorder that is suggested to be characterized by a wide variety of symptoms, such as a lack of empathy and fear, coldheartedness, manipulativeness, impulsivity, and antisocial behaviors, including criminal behavior (Skeem et al., 2011). However, there is still much debate as to which specific symptoms or trait dimensions are key to the psychopathic personality and which of the various extant rating instruments is most useful in predicting crucial outcomes, such as externalizing behaviors in general and criminal behavior in particular (e.g., Skeem et al., 2011).

The most widely used clinical psychopathy rating instrument is the Psychopathy Checklist Revised (PCL-R; Hare, 2003). This instrument consists of an archival analysis supplemented with a 20-item interview protocol, specifically designed for incarcerated criminal samples. The PCL-R contains two distinctive item subsets or moderately correlated factors, with each factor being subdivided into 2 ‘facets’ (Hare, 2003; but see Cook and Michie, 2001). Specifically, Factor 1 is termed the interpersonal-affective scale, containing an interpersonal facet (Facet 1) and an affective facet (Facet 2). Facet 1 involves items related to glibness, grandiose sense of self-worth, pathological lying, and manipulative behavior; Facet 2 contains items reflecting a lack of remorse and guilt, shallow affect, callousness and lack of empathy, and lack of taking responsibility for own actions. Factor 2 is termed the antisocial scale and consists of a lifestyle facet (Facet 3) and an antisocial facet (Facet 4). Facet 3 is related to a need for stimulation, parasitic lifestyle, lack of realistic long-term goals, impulsivity, and irresponsibility.

Facet 4 refers to poor behavioral control, early behavioral problems, juvenile delinquency, revocation of conditional release, and criminal versatility. Two other versions of the PCL have been developed: a brief version, the PCL: SV (screening version; Hart et al., 1995) and a Youth Version (PCL:YV; Forth, Kosson and Hare, 2003). Next to the PCL, there are a number of other psychopathy scales that are based on self-reports, for use with criminal and non-criminal samples. Examples are the Levenson Self-Report Psychopathy (LSRP) Scales (Levenson et al., 1995), the Psychopathy Personality Inventory (PPI; Lilienfeld and Andrews, 1996), or its revised version (PPI-R; Lilienfeld and Widows, 2005), the Antisocial Process Screening Device (APSD, Frick and Hare, 2001), and the Self-Report Psychopathy Scale-Version III (SRP-III; Williams et al., 2007). Each of these instruments also includes a factor denoting disturbed interpersonal-affective processing and a second one describing antisocial behavioral tendencies, although the exact content of these factors and their external correlates may differ for the different instruments (e.g., see Miller and Lynam, 2012, for an evaluation of the PPI Factor 1). Moreover, in each instrument each factor consists of a number of facets or subscales that are similar to the PCL-R facets (e.g., see Walters et al., 2008, for the four facets resulting from a principal components analysis of the LSRP). In the remainder of this paper, we will use the term 'Factor 1' in a general way to refer to items related to the fearless-dominance/interpersonal-affective factors. Facet 1 is used to refer to the interpersonal aspect of Factor 1; Facet 2 to signify the affective component of this factor. Factor 2 denotes items associated with the impulsive-antisocial behavioral tendencies. One key difference between the factors is that Factor 1 is generally believed to represent a constellation of features relatively unique to psychopathy, while Factor 2 is related to more general antisocial behavior that is not unique to psychopathy (e.g., Hare et al., 1991). In this light, the commonalities and differences between psychopathy and generic antisociality have recently been receiving an increasing amount of attention (Gao and Raine, 2009; Verona et al., 2012; Brazil et al., 2012). Moreover, the distinction between Factors 1 and 2 is also highly relevant in the context of theories describing different etiological pathways to psychopathy, in which one factor is linked to reduced reactivity to negative affect (Factor 1) and the other to poor emotional and behavioral control (Factor 2; e.g., Fowles & Dindo, 2009).

1.2. Psychopathy and executive functioning

Another topic that is becoming increasingly visible in the literature is the link between psychopathy and cognitive functioning. While some researchers have linked psychopathy to specific cognitive dysfunctions, such as attentional processing (e.g., Baskin-Sommers et al., 2012) and reversal learning (e.g., Budhani et al., 2006; Brazil et al., 2013), in recent years there has been a growing interest in a broader range of cognitive functions, often denoted with the umbrella-term ‘executive functioning’ (EF) (see De Brito & Hodgins, 2009, for an overview). Executive functions refer to a set of higher order cognitive processes that allow an individual to exert control over lower cognitive processes, possibly through a biasing mechanism in the prefrontal brain regions (Alvarez and Emory, 2006; Miller and Cohen, 2001). A large number of processes have been suggested to be part of this set which enable behavioral adaptation to changing environmental demands and the display of goal-directed behavior.

