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Mapping the Association of Global Executive Functioning Onto Diverse Measures of Psychopathic Traits

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Psychopathic individuals display a callous-coldhearted approach to interpersonal and affective situations and engage in impulsive and antisocial behaviors. Despite early conceptualizations suggesting that psychopathy is related to enhanced cognitive functioning, research examining executive functioning (EF) in psychopathy has yielded few such findings. It is possible that some psychopathic trait dimensions are more related to EF than others. Research using a 2-factor or 4-facet model of psychopathy highlights some dimension-specific differences in EF, but this research is limited in scope. Another complicating factor in teasing apart the EF–psychopathy relationship is the tendency to use different psychopathy assessments for incarcerated versus community samples. In this study, an EF battery and multiple measures of psychopathic dimensions were administered to a sample of male prisoners ($N = 377$). Results indicate that using the Psychopathy Checklist-Revised (PCL-R), the independent effect of Factor 2 was related to worse EF, but neither the independent effect of Factor 1 nor the unique variance of the Factors (1 or 2) were related to EF. Using a 4-facet model, the independent effects of Facet2 (Affect) and Facet4 (Antisocial) were related to worse EF, but when examining the unique effects, only Facet2 remained significant. Finally, the questionnaire-based measure, Multidimensional Personality Questionnaire-Brief, of Fearless Dominance was related to better EF performance, whereas PCL-R Factor 1 was unrelated to EF. Overall, the results reveal the complex relationship among EF and behaviors characteristic of psychopathy-related dimensions. Moreover, they demonstrate the interpersonal and affective traits measured by these distinct assessments are differentially related to EF.

Keywords: executive function, fearless dominance, interpersonal-affective, psychopathic traits

The dynamic control of behavior occurs through cognitive processes that encompass executive functioning (EF), which involves task monitoring, rule learning, response inhibition, and planning.

Conventional wisdom highlights the importance of a person's ability to exert EF in order to regulate the expression of violent behavior, inappropriate drug use, harmful antisocial behavior, shortsighted reward seeking, as well as engage in prosocial behaviors, such as complex social interactions (e.g., making inferences about others behaviors and preferences) (Rueda, Posner, & Rothbart, 2005). Not surprisingly, when individuals engage in behaviors leading to unfavorable outcomes, EF dysfunctions are commonly implicated in these behavioral disturbances. However, a robust connection between EF and maladaptive behavior is not apparent for all subtypes of individuals displaying this type of behavior; namely, psychopathic individuals. Psychopathic individuals display a callous-coldhearted approach to interpersonal and affective situations and chronically engage in impulsive and antisocial behaviors (Cleckley, 1941). However, results are equivocal with regard to the relationship between deficits in EF and psychopathy (Hart, Forth, & Hare, 1990; Morgan & Lilienfeld, 2000; Smith, Arnett, & Newman, 1992).

Although there is little support for a generalized EF deficit in psychopathy, deficits within the EF components of inhibition

and rule learning have been reported (Bagshaw, Gray, & Snowden, 2014; Fisher & Blair, 1998; Newman & Howland, 1987; Snowden, Gray, Pugh, & Atkinson, 2013). These findings are further supported by results from meta-analyses, but such deficits appear ultimately related to antisocial behavior, more broadly, and therefore are not unique to psychopathy (Morgan & Lilienfeld, 2000; Ogilvie, Stewart, Chan, & Shum, 2011). Moreover, though there is evidence for psychopathy-related deficits in inhibition and rule learning, there is also evidence of nonsignificant or negligible relationships between these components of EF and psychopathy (Dolan, 2012; Sellbom & Verona, 2007; see also Maes & Brazil, 2013 for review). There are a number of factors that may contribute to the inconsistency in the research findings on EF in psychopathy. Two such factors may be how psychopathy is operationalized across studies (e.g., a single broad syndrome vs. lower-level trait dimensions) and the selection of measures that are utilized for each study (e.g., interview vs. questionnaire). In an attempt to reconcile some of the methodological issues that plague research on EF as a function of psychopathy, the present study examined the relationship between separate trait dimensions of psychopathy and compared different methods of assessing these dimensions.

Psychopathic Trait Dimensions and Executive Functioning

Across studies, psychopathic individuals have demonstrated deficient, superior, and normative EF performance. Consequently, a question remains about how to understand these diverse findings. As noted above, it is possible that certain dimensions of psychopathy (i.e., specific traits) are more related to EF dysfunctions than others. The potential for specific traits to account for the EF and psychopathy relationship could mean that some relationships would be suppressed or obscured when examining psychopathy as a broad clinical syndrome. In light of this, some investigators advocate parsing psychopathy into dimensional traits so that a more nuanced assessment of relevant correlates may be identified. Because the impulsive and antisocial lifestyle symptoms apply to most forms of disinhibition, it is the interpersonal–affective trait dimensions that distinguish psychopathy from other traits and disorders (e.g., low constraint, antisocial personality disorder). The existence of these distinguishing trait dimensions contributes to the common conceptualization of psychopathy through a lens of dual characteristics: one that captures the interpersonal–affective trait dimensions and the other that captures the impulsive–antisocial trait dimensions of psychopathy.

Such dual-trait conceptualizations of psychopathy are predicated on the two-factor model of Hare's Psychopathy Checklist-Revised (PCL-R; Hare et al., 1990). Here, Factor 1 represents the distinguishing interpersonal (charm, grandiosity, and deceitfulness) and affective (lack of remorse, empathy, and emotional depth) traits of psychopathy, which reflect low anxiety and deficient emotion processing (Neumann, Johansson, & Hare, 2013; Patrick, 2007). In contrast, Factor 2 describes the impulsive and chronic antisocial tendencies associated with psychopathy that are attributed to a deficit in behavioral inhibition and control (Hare & Neumann, 2010). Broadly speaking, research distinguishing these Factors in terms of EF seems to indicate superior performance is primarily related to Factor 1, whereas

inferior EF is associated with Factor 2 (Harpur, Hare, & Hakstian, 1989; Patrick, 2007; Sadeh & Verona, 2008). However, a recent review pointed out that there is little support for a generalized impairment in EF in relation to the two Factors of psychopathy (Maes & Brazil, 2013).

