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Bridging Neuropsychology and Forensic Psychology: Executive Function Overlaps With the Central Eight Risk and Need Factors

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Abstract

Recent research expanded theoretical frameworks of criminality to include biosocial perspectives. This article advances the biosocial integration into traditional criminological theories by focusing on the potential contribution of executive function (EF) to Andrews and Bonta's risk-need-responsivity (RNR) model. EF encompasses a collection of abilities critical to adaptive human functioning, many of which seem to underlie criminogenic risk and need factors. Although the assessment of EF can be elusive, research suggests that offenders with antisocial personality disorder (ASPD) experience EF deficits. Theoretical analysis on neuropsychological and forensic concepts suggests that unitary and discrete EF domains underlie the "Central Eight" criminogenic factors that are related to criminal behavior and, by extension, the RNR model of forensic assessment and treatment. Research and conceptual limitations of the current neuropsychological and forensic literature are discussed along with the limits of our theoretical analysis. A call for more theoretical and applied forensic neuropsychological research is presented.

Keywords

executive function, antisocial personality disorder, risk assessment, intervention, risk-need-responsivity

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The link between social-cognitive theories of criminality and biosocial perspectives is an important consideration in forensics (Beaver, Wright, & DeLisi, 2007; Jantz & Morley, 2018). For example, Newsome and Cullen (2017) applied "biosocial criminology" to Andrews and Bonta's risk-need-responsivity (RNR) model, and the RNR model is arguably the most comprehensive and empirically supported theory of the origins, assessment, and treatment of antisocial behavior (Bonta & Andrews, 2017). In response to Newsome and Cullen, we specifically consider the potential for neuropsychological research to advance the RNR model.

Executive function (EF) is a neuropsychological construct that underlies adaptive human behavior with degrees of impairment associated with psychopathology, including antisocial personality disorder (ASPD). Broadly, ASPD is a complex disorder related to a persistent behavioral pattern marked by the disregard for and violation of the rights of others. Individuals with ASPD commonly find themselves in conflict with the law, as reflected by the elevated ASPD prevalence within correctional settings (e.g., 44.1%; Beaudette, Power, & Stewart, 2015) compared with the general North American population (e.g., 1.0%; Lenzenweger, Lane, Loranger, & Kessler, 2007).

The Central Eight criminogenic risks and needs (Andrews & Bonta, 1994; Bonta & Andrews, 2017) offer a theoretical framework that serves to predict and manage future criminal behavior and to link forensic assessment and treatment. This article proposes that EF assessments of offenders with ASPD may facilitate the assessment of recidivism and subsequent intervention because of the contribution of EF to criminogenic risks and needs. The rationale for our position is derived in three ways: First, we present a critical review on the conceptual and neurological basis of EF and the specific deficits pertaining to those with ASPD; second, we review the Central Eight criminogenic risk and need factors (Bonta & Andrews, 2017) and their efficacy in predicting recidivism for those with ASPD; and third, we analyze the theoretical overlap between EF domains and the Central Eight risk and need factors. Our thesis does not include the etiological pathways of EF deficits as a topic of this breadth merits several papers (e.g., substance use, brain injury, developmental pathology, attention deficit and hyperactivity disorder). Notably, however, meta-analyses have estimated that prevalence rates of brain injury were between 51% and 60% among offenders compared with 2% to 38% in the general population (Farrer & Hedges, 2011; Shiroma, Ferguson, & Pickelsimer, 2010). The high frequency of brain injury among offenders and its deleterious effect on EF suggests that EF deficits are associated with criminality (Ramos, Oddy, Liddement, & Fortescue, 2018; Schwartz, Connolly, & Brauer, 2017; Schwartz, Connolly, & Valgardson, 2017).

Conceptual and Neurological Basis of EF

EF has been described with varying degrees of clarity regarding its conceptual definition and neuroanatomical correlates, even to the degree to which frontal lobe functioning subsumes EF (Alvarez & Emory, 2006). The present debate on the conceptual nature of EF continues to be contested in the area of whether unitary control processes

versus discrete brain regions comprise EF, or both (Garcia-Barrera, Kamphaus, & Bandalos, 2011; Miyake et al., 2000). There is, however, a consensus that EF is a construct that involves higher order cognitions that monitor and govern lower order processes for the purposes of adaptive human behavior in novel situations (Alvarez & Emory, 2006; Snyder, 2013). EF components are correlated with one another, yet still discrete in terms of their behavioral, genetic, and neuroanatomical components (Snyder, 2013).

Efforts to understand the best conceptual and measurement approaches to EF spawned a profusion of EF definitions and theories for use across settings, life span (Luna, Marek, Larsen, Tervo-Clemmens, & Chahal, 2015), and specific populations (Garcia-Barrera et al., 2011). Miyake and colleagues found support for separate EF domains of mental set shifting, updating and monitoring information, and inhibition of automatic responses, but also found support for intercorrelations that suggest a unitary general EF resource (Miyake et al., 2000). This added to the evidence for both unitary and discrete EF domains, a finding also supported by others (e.g., Fisk & Sharp, 2004; Friedman et al., 2008). These approaches to modeling EF, however, fail to account for the broad array of cognitive resources required to monitor higher order behavior in a complex world. Garcia-Barrera et al. (2011) used a sophisticated statistical model to design a four-component model of EF comprised of the following: problem solving, attentional control, behavioral control, and emotional control. Problem solving included the capacity to plan, find solutions, make decisions, and organize information for goal-directed behavior. Attentional control involved the ability to focus, sustain, shift attention, and use working memory. Importantly, this model of EF included behavioral control, which incorporated elements of behavioral self-regulation, inhibition, and impulse control. Finally, emotional control consists of emotional self-regulation in response to environmental and internal cues.