From the many definitions and suggested components of executive functions (see Jurado and Rosselli, 2007, for an overview), we largely adopt the framework proposed by Miyake et al. (2000) in the present paper. Briefly, based on a latent-variable analyses, Miyake et al. suggested that most EF tests call upon three basic functions: 1) inhibition of pre-potent or automatic responses, 2) information monitoring and updating in working memory, and/or 3) mental set shifting. Although extant EF tests almost by definition incorporate many different lower-level processes, which are controlled by the executive function(s), in our review we focused on tests that are relatively ‘pure’ with respect to the specific executive function involved. With regard to the basic functions proposed by Miyake et al., the go/no-go and Stroop interference tasks are examples of prototypical tests that yield relatively unmixed measures of inhibition (see Lezak, 2004, for a description of these tests, and the other neuropsychological tests mentioned hereafter). The n-back or reversed digit span tasks are relatively pure tests that can be mapped on to the working memory aspect, and the Trail-Making-Part B (TMT- B) test and attentional set-shifting tests (e.g., the Wisconsin Card Sorting Test, WCST; see Eling et al., 2008) are frequently used to examine the shifting component. Importantly, if an EF test was used that potentially involves more than one EF aspect, like the WCST, or (verbal) fluency tasks (e.g., the Controlled Oral Association Task, COWAT), both of which also demand working memory and inhibition capacities next to shifting abilities, we focused on dependent measures from these tasks that are generally believed to primarily tap one specific executive function. For example, the number of perseveration errors from the WCST was used as a measure of shifting capacity, whereas the number of rule breaks in fluency tasks was used as a measure of response inhibition. The EF literature also frequently uses tasks presumed to tap ‘planning’, the ability to identify and organize the steps needed to achieve a goal (Lezak, 2004), as a fourth type of executive function. Although the planning concept is less circumscribed than is the case for each the other three EF aspects, we also included articles using prototypical planning tests, such as the Tower of London and the mazes test from the Wechsler Intelligence Test for Children (WISC).

The foregoing implicates that we excluded studies employing tasks that clearly involve a learning component, such as passive-avoidance (e.g., Newman and Schmitt, 1998) or reversal learning (e.g., Budhani et al., 2006) tasks. Next to executive capacities, performance on these tasks clearly depends on other, non-executive, processes, such as those related to feedback processing and reward/punishment sensitivity. Our selection of EF tasks partly parallels the distinction between so-called hot and cool EFs (e.g., Zelazo and Cunningham, 2007). Cool EF tasks are relatively abstract tasks without motivational or emotional relevance, largely mediated by lateral inferior and dorsolateral frontostriatal and frontoparietal networks (e.g., Christakou et al., 2009). Instead, hot EF tasks are motivationally or emotionally salient and mediated by orbitomedial and ventromedial frontolimbic structures (e.g., Northoff et al., 2006). To assess relatively pure (dorsal) frontally-mediated executive functions, in our review we specifically focussed on cold EF tasks, which are assumed to be relatively immune to motivational or affective processes that are subserved by subcortical limbic structures like the amygdala.

The association between psychopathy and EF has most frequently been investigated in samples typified by antisocial behaviors that are primarily captured by the impulsive-antisociality factor. A number of studies consistently found a negative association between antisociality and EF (e.g., see Dolan and Anderson, 2002, Morgan and Lilienfeld, 2000, and Ogilvie et al., 2011, for reviews), indirectly supporting the hypothesis that psychopathy Factor 2 is negatively associated with EF. This hypothesis fits with a recurrent finding in meta-analytic and review studies that, at least in psychopathic participants, this factor appears to be linked to prefrontal abnormalities, specifically the orbitofrontal/ventromedial prefrontal cortex, which, as indicated above, is linked to hot rather than cold EFs (e.g., Anderson and Kiehl, 2012; Gao and Raine, 2009; Yang and Raine, 2009).

Interestingly, the suggestion that Factor 1 is *positively* associated with executive functioning, or that persons with a high Factor 1 score even have above-normal EF capacities is occasionally made in the literature (e.g., Gao and Rain, 2010), but these suggestions are primarily based on results reported by Ishikawa et al. (2001). Note, however, that Gao and Raine (2010) made this suggestion for non-convicted, 'successful' psychopaths, who may be assumed to present relatively few Factor 2 characteristics in combination with strong Factor 1 features. Importantly, only one EF test (the WCST) was used in the study by Ishikawa et al. (2001) and comparisons were made at a group level by contrasting two psychopathy groups scoring high on the PCL-R and a control group scoring low on this measure. The two psychopathy groups were divided into a group of participants with a history of crime conviction ('unsuccessful psychopaths') and a group without such history ('successful psychopaths'). The latter two groups differed on Factor 2 scores, not on Factor 1 scores, with the successful psychopaths having a relatively lower Factor 2 score than the unsuccessful psychopaths. It was observed that the successful psychopaths exhibited better executive functioning than both the unsuccessful and control participants, as indexed by especially fewer non-perseverative errors and more categories achieved in the WCST. At best, these results only provide indirect evidence for a positive association between Factor 1 and EF.