Following the logic that parsing psychopathy into trait dimensions affords a detailed understanding of the complex EF–behavior relationships, some investigators have proposed that further division of the Factors into facets (Facet1: Interpersonal; Facet2: Affect; Facet3: Lifestyle; Facet4: Antisocial) may lead to an even more specific understanding of these traits and related correlates (Hare & Neumann, 2008; Neumann, Hare, & Pardini, 2014; Neumann & Pardini, 2014). Each of these facets represents a cluster of related symptoms with the potential for different etiological correlates. Interpersonal traits reflect a tendency to engage in impression management, to be grandiose, to use pathological lying, and to be conning and manipulative; affective traits tap the individuals propensity toward a lack of remorse, shallow affect, callousness, and a failure to accept responsibility; the lifestyle traits relate to stimulation seeking, impulsivity, irresponsibility, a parasitic orientation, and a lack of realistic goals; and, the antisocial traits reflect poor anger control, early behavior problems, serious criminal behavior, violation of conditional release, and criminal versatility (Hare & Neumann, 2008; Vitacco, Neumann, Caldwell, Leistico, & Van Rybroek, 2006).

Currently, only a handful of studies examined the relationship between psychopathy facets and EF, with Facet 2 (Affect) relating to deficient inhibition (Feilhauer, Cima, Korebrits, & Kunert, 2012; cf., Sadeh & Verona, 2008) and rule learning (Mahmut, Homewood, & Stevenson, 2008). Along with Facet 2, Facet 4 (Antisocial) has been related to deficient inhibition (Feilhauer et al., 2012). Despite these results, there are inconsistent results with regard to EF, including within inhibition and rule learning (see Maes & Brazil, 2013 for review). The dimensional models represented by the Factors and facet approach to psychopathy may provide a means to understand the relationship between specific traits and functions; but, the transition away from a broad syndromal representation to the dimensional trait level creates an issue related to how those traits are operationalized and measured across samples. Thus, the issue of mode of measurement may further influence the complex relationship between psychopathic dimensions and EF performance.

Psychopathic Trait Dimensions and Issues of Measurement

Early work with the PCL-R was conducted in correctional settings, given the high prevalence of psychopathy in offender samples. However, the basic construct of psychopathy and its replicable two-factor structure has been extended to other populations, including community and undergraduate samples (e.g., Seara-Cardoso & Viding, 2014). Using nonincarcerated offender populations necessitated a shift in assessment, because the PCL-R relies on the availability of collateral information, such as criminal records. Consequently, a number of self-report questionnaire measures emerged, purporting to capture psychopathic trait dimensions in nonoffender samples. The Multidimensional Personality Questionnaire (MPQ) uses scales to estimate the factors of psychopathy within a broad inventory of normal personality functioning (Ben-

ning, Patrick, Blonigen, Hicks, & Iacono, 2005; Benning, Patrick, Hicks, Blonigen, & Krueger, 2003). Specifically, MPQ subscales, Fearless Dominance (FD) and Impulsive-Antisociality (IA), which were a derivative of the Psychopathic Personality Inventory (Lilienfeld & Andrews, 1996), supposedly map onto PCL Factor 1 and Factor 2 dimensions and relevant external correlates, respectively (cf., Lynam & Miller, 2012; Malterer, Lilienfeld, Neumann, & Newman, 2010; Neumann, Malterer, & Newman, 2008). The FD domain, like Factor 1, tends to be positively related to sociability, narcissism, and adventure seeking, but negatively related to internalizing disorders and fearfulness (Benning et al., 2005; Hicks & Patrick, 2006). By contrast, IA is positively correlated with externalizing disorders, impulsivity, trait anxiety, but negatively correlated with socialization. Although the development of different assessments for psychopathic dimensions has many advantages, a controversy has emerged regarding the extent to which different measures, such as PCL-R and MPQ-derived subscales tap the same construct (Miller & Lynam, 2012).

As noted above, interpersonal-affective traits are central to the conceptualization of psychopathy. However, especially with the development of alternative assessment measures, there is a lack of consensus about what constitutes these unique traits of psychopathy. One view posits that the interpersonal–affective traits of psychopathy are associated with certain features of healthy or adaptive functioning, such as a relative lack of anxiety and fear, charm, boldness, and social poise (Lilienfeld et al., 2012). Consistent with this view, MPQ-derived measures of psychopathy containing orthogonal factors (FD and IA), are widely used with nonoffender populations, and lack explicit assessment of antisociality or criminality. By contrast, another view argues that psychopathy, including the interpersonal-affective traits, is inherently linked to maladaptive features that interface with antisocial behavior (Lynam & Miller, 2012; Neumann, Hare, & Newman, 2007). Moreover, Lynam and Miller (2012) go on to suggest that FD provides an assessment of extraversion, which may have some association with traits of psychopathy, but is not an essential feature of the construct. Conversely, the PCL-R, which contains highly correlated factors that tap *both* interpersonal-affective and impulsive-antisocial traits (Factor 1 and Factor 2), is widely used with incarcerated criminal populations, but has been criticized for eliminating the "positive-adjustment features" (Skeem, Polaschek, Patrick, & Lilienfeld, 2011) of psychopathy.