However, there are other considerations that additionally might support the suggestion of a positive association between Factor 1 and EF. For instance, a number of studies report a positive association between Factor 1 and/or specifically Facet 1 on the one hand and general IQ on the other after controlling for the effect of Factor 2 (e.g., Heinzen et al., 2011; Neuman and Hare, 2007; Salekin et al., 2004; Vitacco et al., 2005, 2008), although there are also earlier studies reporting no significant associations (Forth et al., 1990; Harpur et al., 1989). However, evidence suggests that specifically the inhibition and shifting components are not related to intelligence, as measured with standard IQ tests (Friedman et al., 2006), indicating that a positive association between Factor 1 and IQ does not automatically implicate a similar association between Factor 1 and EF. The suggestion of a positive association between EF and Factor 1 may be further supported by the idea that an enhanced capacity to exert social dominance and to manipulate other people for one's own benefit may require intact/enhanced EF capabilities (e.g., Babiak, 2008), and by the finding of a significant positive association between prefrontal white matter volume and the interpersonal facet specifically (although a negative association existed for gray matter volume; Yang et al., 2005). Moreover, at least based on self-reports of attentional capacities, Factor 1 has been found to be positively associated with (judged) selective-attention and attentional shifting abilities (Baskin-Sommers et al., 2009, 2012). Finally, Factor 1 has been associated with impaired processing of emotional stimuli due to deficient amygdala functioning, specifically its basolateral nucleus (e.g., Anderson and Kiehl, 2012; Moul et al., 2012). This may implicate reduced emotional interference during cognitive processing (see also Verona et al, 2012). Combined with the notion of emotional and executive processes competing for shared limited cognitive (e.g., attentional) resources (e.g., Pessoa, 2009), reduced emotional interference may cause a relative increase in the amount of cognitive resources that are available for other concurrent executive processes.

The foregoing considerations implicate that, in assessing the relationship between Factor 1 and EF, it is important to evaluate this relationship for the interpersonal and affective facets separately. Previous results suggest that the interpersonal facet may have the strongest positive association with cold EF, and although it is difficult to predict which specific EF component(s) will show such an association, one could argue that it will particularly concern the planning aspect. More specifically, extant findings suggest that only the interpersonal facet is positively associated with instrumental (or planned/goal-directed) aggression (e.g., Vitacco et al., 2006). However, because ‘planning’ is likely to be related to each of the other EF components (albeit moderately), the question whether the interpersonal facet is also significantly positively related with these other components remains unanswered. Concerning the affective facet, one could speculate that any positive association with EF components, as assessed with EF tasks, is mediated by the limited emotional processing that is covered by this facet. If so, a positive association would not reflect ‘real’ enhanced (prefrontal-mediated) executive functioning but positive effects that are due to decreased general test arousal or anxiety (e.g., see also Carlson et al., 2009). Moreover, this theorizing would not result in a clear prediction as to which specific EF component would most benefit from this facet, perhaps other than the hypothesis that performance on the most difficult or arousing test would be most positively associated with this facet. Alternatively, one could hypothesize a positive association between this facet to be especially present for the inhibition component, particularly inhibition of task-interfering information. For example, it has been suggested that emotional impairments, as may be reflected in the affective facet of Factor 1, is associated with enhanced selective attention for non-emotional, task-relevant aspects (e.g., Hiatt and Newman, 2006).

1.3. Rational and aim

The foregoing supports the suggestion that individuals scoring high on Factor 1- related traits and behaviors may show enhanced performance on EF tasks. However, the studies making this suggestion do not provide direct empirical support, reporting data on the relationship between Factor 1 and/or Facet 1 or 2 scores on the one hand and the performance on relatively process pure and objective EF tests on the other, preferably while controlling for Factor 2 or Facet 3 or 4 scores. The purpose of the present study was to systematically search the literature for empirical data directly indicating a significant positive association with cognitive processes that are regarded as part of EF. Knowing whether or not Factor 1 is positively associated with EF may have theoretical implications. For example, intact, or perhaps even above-normal EF capacities that are mediated by dorsal prefrontal areas may interact with impaired behavioral and emotional control, mediated by ventromedial prefrontal areas, to help producing at least some of the traits that are unique to psychopathy. Accordingly, intact or superior cold EF capacities, in combination with deficits in hot EF and affective processing, may facilitate the development of typical interpersonal symptoms, such as manipulative and conning behavior, glibness, and the display of social dominance, which putatively require cognitive processes that are also involved in executive functioning. Moreover, strong EF capacities may contribute to maintain focus on a primary goal and avoid responding to other cues, resulting in affective deficits (Facet 2) when the stimuli that are kept outside the focus of attention concern emotional stimuli.

As a secondary aim, we also assessed whether studies included in the review indeed support the suggestion that was derived from earlier reviews (Dolan & Anderson, 2002: Morgan & Lilienfeld, 2000; Ogilvie et al., 2011) that Factor 2 is reliably negatively associated with EF as measured by a large variety of (both hot and cold) EF, and if so, for which of the cold EFs this is the case. These reviews were largely based on studies examining antisocial populations, so that the presumed association between psychopathy Factor 2 and EF was not examined directly.