The divergence in the conceptualization of psychopathy broadly, and interpersonal–affective traits more specifically, has resulted in contradictory findings on key correlates of these trait dimensions. One domain where heterogeneity of the construct has lead to mixed results relates to EF. On the one hand, it makes intuitive sense that individuals with interpersonal-affective traits would display enhanced EF abilities, given their ability to exert social dominance and to manipulate other people for their own benefit. In fact, some evidence supports the proposition that these traits are associated with intact or enhanced brain, physiological and executive functioning (Carlson & Thai, 2010; Gao & Raine, 2010; Neumann & Pardini, 2014; Sellbom & Verona, 2007; see Maes & Brazil, 2013). Notably, the majority of these studies were completed using community and undergraduate samples. On the other hand, when considering interpersonal-affective traits within the context of antisoci-

ality, often within incarcerated samples, there is little evidence that Factor 1 is associated with enhanced EF, and in fact, individuals high on these traits may reflect deficient EF (Bagshaw, Gray, & Snowden, 2014; Gao & Raine, 2009; Mol, van Den Bos, Derks, & Egger, 2009; Morgan & Lilienfeld, 2000; Ogilvie et al., 2011). The differences in conceptualization of the phenotype and the methodology used to measure these dimensions may contribute to these contradictory findings and perspectives. Thus, the construct of interest may not only be obfuscated, but also is its relationship to important external correlates.

The Present Study

To begin to address these concerns, the goals of the current study were twofold. First, using a sample of incarcerated male offenders, we examined the relationship between psychopathic trait dimensions and performance on an EF battery, to evaluate whether EF impairments are related to specific dimensions, rather than the syndrome of psychopathy as defined by the aggregation of diverse trait dimensions. We examined the relationships the using traditional two-factor model, and also the four facet model to assess if by further parsing psychopathic trait dimensions, a more nuanced relationship with EF emerged. Second, we examined the consistency across measures of the association between psychopathic trait dimensions and performance on an EF battery. MPQ-derived FD is most often used in student samples, which can generally be regarded as a subset of high functioning individuals. Thus, based on the scale development and type of samples evaluated, it is plausible that as scores on FD increase certain adaptive features that intersect with EF also increase. In contrast, PCL-R Factor 1 emerged from work in correctional settings and is often used to assess offenders; individuals that may be less educated, are in a less enriched environment, and experience profound inhibitory problems as evidenced by their incarceration. In this type of sample and based on the information used to rate interpersonal-affective traits of the PCL-R, the link to the maladaptive features of the construct may be more prominent, and consequently, there may be no, or even a negative, relationship between PCL-R Factor 1 and EF.

Method

Participants

Participants were recruited from medium-security correctional institutions in Wisconsin. A prescreen of institutional files and assessment materials was used to exclude individuals who had performed below the fourth-grade level on a standardized measure of reading (Wide Range Achievement Test-III; Wilkinson, 1993), who scored below 70 on a brief measure of IQ (Wechsler Adult Intelligence Scale-III; Wechsler, 1997), who had diagnoses of schizophrenia, bipolar disorder, or psychosis, not otherwise specified (Structured Clinical Interview for DSM Disorders; First, Spitzer, Gibbon, & Williams, 1997), or who had a history of medical problems (e.g., uncorrectable auditory or visual deficits; head injury with loss of consciousness greater than 30 minutes) that may impact their comprehension of the materials or performance on the EF tasks. Ad-

ditionally, all participants were between the ages of 18 and 45 because antisocial behavior has been found to change with advancing age (Steffensmeier, Allan, Harer, & Streifel, 1989). The final sample consisted of 377 male participants (see Table 1). All participants provided written informed consent according to the procedures set forth by the University of Wisconsin–Madison Human Subjects Institutional Review Board.

Measures

Psychopathy Checklist–Revised (PCL-R; Hare, 2003). PCL-R ratings were completed using information from prison files and a semistructured interview that lasted approximately 60 minutes. Based on information gathered from the interview and file review, the 20 items of the PCL-R were rated 0, 1, or 2, reflecting the degree to which a trait was present: significantly (2), moderately (1), or not at all (0). Early work with the PCL-R revealed a replicable two-factor structure (Hare et al., 1990) with Factor 1 items assessing Interpersonal–Affective traits (e.g., glib, callous) and Factor 2 items relating to Impulsive–Antisocial behavior (e.g., irresponsible, criminality). Using Confirmatory Factor Analysis, subsequent work also identified a four facet model of the PCL-R (Hare & Neumann, 2008; Neumann, Kosson, & Salekin, 2007). More specifically, Factor 1 was separated into Interpersonal (e.g., manipulation of others, pathological lying) and Affect (e.g., callousness, shallow affect) facets, whereas Factor 2 was separated into Lifestyle (e.g., sensation seeking, impulsivity) and Antisocial (e.g., criminality, early behavior problems) facets. Interrater reliability for PCL-R Factor scores based on 42 dual ratings was .94 and .91, respectively.

Multidimensional Personality Questionnaire–Brief Form (MPQ-B; Patrick, Curtin, & Tellegen, 2002). The MPQ-B is a 155 item self-report questionnaire that consists of 11 primary trait scales. The FD and IA dimensions of psychopathy are calculated as linear combinations of specific standardized (i.e.,

z-scored) MPQ-B primary trait scales. Specifically, FD is calculated as $(.34 \times z$Social Potency$) + (-.42 \times z$Stress Reaction$) + (-.21 \times z$Harm Avoidance$)$. IA is calculated as $(.16 \times z$Aggression$) + (.31 \times z$Alienation$) + (-.13 \times z$Traditionalism$) + (-0.29 \times z$Control$) + (-.15 \times z$Social Closeness$)$ (Benning et al., 2003). Prior research suggests that in prisoners, FD is selectively related to Factor 1 and IA is preferentially associated with Factor 2 of the PCL-R. The MPQ-B has shown good internal consistency and validity (see Patrick et al., 2002). For the present study Cronbach's alpha for MPQ-B FD and MPQ-B IA were .98 and .83, respectively.

Delis–Kaplan Executive Function System (D-KEFS; Delis, Kaplan, & Kramer, 2001). The D-KEFS was developed to assess components of EF through well-established tests. Four of the eight tests from the D-KEFS were selected for this study based on their demonstrated utility in previous research to assess different aspects of executive functions (working memory, inhibition, planning and rule learning, and abstraction): Letter Fluency, Color-Word, Tower, and Proverbs tests. Each of these tests generates a summary score based on age norms, and additional contrast and percentile scores. As noted below, the use of the D-KEFS was to assess a general aptitude for regulation and problem solving (Crawford, Garthwaite, Sutherland, & Borland, 2011).

EF comprises a broad set of cognitive processes such as "planning, organizational skills, selective attention and inhibitory control, and optimal cognitive-set maintenance" (Morgan & Lilienfeld, 2000, p. 114). Given the range of EF processes, identification of a clear factor structure of EF has been challenging, though recent research across a diversity of EF batteries suggests that several correlated factors often emerge. Furthermore, correlated EF factor domains provide evidence for a general EF factor, which may reflect a central executive function (see example with D-KEFS in Latzman, Elkovitch, Young,

Table 1
Descriptive Statistics and Zero-Order Correlations (n = 377)

Variable	Mean	Standard deviation	Range	1	2	3	4	5	6	7	8	9	10	11	12
Demographic															
1. Age	30.97	6.97	27.00	—	−.08	.07	−.02	−.08	−.12*	−.17*	.03	−.06	−.07	−.05	−.06
2. WAIS-III	98.95	12.79	63.70		—	.59*	.00	−.09	.21*	.01	.38*	.14*	.33*	.51*	.56*
3. WRAT-III	45.29	6.10	33.00			—	−.05	−.13*	.13*	−.01	.39*	.19*	.19*	.34*	.46*
Individual differences															
4. Factor 1	8.93	3.13	16.00				—	.54*	.26*	.29*	.10	−.12*	−.09	.03	−.03
5. Factor 2	12.61	3.96	18.00					—	.14*	.34*	.07	−.02	−.19*	−.02	−.07
6. Fearless dominance	.06	.58	2.99						—	−.12*	.20*	.11*	.17*	.18*	.27*
7. Impulsive antisociality	−.04	.62	3.38							—	−.08	−.08	−.10	.03	−.10
Executive function (D-KEFS)															
8. Letter fluency	9.91	3.38	17.00								—	.09	.13*	.26*	.62*
9. Color–word	10.32	2.74	18.00									—	.07	.10	.53*
10. Tower	9.89	2.53	17.00										—	.23*	.60*
11. Proverb	10.44	2.80	13.00											—	.67*
12. Composite	0.00	0.65	3.20												—

Note. WAIS-III = Wechsler Adult Intelligence Scale-III; WRAT-III = Wide Range Achievement Test-III; Factor 1 = Psychopathy Checklist–Revised Factor 1; Factor 2 = Psychopathy Checklist–Revised Factor 2; D-KEFS = Delis–Kaplan Executive Function System; Composite = SEM-derived composite of Color-Word, Tower and Proverb.
* $p < .05$.

& Clark, 2010). Evidence for a general EF factor has also been provided by Li et al. (2015) based on a sample of adolescents ($N = 142$, 12–18 years) who were administered the D-KEFS. Moreover, as noted by Crawford et al. (2011) the use of a general EF composite also has the advantage of providing greater reliability of EF assessment, given that the individual D-KEFS scores have lower reliability. Consistent with results using the D-KEFS, Kramer et al. (2014) examined a large diverse sample ($N = 1,248$) of adults who were administered the NIH-EXAMINER battery and also found evidence for three EF factors (control, working memory, and fluency), which could be accounted for in terms of a general EF factor. Together, these factor analytic and empirical findings are consistent with research on brain development that reveals a dynamic process of emerging interactions between different brain regions (Johnson, 2003), and thus it is reasonable to expect that different EF processes can be represented in terms of a general central EF factor.

Data Analysis

To evaluate the relationship between EF and psychopathic trait dimension, our analysis of the D-KEFS data occurred in two stages. The first stage involved identification of a theoretically and empirically meaningful latent EF factor(s) (see *D-KEFS* section above). Because there are a number of D-KEFS scaled, contrast, and percentile scores that can be used for indexing a given EF ability for each measure, there is considerable redundancy in the EF variable set. Exploratory factor analysis (EFA) has been regularly used in the EF literature given that it allows investigators to succinctly summarize a large set of observed variables, as well as isolate variables that make little contribution to a given factor (Neumann et al., 2007). In EFA, variables are allowed to freely cross-load onto any number of factors, and in the case of neuropsychological data cross-loadings may simply reflect method factors (e.g., timed tests) or redundancy in related scores.

Using Mplus (Muthén & Muthén, 1998–2000), EFA was run using scaled, contrast, and percentile scores from the Letter Fluency, Color-Word, Tower, and Proverbs tests. We also included WAIS-IQ and WRAT-Reading to insure we were not simply uncovering a general IQ/education factor. Given that previous factor analytic research on EF assessments has found that not all EF tasks load significantly on a given factor, and that many EF scores show substantial cross-loadings on several factors (cf. Latzman & Markon, 2010), we also ran an EFA on only a subset of EF variables that loaded significantly and in a theoretically coherent manner in the initial EFA. Then, confirmatory factor analysis (CFA) was used to provide a strict test of model fit for the reduced EF variable subset identified from the EFA. In other words, CFA was conducted to test a model that specified the respective EF variables to load only onto their respective factors (i.e., no cross-loadings).

Model fit was evaluated according to several criteria: the comparative fit index (CFI), the root mean-squared error of approximation (RMSEA), and the relative chi-square index (the ratio of the chi-square statistic to the degrees of freedom). The CFI, which adjusts for the degrees of freedom, compares the fit of the model against the (unstructured) null model, with scores over .90 (maximum = 1) representing acceptable fit (Bentler, 1992). The RMSEA takes into account model complexity and a fit less than .05 is considered a good fit, and a fit less than .08 is acceptable. Finally, for the ratio of the chi-square statistic to the degrees of freedom, values less than 5 indicate an acceptable model (Bollen, 1989).