2. Methods

Using the Web of Science, PubMed, and PsycInfo databases, the key word 'psychopathy' was combined with 'executive functioning' or 'cognitive control'. This yielded a total of 285 non-overlapping articles. These articles were subsequently screened using the following inclusion criteria:

1. The article had to be in English and published in a peer-reviewed journal or textbook.
2. The paper had to describe the results of an experimental/empirical study (no reviews, theoretical papers, comments, or abstracts).
3. One of the more-or-less common psychopathy measures had to be used, and data concerning the participants' score on Psychopathy Factor 1 and/or its facets (as described in the introduction), or on scales closely related to this factor or these facets, had to be available. Examples of accepted measures (employed in the included papers) are Factor 1 or Facets 1 and 2 from the PCL-R, Factor 1, or constituent subscales of the PPI(-R), the interpersonal-manipulation and callous-unemotional subscales of the SRP-III, and the callous-unemotional subscale of the APSD (which was considered to represent Facet 2).
4. The study had to include one or more EF test(s). In our review, we focused on four aspects of EF: inhibition, working memory monitoring and updating, mental set shifting, and planning, as described above.
5. The study had to report a correlation analysis or a group comparison, evaluating the relationship between total Factor 1 score or Facets 1 (interpersonal aspect) or 2 (affective aspect) on the one hand, and performance on one or more of the EF tests on the other.

2.1. Included articles

Of the 285 unique articles, 18 were not in the English language and 8 consisted of non-published dissertations (criterion 1). Of the remaining 259 articles, 68 were not empirical papers (criterion 2). Of the remaining 191 papers, 180 did not report results isolating the separate contribution of Factor 1 or Facet 1 and/or 2 scores to task performance (or the article did not include a common measure of psychopathy at all) and/or did not employ an (appropriate) EF test (criteria 3 5). This leaves 11 articles, listed in Table 1, which met all inclusion criteria. For each paper in this table we report the psychopathy measure used, participant characteristics, exclusion criteria, assessed executive function(s), task(s) and dependent measure(s) used to examine this/these function(s), the type of data analysis, the result of the analysis, and the direction of the significant or non-significant effect, indicating whether participants who scored high(er) on Factor 1 or 2, or the facets of these factors, performed better or worse than those with low(er) scores. The analyses involved simple bivariate correlations, partial correlations or hierarchical regression analyses controlling for the effect of the correlation between Factors 1 and 2, or analysis of variance (ANOVA). The results indicate the value of each correlation (r) or F/t-statistic, and its significance. Importantly, we did not use the outcome of the statistical results to perform meta-analyses, because, as will also become clear when discussing the results in more detail below, the studies proved to be far too heterogeneous with respect to participants, EF tests, and statistical analyses, to perform such meta-analyses in a meaningful way. However, in Table 2, we did attempt to provide a summary of the direction and significance of the results in terms of positive or negative associations between each of the two factors and the EF components.

2.2. Participant characteristics

The data from 721 (482 male) participants were used in the included studies. The majority (56.3%; 5 studies) were non-incarcerated adults (students and non-students), 32.5% (four studies) consisted of adult offenders from forensic institutes, 7.4% (one study) were youth offenders from forensic institutes, and 3.9% (one study) were children with autism spectrum disorder combined with violent tendencies. The presence of DSM Axis 1 disorders had been an exclusion criterion in two studies (20.7% of the participants). Head injuries and neurological disorders were exclusion criteria in four studies (36.6%). Substance dependence and/or current use of drugs were either exclusion criteria or controlled in three studies (28.0%). Level of education and/or IQ was an exclusion criterion or controlled in seven studies (72.3% of the participants), and deficient language skills was an exclusion criterion in two studies (13.3%). Finally, the use of psychotropic medication was an exclusion criterion in one study (13.3%).

2.3. EF tests and measures

Inhibition was examined in a majority of the studies (1, 2, 3, 4, 6, 8, 10, 11: numbers refer to references in Table 1; see also hereafter), using a variety of tests. Six studies (1, 2, 4, 8, 10, 11) employed tasks primarily tapping inhibition of pre-potent responses (go/no-go tasks, COWAT, AX-continuous performance test, and Number-Stroop task); three studies (3, 6, 8) examined the inhibition of distracting stimuli (flanker and target detection tasks). Dependent measures consisted of response times and/or accuracy data (number of errors or correct responses).

The shifting component was assessed in five studies (1, 5, 7, 8, 10), examining the number of errors during the extra-dimensional shift phase of the Cambridge Neuropsychological Test Automated Battery (CANTAB), the number of perseveration errors during the WCST, and the completion time during the TMT-B. Notably, in the two studies employing the TMT-B, no correction for cognitive processing and motor speed was used (based on TMT-A).

Working memory was examined in two studies (8, 9), using accuracy data (number of errors or correct responses) in a digits backwards task, a 2-back task, and the visual working memory component of the CalCap (detection of serially presented numbers appearing in increasing order; Miller, 1990).

Finally, planning capacity was assessed in two studies (1, 8), measuring planning time and/or accuracy-related variables within the Tower of London and WISC-III mazes tasks.