From the initial EFA, nine variables emerged as an indicator for one of three coherent factors (*Color-Word*: performance on Inhibition trials and performance on the Inhibition-Switch trials; *Tower*: time to first move, ratio of time per move, and ratio of accuracy per move; *Proverb*: performance on the common and uncommon proverbs, total accuracy on the proverbs, and accuracy on the abstract proverbs). After the initial EFA was conducted with the entire variable set and a viable subset of variables identified (i.e., those which loaded primarily onto a theoretically meaningful factor), a second EFA was conducted with the subset of EF variables, and this EFA was associated with good model fit, CFI = .95, RMSEA = .06, χ^2/df (68.31/25) = 2.73, for a three-factor solution.

Following this EFA, the results indicated good fit for a three-factor CFA model, (CFI = .96, RMSEA = .05, χ^2/df (56.47/24) = 2.35), and all of the EF variables loaded significantly onto their respective factor and the three EF factors were significantly intercorrelated ($ps < .01$–.001). As it turns out, the three first-order EF factors could be loaded onto a second-order (superordinate) factor and this hierarchical CFA model was statistically identical to the initial CFA model with three correlated first-order factors. The equivalent superordinate model is referred to as an alternative equivalent model (Neumann, Vitacco, Hare, & Wupperman, 2005). In this case, the superordinate factor provides evidence for a broad EF factor consistent with the previous literature, and moreover, that the subset of EF variables could be used to form a unidimensional composite scale, which has significant advantages when mathematically representing psychological processes (Smith, McCarthy, & Zapolski, 2009; see also Crawford et al., 2011; Latzman & Markon, 2010).

For the second stage of analysis, the results from the EFA/CFA were used to compute an EF composite measure by standardizing (z-score) each identified EF scale score (see 9 scales above) and combining the standardized measures as an arithmetic mean. Then, multiple separate regression models were run, using psychopathic traits, as continuous predictors of the EF composite. More specifically, PCL-R Factors were entered as standardized (z-score) continuous variables, both the independent and simultaneous (i.e., unique effects) models. Similar analyses were conducted using the four facets in place of the Factors. Finally, analyses were conducted to compare EF performance based on the measurement of psychopathic trait dimensions using questionnaire versus interview measures (e.g., MPQ-B vs. PCL-R). For these analyses, measures of psychopathic trait dimensions were entered as continuous variables independently and simultaneously to directly compare different psychopathy measures.

Results

Sample characteristics and bivariate correlations are presented in Table 1. Below we present analyses that examine (a)

the relationship between psychopathic trait dimensions and EF and (b) the impact of potential measurement differences for understanding the relationship between psychopathic trait dimensions and EF.

Psychopathic Trait Dimensions and EF Performance

First, using the two-factor model, PCL-R Factor 1 was negatively, but nonsignificantly related to EF performance, $F(1, 374) = 2.62$, $\beta = -.09$, $p = .08$, $\eta_p^2 < .01$ (Figure 1A). Conversely, PCL-R Factor 2 was significantly and negatively related to EF performance, $F(1, 352) = 4.69$, $\beta = -.12$, $p = .03$, $\eta_p^2 = .01$. However, when PCL-R Factors 1 and 2 were entered simultaneously, neither Factor was significantly related to EF performance (unique effects of Factor 1: $F(1, 352) = .76$, $\beta = -.06$, $p = .39$, $\eta_p^2 = .01$; unique effects of Factor 2: $F(1, 352) = 1.84$, $\beta = -.09$, $p = .18$, $\eta_p^2 = .01$).[1]

Second, using the four-facet approach, the Interpersonal facet was nonsignificant and negative, $F(1, 374) = .46$, $\beta = -.04$, $p = .50$, $\eta_p^2 < .01$, the Affect facet was significant and negative, $F(1, 374) = 6.15$, $\beta = -.13$, $p = .01$, $\eta_p^2 = .02$, the Lifestyle facet was nonsignificant and negative, $F(1, 374) = 1.74$, $\beta = -.07$, $p = .19$, $\eta_p^2 < .01$, and the Antisocial facet was significant and negative, $F(1, 373) = 6.00$, $\beta = -.13$, $p = .02$, $\eta_p^2 = .02$. However, when all four facets were entered simultaneously, only the Affect facet effect remained significant (Interpersonal: $F(1, 346) = .38$, $\beta = .03$, $p = .54$, $\eta_p^2 < .01$, Affect: $F(1, 346) = 4.49$, $\beta = -.13$, $p = .04$, $\eta_p^2 = .01$, Lifestyle: $F(1, 346) = .04$, $\beta = -.01$, $p = .84$, $\eta_p^2 < .01$, Antisocial: $F(1, 346) = 1.50$, $\beta = -.08$, $p = .22$, $\eta_p^2 < .01$).

PCL-R Trait Dimensions Supplemental Analysis

Given the extensive evidence for a latent four facet PCL-based model of psychopathy (Neumann, Hare, & Pardini, 2014), and that latent variable methods provide rigorous control of measurement error, we also conducted a structural equation (SEM) model in-line with the four facet regression reported above. Specifically, we used the PCL-R items as indicators of their respective factors (Interpersonal, Affect, Lifestyle, & Antisocial) and specified the PCL-R factors as predictors of the superordinate EF factor. The results indicated acceptable fit for the SEM (CFI = .90; RMSEA = .04, robust weighted least squares-χ^2/df (770.74/399) = 1.93). Consistent with the regression results reported above, the Affect facet (standardized parameter: $-.43$, $p < .01$) was negatively related to EF performance. Additionally, unlike the regression results, the Interpersonal facet (standardized parameter: $.24$, $p < .05$) was positively related to the EF performance (see Figure 2). SEM formally accounts for measurement error (unlike linear regression) and, thus, it is possible to obtain more precise parameter estimates, lower standard errors, and thus, more significant results (e.g., significant Interpersonal and Affect facet effects using SEM).