3. Results

Here we summarize the most relevant aspects of the results (see also Table 2).

Inhibition

Higher Factor 1 scores were associated with significantly better performance on inhibition tasks (one go/no-go, one AX-CPT, and one target detection task) in three of the eight studies (2, 4, 6) measuring inhibition (rs > .24; all rs with p <.05 are considered significant) Significant correlations were found for both incarcerated and non-incarcerated adult populations. Two of these studies (2, 6) also provided information concerning facets and factor subscales and found these correlations with the affective component of Factor 1 (rs>.23), but not with the interpersonal component (rs< .13). Five of the eight studies measuring inhibition, using go/no-go, COWAT, Stroop, and Flanker tasks, reported non-significant correlations (1, 3, 8, 10, 11; rs < .23) with Factor 1 and/or Facets 1 and 2, or non-significant performance differences between participants scoring high and low on Facet 2 (callousness scale of the APSD; study 10, Fs < 1.2). The population involved in the studies reporting non-significant results was mixed, consisting of incarcerated and non-incarcerated adult and adolescent samples. Regarding the direction of the non-significant results in terms of better or worse performance with high Factor 1/facet scores, two studies (8, 11) (primarily) reported better functioning, two (3, 10) worse functioning, and no data were available for one study (1). Concerning the relationship between Factor 2 and/or Facets 3 or 4, three studies (2, 3, 8) reported significant negative relations with inhibition (rs > .24), with one study (3) reporting this association specifically for Facet 3, and one study (2) for Facet 4. One study (11) reported a significant positive association with inhibition performance (r=.32), and one study (4) a non-significant positive correlation (r=.03). Finally, one study (6) reported mixed results, both a significant negative association for the PPI blame externalisation scale (r=.25) and a significant positive correlation for the PPI carefree nonplanfulness and impulsive nonconformity scales (rs>.21).

Shifting

Two out of five studies (7, 8), both using non-incarcerated student populations, reported (partly) significant correlations between Facet 2 or Factor 1 scores on the one hand and measures of shifting capacity (TMT-Part B and WCST perseverative errors) on the other, albeit with mixed results regarding the direction of the correlations (Study 7, worse performance, r=.20, for Facet 2 and the TMT-B, and Study 8, better performance, at least for the WCST, r=.23). Three out of the five studies (1, 5, 10) measuring shifting in delinquent adults and in children with autism spectrum disorder and violent tendencies, using the CANTAB or WCST, found no significant association between Factor 1 and/or Facets 1 and 2 and shifting performance (rs<.15, Fs<1), although the differences were reported to be in the direction of better performance with high factor scores in two of these studies (5, 10). Four studies (1, 5, 7, 8) also reported quantitative results for Factor 2 and/or related facets. One (8) found a significant negative association for TMT-B performance (r=.20), one study (5) found a non-significant negative association using the WCST (r=.09), and one study study (7) using the TMT-B found non-significant positive correlations for Facets 3 and 4 (rs<.07).

Working memory

Working memory performance, as measured by digits backwards, CalCap/SPM2, and 2-back tasks, was significantly and positively correlated with Factor 1 or Facet 1 in each of the two studies (8, 9) assessing this function in incarcerated and non-incarcerated adult populations (rs>.23). One study (8) reported a non-significant negative association for Factor 2 (r=.14) and the other one (9) reported non-significant associations for Facets 2-4 (no quantitative data provided).

Planning

Both studies (1, 8) incorporating measures of planning, using Tower of London or WISC-mazes tasks in incarcerated and non-incarcerated adult populations, reported non-significant correlations with Factor 1 or associated Facets 1 and 2 scores. One of these studies (8) reported high Factor 1 scores to be non-significantly associated with better planning performance (r=.12), and Factor 2 scores to be non-significantly associated with worse performance (r=.17). The other study (1) did not report corresponding quantitative data.

4. Discussion

4.1. Summary and evaluation

The results of our literature search indicate that there are relatively few data available on the relationship between the interpersonal-affective psychopathy Factor 1 (and associated facets and subscales) and performance on EF tests. Within the limited number of relevant articles, a very heterogeneous set of participant samples was used, ranging from incarcerated adult offenders to children with autism and violent tendencies. Moreover, multiple psychopathy measures (mostly PCL variants for offenders and PPI for non-offenders), and tests and measures within the different EF domains were employed. Combined with the mixed results of the analyses, this makes it impossible to derive any clear pattern(s) of results. For example, none of the participant categories (offenders/non-offenders, adults/non-adults, and combinations of these categories) and none of the psychopathy instruments consistently showed significant positive associations between Factor 1 and all (or even a single) EF. Also, none of the possible combinations of sample type, psychopathy instrument, and/or EF component failed to show consistent significant results, and/or many combinations were only covered by one study or were not covered at all (e.g. measuring shifting capacities in non-adult non-offenders, or measuring shifting in non-adult offenders and using the PCL for determining the Factor 1 score). Generally, there was a relative emphasis on the inhibition and shifting EF components, with a relative lack of research directed at working memory and planning. Except for two studies (Hansen et al., 2007, and Blair et al., 2006), all studies controlled for the effect of potentially relevant confounding or mediating factors, although the specific content of those factors greatly differed across the studies. Finally, in 6 studies using zero-order correlations and/or simple ANOVAs, there was no control for the effect of the correlation between Factors 1 and 2, when assessing the association between Factor 1 and EF components. Clearly, this is a serious limitation for evaluating the specific, unique link between Factor 1 and EF.

There was no consistency in the results of the studies regarding the association between Factor 1 and associated facets and scales, and inhibitory capacity. Three studies reported a significant positive and 5 studies a non-significant positive or negative association. Notably, two of the three studies reporting significant results identified the affective aspect of this factor to be responsible for the association. The results were also mixed with respect to the shifting component, both regarding the significance and direction of the associations. The only consistent results were found in the two studies assessing working memory and planning. Both studies examining working memory reported a positive association between Factor 1 and related facets and performance. Notably, the study by Hansen et al. (2007) found this significant association for the interpersonal Facet 1 and not for the affective Facet 2. Neither of the two studies examining planning found a significant association with Factor 1 or Facets 1 and 2. Given that the studies were not primarily or exclusively performed to assess the association between Factor 1 and EF, and the frequent report of non-significant results, there does not seem to be any problems of publication bias in this literature search.

We now turn to the secondary aim of our review, assessing whether the included articles consistently found a negative association between Factor 2 and/or related facets and EF.

Although Table 2 clearly shows more negative associations between Factor 2 and EF than is the case for the association between Factor 1 and EF, the majority of these associations were non-significant. This seems to be at odds with previous literature reviews reporting more consistent significant negative associations (also for cold EFs) in populations demonstrating antisocial and/or violent behavior (Dolan & Anderson, 2002; Morgan & Lilienfeld, 2000; Ogilvie et al., 2011; but see De Brito & Hodgins, 2009), which may be considered to represent samples with high Factor 2 scores. However, because the studies included in these reviews used a great variety of instruments to assess antisociality, they may not have captured the same aspects of Factor 2 as the measurement instruments used in the studies in the present overview. In addition, it has been shown that the presence of Factor 1 traits tends to mask the effects of Factor 2 traits and vice versa (a so-called ‘suppression effect’; e.g. Patrick, 1994). Because at least some of the studies identified in our search consist of samples characterized by the strong presence of Factor 1 traits it is plausible that this may have occluded the presence of (some) Factor 2-related symptoms, such as EF deficits, which presumably was not the case in the samples included in the majority of studies described in these previous reviews. This also stresses the importance of assessing the unique association between each factor, including their interaction, and EF, when possible by employing targeted statistical analyses.

4.2. General implications and implications for future research

At a general level we conclude that the suggestion of a positive association between Factor 1 and EF can be neither supported nor refuted at this stage, given the scarcity of studies, the heterogeneity of examined populations, tests and measures used, and the mixed results. Still, the lack of clear empirical evidence points out that previously found positive relationships between psychopathy (even to the extent of superiority) and specific cognitive domains (such as attention) cannot be extrapolated to a general concept like EF based on extant literature. Clearly, more research is needed in both clinical and non-clinical populations to assess which, if any, of the two different facets of Factor 1 is associated with which specific aspects of EF. The same holds true for the often-suggested negative relationship between the different facets of Factor 2 and EF, as direct support for this relationship seems absent when previous results are reconsidered in the light of tasks offering relatively ‘pure’ measures of cold EF. For the sake of comparability between studies, such endeavour would greatly profit from reaching some consensus or uniformity with respect to the tests and measures to be used to assess the different aspects of EF, and to systematically examine all combinations of psychopathy instruments, populations, and EF components, to fill in the missing data. Moreover, possible interaction effects between the two factors should be explicitly examined.

At a more detailed level, the (few) results suggest that, in future studies on EF, it is highly desirable to distinguish between the different facets of Factor 1. For example, as indicated above, at least for the inhibition component there is some support for the suggestion that specifically the affective facet (Facet 2) is associated with better inhibitory capacities (Feilhauer et al., 2012; Sadeh and Verona, 2008). As also indicated in the introduction, one hypothesis is that this positive association reflects reduced potential interference from emotions, such as test anxiety, that causes a performance improvement. A general reduced emotional-interference effect might also underlie the reported non-significant trend towards better performance on the other EF components. Alternatively, the causal relationship may be in the reversed direction: greater inhibitory capacities may result in a greater ability to maintain focus on a primary goal, in turn resulting in an enhanced capacity to inhibit responses to emotional stimuli. Future research could try to first systematically vary emotional aspects of the test environment and to assess the corresponding degree of performance improvement on cool EF tasks in relationship with Facet 2 scores.