The Influence of Measurement on the Relationship Between Psychopathic Trait Dimensions and EF Performance

A second goal of the present study was to compare measurements methods of psychopathic trait dimensions. PCL-R Factor

1 and MPQ-B FD were only correlated at $r = .26$, reinforcing the idea that these measure may be tapping a somewhat similar construct, but are far from equivalent (see Benning et al., 2005). Consistent with the proposal that certain traits of psychopathy are related to adaptive characteristics, MPQ-B FD was significantly and positively related to the EF composite, $F(1, 351) = 11.10$, $\beta = .23$, $p < .01$, $\eta_p^2 = .03$; Figure 1B.[2] There were no significant effects involving MPQ-B IA ($\beta = -.08$, $p = .14$). Unique effects (i.e., simultaneous) models indicated that the FD effect remained significant, $F(1, 351) = 11.10$, $\beta = .23$, $p < .01$, $\eta_p^2 = .03$, whereas the IA effects remained nonsignificant ($\beta = -.05$, $p = .34$). Finally, comparison (i.e., simultaneous regression) of PCL-R Factor 1 and FD indicated that PCL-R Factor 1 was negatively and significantly related to EF performance, $F(1, 328) = 4.10$, $\beta = -.18$, $p = .03$, $\eta_p^2 = .02$, whereas

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[1] For all models, we examined whether race/ethnicity, IQ, and/or reading scores impacted the results. None of the effects reported in the main text were altered by the inclusion of race/ethnicity. When IQ was included as a continuous covariate, the independent effect of Factor 1 was significant, $F(1, 368) = 5.23$, $p = .02$, $\eta_p^2 = .01$. However, the addition of Reading scores yielded a nonsignificant effect, $F(1, 316) = 2.05$, $p = .15$, $\eta_p^2 < .01$, consistent with the findings reported in the main text. For Factor 2, inclusion of IQ resulted in a negative, but nonsignificant effect, $F(1, 347) = 1.69$, $p = .19$, $\eta_p^2 < .01$. With both Reading and IQ scores entered as covariates, there was no significant relationship between Factor 2 and EF performance, $F(1, 298) = .32$, $p = .57$, $\eta_p^2 < .01$. Finally, for the unique effects model, none of the effects changed (i.e., neither Factor 1 nor 2 were related to EF performance). Finally, with the inclusion of IQ the Affect facet effect remained significant ($F(1, 368) = 4.60$, $p = .03$ $\eta_p^2 = .01$) and the Antisocial facet effect was nonsignificant ($F(1, 346) = 2.99$, $p = .09$, $\eta_p^2 < .01$). When reading scores were included both of these effects were nonsignificant. In the unique effects model for the facets, the inclusion of IQ and/or reading scores resulted in no significant effects of the facets on EF performance.

[2] One goal of the present study is to compare measures of psychopathic trait dimensions. Although the selection of the PCL-R and MPQ-B as measures of psychopathic trait dimensions represent prominent examples of scales that may be differentially related to external correlates, a number of other measures of psychopathic traits have emerged. Therefore, we also examined the relationship between psychopathic trait dimensions and EF using another self-report questionnaire, the Psychopathic Personality Inventory (PPI; Lilienfeld & Andrews, 1996). The PPI is a self-report questionnaire that includes eight subscales that independently assess Factor 1 and Factor 2. Like the MPQ-B, the PPI estimates psychopathic trait dimensions using a variety of personality traits. Social Potency, Coldheartedness, Fearlessness, Impulsive Nonconformity, and Stress Immunity comprise Factor 1 (PPI-I), whereas Machiavellian Egocentricity, Blame Externalization, and Carefree Nonplanfulness items comprise Factor 2 (PPI-II). The PPI shows good convergent validity with other self-report measures of psychopathy (Lilienfeld & Andrews, 1996; Tonnaer, Cima, Sijtsma, Uzieblo, & Lilienfeld, 2013). Results for the PPI were consistent with the results for FD. PPI-I was associated with better EF performance (independent model: $F(1, 368) = 7.78$, $p < .01$, $\eta_p^2 = .02$; unique model: $F(1, 368) = 7.65$, $p < .01$, $\eta_p^2 = .02$) and PPI-II was unrelated to EF ($ps > .55$). Comparing PCL-R Factor 1 and PPI-I, Factor 1 was negatively and significantly related to EF performance $F(1, 368) = 7.63$, $p = .01$, $\eta_p^2 = .02$, whereas PPI-I remained positively and significantly related to EF performance $F(1, 368) = 12.00$, $p < .01$, $\eta_p^2 = .03$. Therefore, much like FD, higher scores on PPI-I seems to indicate better EF performance and may tap more adaptive traits than PCL-R Factor 1.
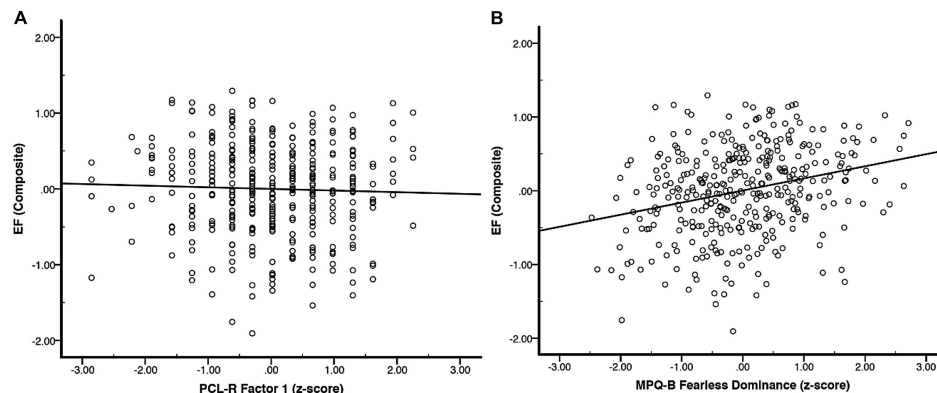
Figure 1. (A) PCL-R F1 was unrelated to the EF composite ($p > .05$). (B) MPQ-Estimated FD was significantly and positively related to the EF composite ($p < .01$).