An explanation in terms of a general reduced emotional-interference effect may also not hold for the (very scarce) indications of a positive association between Factor 1 and working memory capacity, as at least one study found specifically the interpersonal facet to be positively related to this function, although this study did not control for the effect of the other facets or factors (Hansen et al., 2007). Currently, it is unclear why particularly working memory performance should be linked to Facet 1. Perhaps there is some direct link between the brain regions typically associated with working memory, namely the dorsolateral prefrontal cortex (DLPFC; e.g., Petrides, 2000) and Facet 1. Activity in this area has been linked to manipulating information in working memory (see D'Esposito et al., 1999). In this respect, it may be of interest to note that within the framework of moral judgements, working memory capacity has been shown to be positively associated with making purely utilitarian (rather than non-utilitarian) choices in moral dilemmas (Moore et al., 2008), which in turn has been shown to be linked to primary psychopathy (low-anxious psychopaths; Koenigs et al., 2012). Moreover, within this same moral-judgement framework, high psychopathy scores have been shown to be associated with <u>increased</u> DLPFC activity (Glenn et al., 2009), although this relationship was only significant for Factor 2 aspects (Facets 3 and 4). Alternatively, the association between working memory and Facet 1 found by Hansen et al. (2007) might merely reflect that working memory tasks are more demanding than tests used to tap other EF components and might therefore be more sensitive to uncover positive effects of high Facet 1 scores. In any case, if this result could be replicated this could be considered experimental support for the idea that Factor 1 indeed is positively related with EF and that this association is not merely due to reduced emotional interference, at least with respect to the working memory component.

In sum, our search shows that the current literature does not provide direct empirical evidence for the claim that Factor 1 is positively related to EF. Therefore, caution is needed when making this claim, as well as more clarity when theoretical or empirical arguments are used to substantiate it. More focus on this matter will promote our understanding of psychopathy from a clinical, cognitive, and neurobiological perspective.

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Table 1. Articles meeting the inclusion criteria and study characteristics

Reference	Psychopathy Measure	Participants (on which relevant analyses were based)	Exclusion criteria or controlled variables	EF studied	Task + relevant behavioural measure(s)	Type of analyses	Result (correlation/F/t value)	Direction of (s or ns) effect
1. Dolan, 2012	PCL:SV - facets	Offenders (m) with ASPD from detention centers and forensic clinics (n = 96; mean age: 37)	1,2,3,4,6	Planning Shifting Inhibition	SOC-Tower of London (various measures) CANTAB ID/ED (ED-shift errors) Go/no-go (correct inhibitions)	Zero-order correlation	ns(no data) ns (no data) ns (no data)	no quantitative data for factors or facets
2. Feilhauer et al., 2012	PCL:YV -factors and facets	Delinquents (m) from detention centers and forensic clinics (n=53; mean age: 16)	1,2,3,5,6	Inhibition	TAP (go/no-go task; error rate)	Partial correlation/ multiple regression	Factor 1: -.29/-.24 (s) Facet 1: .059 (ns) Facet 2: -.35 (s) Factor 2: .39/.47 (s) Facet 3: .17 (ns) Facet 4: .35 (s)	better+ worse better+ worse+ worse worse+
3. Racer et al., 2011	APSD -CU (facet 2) - N (facet 1) -I (facet 3)	Adolescents (m/f) from community and counseling/family service agencies (n=43; mean age: 12	2,5	Inhibition	Cued Flanker task (RT)	Zero-order correlation/multiple regression	Facet 1: .11 (ns)* Facet 2 < .23 (ns) Facet 3: .38 (s)	worse worse worse+
4. Carlson & Thai, 2010	PPI -factors	Undergraduates (m/f; n=72; mean age: 20)	2	Inhibition	Expectancy AX-CPT (RT)	Multiple regression	Factor 1: -.28 (s) Factor 2: -.03 (ns)	better+ better
5. Mol et al., 2009	PCL-R -factors	Patients (m) from forensic clinic (n=53; mean age: 39)	3,6	Shifting	WCST (no. of perseverative errors)	Partial correlation/group comparison	Factor 1: -.15 (ns) Factor 2: .09 (ns)	better worse
6. Sadeh & Verona, 2008	PPI -factors + subscales	Adults from community and students (m; n=95; mean age:20)	6	Inhibition	Target detection under different perceptual and working memory load conditions (error rate and RT)	Zero-order correlation	Factor 1: -.25 (s)** Facet 1: rs<-.13 (ns) Facet 2: rs>.23 (s) Factor 2: -.31r<.25 (s) BE: .25 (s) CN: -.31 (s)	better+ better better+ mixed: better/worse+ worse better better

							IN:: -.21 (s)	
7. Mahmut et al., 2008	SRP-III-CA (facet 2), -IPM (facet 1),- ELS (facet 3), -CT (facet 4)	Students (m/f; n=101; mean age:23)	6	Shifting	TMT-B (completion time)	Zero-order correlation	Facet 1: .06 (ns) Facet 2: .20 (s) Facet 3: -.03 (ns) Facet 4: -.07 (ns)	worse worse^{+} better better
8. Sellbom & Verona, 2007	PPI -factors	Undergraduates (f; n=95; mean age:20)	6	WM Shifting Planning Inhibition	Digits backwards (no. of correct responses) WCST (no. of perseverative errors) TMT-B (completion time) WISC-III Mazes (completion time) COWAT (no. of proper responses) Flanker Task (RT/no. of commission errors)	Partial correlations/multiple regression	Factor 1: .23 (s) Factor 2: -.14 (ns) Factor 1: -.23 (s) Factor 2: .12 (ns) Factor 1: -.18 (ns) Factor 2: .20 (s) Factor 1: -.12 (ns) Factor 2: .17 (ns) Factor 1: .10 (ns) Factor 2: -.02 (ns) Factor 1, RT: -.12 (ns) Factor 1, Errs:.08 (ns) Factor 2, RT: .02 (ns) Factor 2, Err: .25 (s)	better^{+} worse better^{+} worse better worse^{+} better worse better worse better worse worse worse^{+}
9. Hansen et al., 2007	PCL-R -facets	Delinquents (m) from standard prison (n=48; mean age: 32)		WM	CalCAP/SPM2 (no. of (in-)correct responses 2-back task (no. of correct/incorrect responses	Zero-order correlation ANOVA (median split based on facet 1 and 2 scores)	Facet 1,Err.: -.29 (s); t=1.84 (s) Facet 1, Correct responses: .27 (s); t=2.55 (s) Facets 2-4: ns	better^{+} better+ no data
10. Rogers et al., 2006	APSD-CU (facet 2)	Children (m) with autism spectrum disorder (with focus on participants with violent tendencies; n=28; mean age: 14)	6	Inhibition Shifting	Go/No-go correct rejections/ errors of omission) CANTAB-ID/ED (no. of ED errors)	ANOVA (median split based on CU scores)	Facet 2: Fs< 1.2 (ns) Facet 2: F<1 (ns)	worse better
11. Blair et al., 2006	PCL-R -factors	Forensic institute (m; n=37; mean age: 33)		Inhibition	Number-Stroop (interferenceRT/ errors)	Zero-order correlation	Factor 1, RT: rs <-.22 (ns), Err.: ns (no data) Factor 2, RT: r=-.32 (s) Err., ns (no	better better^{+}

							data)	

Note. PCL:SV = Psychopathy Checklist Screening Version; PCL:YV = Psychopathy Checklist Youth Version; ASDP= antisocial personality disorder as assessed with the Structured Clinical Interview for DSM-IV Axis II Personality Disorders; APSD= Antisocial Process Screening Device; -CU=callous-unemotional, -N= Narcissism,-I=Impulsivity subscale; PPI=Psychopathic Personality Inventory; BE=PPI Blame Externalization subscale; CN= PPI Carefree Nonplanfulness subscale; IN=PPI Impulsive Nonconformity subscale; SRP-III= Self-Report Psychopathy scale Version 3; -CU=Callous Affect facet; -IPM=Interpersonal Manipulation facet; -ELS= Erratic Lifestyle facet; -CT= Criminal Tendencies facet; EEQ=Emotional Empathy Questionnaire; m/f = male/female; exclusion criteria: 1) Axis I disorders, 2) head injury/neurological disorders, 3) substance dependence/current use; 4) psychotropic medication; 5) language skills; 6) low IQ/level of education/learning ability; SOC = Stockings of Cambridge planning task; WM=working memory; CANTAB ID/ED = CANTAB intra-dimensional/extra-dimensional set-shifting task; TAP = Test for Attentional Performance; AX-CPT=AX Continuous Performance Test; WCST=Wisconsin Card Sorting Test; TMT-B=Trail Making Test Part B; WISC-III Mazes= Wechsler Intelligence Test for Children Version III; COWAT=Controlled Oral Word Association Test; CalCAP-SPM2= California Computerized Assessment Package-Serial Pattern Matching test 2; s/ns = significant/not significant; better and worse refer, respectively, to better and worse performance on the test indicated with higher factor/facet scores; $^{+}$=significantly worse/better; no (quantitative) data = authors did not report the actual, numeric correlations, so that the direction of the effect could not be determined; *=additional data received upon request; **= depending on subscale and perceptual and WM load conditions; only significant results are reported here.

Table 2. Summary of results

Executive function	**Direction and significance of result for Factor 1 (or facets 1 or 2)**	**Direction and significance of result for Factor 2 (or facets 3 or 4)**
Inhibition	+ + + + + 0	+ + +/ 0
Shifting	+ + + 0	+ 0
WM	+ +	0
Planning	+ 0	0

Note. Each +, , or 0 represents 1 study examining the corresponding executive function. +, + = respectively, significant or non-significant positive association between the factor (and/or constituting facet(s)) and the tested executive function. , = respectively, significant or non-significant negative association between the factor (and/or constituting facet(s)) and the tested executive function. 0 = no data available concerning the direction of the non-significant association (no quantitative data provided). +/ = mixed significant positive and negative associations. In case a study reported results of more than one measure of a specific EF component, the association between the factor and that function was considered to be significant if at least one of these measures yielded a significant result.