FD remained positively and significantly related to EF performance, $F(1, 328) = 10.99$, $\beta = .28$, $p < .01$, $\eta_p^2 = .03$.[3,4]

Discussion

Although there has been substantial research regarding EF in psychopathy, the overall pattern of results lacks consistency. Although EF may be weakly and inconsistently related to the broad construct of psychopathy, there is some evidence that it may be significantly associated with specific dimensions that capture aspects of psychopathy (see Maes & Brazil, 2013; Morgan & Lilienfeld, 2000). Moreover, the type of measures used to define these dimensions may influence the emerging associations with external correlates. Clarifying these associations can yield important insights into the specific dimensions associated with psychopathy, and, in the process, clarify the correlates responsible for characteristic behaviors.

Psychopathic Trait Dimensions and EF Performance

A potential advantage of examining psychopathy in terms of various trait dimensions is that relationships may be revealed that are often not apparent when examining total psychopathy scores (i.e., the clinical syndrome). Consistent with previous research linking general antisocial behavior with deficient EF, the independent effect of Factor 2 and the Antisocial facet were negatively related to EF performance. The association between antisocial behavior and poor EF corroborates previous suggestions (e.g., Morgan & Lilienfeld, 2000). Individuals with EF deficits are less able to override maladaptive response inclinations to maintain more appropriate and personally beneficial behavior. Consequently, they are at higher risk for persistent rule breaking and committing acts of violence. Thus, deficits in EF may underlie the lack of pro-social behavior and some decision-making deficits that have been found to characterize antisocial behavior (e.g., Yechiam et al., 2008; Radke, Brazil, Scheper, Bulten, & de Bruijn, 2013).

However, when controlling for Factor 1 traits (e.g., callousness) or the Affect facet, the association between antisocial behavior and EF became nonsignificant. On the one hand, there are potential pitfalls of partialing the independent effects of one variable from another (Lynam, Hoyle, & Newman, 2006), in the sense that removing interpersonal and affective traits from antisocial behavior may be artificially splitting traits that within an individual are important in combination for informing behavior, particularly in offenders. Furthermore, recent work suggests that the shared variance between psychopathy-related traits might be of great explanatory value in characterizing the interplay between psychopathy and cognitive functioning (Brazil, 2015; Maes & Brazil, 2015). On the other hand, examination of specific relationships with particular traits may become statistically meaningful while controlling for other aspects of psychopathy. In this case, the Affect facet of psychopathy appears most robustly related to EF deficits (see also the Supplemental analysis where the PCL-R Interpersonal facet was positively related to EF performance). Though somewhat surprising, it is possible that difficulty inhibiting dominant responses, rule learning, and abstract reasoning for individuals high on the Affect facet may influence their ability to callously disregard their own well-being, the well-being of others, and chronically fail to engage in responsible behaviors. This interpretation is consistent with evidence that the Affect facet of psychopathy prospectively predicts aggressive and violent behavior (Vitacco, Neumann, & Jackson, 2005). These findings suggest that the affect dimension of psychopathy may be uniquely related to EF and

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[3] Statistics based on the normal distribution (frequentist statistics) are incapable of assessing whether the model for the null-hypothesis (H0) predicting the absence of a correlation is more probable than the alternative model (H1) predicting the presence of a correlation. Therefore, we computed log-transformed Bayes Factors (BF10) to assess whether H0 or H1 is more likely using the R software package (Wetzels & Wagenmakers, 2012). The BF10 was 0.049 for the correlation between EF and Factor 1, indicating that the lack of relationship between EF and Factor 1 is about 21 times more likely to be true. For the FD-EF correlation, the BF10 was 57602, thus providing decisive evidence in favor of the positive relationship between these two variables. These results substantiate the validity of the main findings from an alternative statistical framework.

[4] Because the MPQ-B and relatedly the PPI do not have clear item-to-factor latent structures, it was not possible to test a SEM of the MPQ-B/EF relations. Moreover, serious questions have been raised regarding the latent variable integrity of the PPI two-factor model, and by association scales like the MPQ-B (see Neumann, Uzieblo, Crombez, & Hare, 2013 for example).
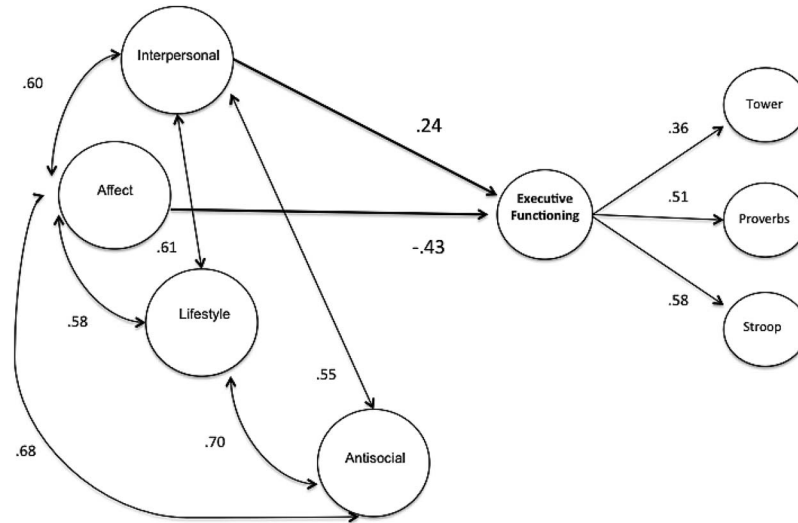
Figure 2. Structural equation model of PCL-R facets predicting EF performance.

understanding that association can help clarify the specific EF dysfunctions associated with these dimensions, but not psychopathy as a clinical syndrome, per se.

Comparison of Psychopathy Measures and EF Performance

In extant literature, PCL-R Factor 1 and FD are often used interchangeably to assess the interpersonal–affective traits of psychopathy. However, the pattern of results from the current study demonstrates that the interpersonal–affective traits of the respective measures are only modestly correlated and are differentially related to EF performance. Results indicate that better EF performance was associated with higher scores on MPQ-B FD, whereas PCL-R Factor 1 did not predict EF performance. Thus, the general claim that interpersonal-affective traits are associated with higher EF can neither be wholly supported nor refuted (Maes & Brazil, 2013; but see Footnote 3). Rather, consistent with previous research, the suitability of this claim is dependent on the operative assessment tool.

As noted in the Introduction, the construct of FD is derived from a normal personality trait model. For example, FD components, such as fearlessness and low stress reaction, may tap a propensity toward decreased general arousal and anxiety, which would enhance a person's "capacity to remain calm and focused in pressured or threatening situations, rapid recovery from stressful events, high self-assurance and social efficacy, and a tolerance for unfamiliarity and danger" (Skeem et al., 2011, p. 106). In turn, such freedom from negative affect may alleviate demands on EF, and leave more capacity available for screening out interfering information and inhibitory control (i.e., superior performance on EF measures). PCL-R Factor 1, by contrast, places more emphasis on the antisocial features inherent to the construct of psychopathy (Hare & Neumann, 2010). Factor 1 items, such as glibness, manipulativeness, shallow affect, failure to accept responsibility, and pathological lying, are often rated based on criminal activities or behaviors that are contradictory to social mores (e.g., theft, sexual

crimes, covering up indiscretions). Although these traits may be related to better EF functioning, they do not appear as closely linked as the traits comprising FD.

Consistent with this conceptualization and the nature of the Factor and four-facet models (Hare & Neumann, 2008), the recently proposed Triarchic model decomposes symptoms related to psychopathy into three clusters: Meanness, Boldness, and Disinhibition (Patrick, Fowles, & Krueger, 2009). Within this model, the interpersonal–affective traits of psychopathy appear to be differentially related to the Triarchic subcomponents. Although the Triarchic subcomponents show a range of significant correlations with the Interpersonal, Lifestyle, and Antisocial facets of the PCL-R, they are only modestly linked with the Affect facet of the PCL-R (Venables, Hall, & Patrick, 2014). Moreover, the Triarchic subcomponents appear differentially related to measures that assess these interpersonal-affective traits. That is, Boldness (emotional resiliency, social assertiveness) aligns with FD and is presumed to reflect individual differences in reactivity of the brain's core defensive system. By contrast, Meanness (lack of empathy, exploitativeness) is more aligned with PCL-R Factor 1 and seems to reflect a "biologically based predatory orientation entailing aggressive resource seeking without concern for others" (Patrick & Drislane, 2014, p. 4). Alternatively, both FD and PCL-R Factor 1 may be related to low arousal (reactivity) and anxiety, but for different reasons relating to the nature of their link with EF. Specifically, FD and its related behaviors may be dependent upon enhanced top-down control (i.e., EF), which facilitates their ability to control negative emotions and navigate surroundings (Bishop, 2007), whereas PCL-R Factor 1 traits may be unrelated to top-down control, but driven by deficits in bottom-up processes that undermine the experience of negative affect (Patrick, 2007). Regardless of the specific etiological model, the conceptualizations of FD and PCL-R Factor 1 items seem to capture phenotypically similar constructs, but may reflect different underlying psychobiological processes.

Although the findings from the present study are intriguing, a few limitations should be mentioned. First, given that this study was conducted within a prison setting, the pattern of results may not generalize to populations outside of correctional institutions. This issue is particularly important given that FD was developed and largely validated in a community sample. Researchers in the future may want to conduct a large-scale study in the community using FD and the PCL-Screening Version (a community analogue to the PCL-R). Second, the present sample was limited to male offenders, thus it is unclear whether or how gender may impact the relationship between measures of interpersonal–affective traits and EF. Finally, the measure of EF was selected to represent a broad spectrum of EF processes. It is possible that more nuanced relationships within a subset of EF processes exist between various psychopathic trait dimensions. Despite these limitations, the present study illustrates that not all psychopathy-related dimensions and measures are alike, and differ in their relationships with EF in important and measurable ways.

Skeem and colleagues (2011) have suggested that exclusively favoring the PCL-R over other measures of psychopathy may negatively impact research, because they believe the measure is eclipsing the construct itself (cf. Hare & Neumann, 2010). Therefore, they propose that an optimal study would include multiple measures of psychopathic dimensions. Although this may be a more comprehensive approach, it then becomes paramount to discuss—and if possible, reconcile—the differences across measures, such that these measures are not discussed as if they are interchangeable.

The present study shows that specific dimensions are related to EF dysfunction and that those relationships are dependent on measure (e.g., FD may be associated with adaptive functions, whereas PCL-R Factor 1 is not). Therefore, caution is needed when suggesting that psychopathy broadly, or interpersonal-affective traits specifically, are positively related to EF (Maes & Brazil, 2013). And, most critically, greater clarity is needed about the theoretical arguments and assessment measures used to substantiate an adaptive versus maladaptive view of interpersonal-affective traits of psychopathy. Ultimately, clarifying the interaction between measure, construct, and functioning will promote our understanding of psychopathy, particularly interpersonal–affective traits, from clinical, cognitive, and psychobiological perspectives.

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