Concerning the neurological correlates of EF, there is an abundance of support for both discrete and unitary neurological networks that correspond to conceptually distinct EF domains. According to Schoenberg, Marsh, and Lerner (2011), EF domains have traditionally been described as being "housed" within three discrete regions of the prefrontal cortex. The dorsolateral prefrontal cortex is connected with tasks such as reasoning, problem solving, and persistence. The orbitofrontal region is related to inhibition, working memory, and learning. The anterior cingulate region is implicated in attention, motivation and initiation, and self-awareness. Although this is a helpful neurological roadmap, it is oversimplified in that it ignores connected circuitry throughout the brain (Jurado & Rosselli, 2007). It has been known for some time that one must consider both the distributed neural network that underlies EF processes, and the unique contributions of specific regions that are activated across tasks to fully appreciate EF (Miller & Cohen, 2001; Niendam et al., 2012). To this end, a cognitive control network whereby all EFs are buttressed by the unitary and domain-specific activation of cortical and subcortical regions has been proposed. For example, a meta-analysis by Niendam et al. (2012) combined results from approximately 200 functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) studies to examine a common cognitive control network underlying traditional EFs

(i.e., initiation, inhibition, working memory, flexibility, planning, and vigilance) and their respective domain-specific activations (for more, see Chan, Shum, Toulopoulou, & Chen, 2008). In contrast to the cognitive network (sometimes referred to as "cool" EF), the affective network (sometimes referred to as "hot" EF) encompasses the orbitofrontal prefrontal cortex with connections to the limbic cortex including the amygdala and hippocampus, which underlies emotion regulation and motivation (Arnsten & Rubia, 2012).

Bridging conceptual and neurological EF understandings, a review by Friedman and Miyake (2017) reported that the neurological mapping of the unity and separability of EF networks have been replicated across multiple independent samples across the life span and are highly heritable, but also amenable to environmental influence. Given the richness in neuroimaging studies, perspectives that describe the functional organization of the prefrontal cortex range from narrowly labeling specific EFs onto discrete brain areas, to broadly modeling anterior-posterior, dorsal-ventral, and medial-lateral hierarchical organizations based on EF complexity, type of information, and emotional or motivational cues. Nevertheless, all of these overlapping views describe pieces of the broader EF phenomenon.

There are some limitations to consider when interpreting the overall neuropsychological research on EF deficits in psychopathology. One issue with evaluating the neuroanatomical correlates of EF is that discrete and unitary components are diverse, and thus, only testable individually across different situations and methods of measurement. It is difficult to determine the reliability of findings when inequivalent EF constructs are used across studies, and diverse brain regions are activated by theoretically distinct EFs (i.e., task impurity; Jurado & Rosselli, 2007). Moreover, much of the research focuses on the cognitive rather than the affective or motivational facets of EF. The issue of ecological validity is a concern with regard to how decontextualized cognitive testing translates into complex daily functions that draw upon multiple EFs. Principals that account for ecological validity are of greater importance when assessing EF deficits in psychopathology (Snyder, 2013).

EF Deficits of Those With ASPD

ASPD is a diagnosis defined in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; American Psychiatric Association, 2013) as a pervasive pattern of disregard for and violation of the rights of others (American Psychiatric Association, 2013). The diagnosis covers a range of socially disapproved behaviors including repeated criminal acts, deceitfulness, impulsivity, repeated fights or assaults, recklessness, consistent irresponsibility, and lack of remorse. Three of these symptoms, along with the presence of a conduct disorder diagnosis before age 15 years, are required for diagnosis. ASPD is a well-studied disorder that is supported by massive bodies of research from prospective longitudinal studies (e.g., Moffitt, 1990, 2006; Moffitt & Henry, 1989). Even from youth, EF deficits have been shown to be related to the development of ASPD as more aggressive and impulsive juvenile offenders exhibited lower scores on EF measures (Moffitt & Henry, 1989).

Research on EF deficits among those with ASPD is both growing and changing, but limited by the factors discussed earlier. Early research yielded equivocal results, while more recent research has shown evidence of stronger associations. Two meta-analyses have examined antisocial behavior (a prerequisite of ASPD diagnosis) and EF deficits. Both studies yielded similar conclusions, yet allowed markedly different research designs in their selection of studies. Morgan and Lilienfeld (2000) conducted a meta-analysis that examined 60 years of literature to include 39 studies ($N = 4,589$) on EF and antisocial behavior. They found a significant negative association between ASPD and EF, suggesting that the dorsolateral prefrontal cortex and orbitofrontal are impaired structurally and functionally in those with ASPD, particularly in males. There were, however, a number of limitations with their meta-analysis. First, the studies were limited to males and thus nothing may be concluded about females with ASPD. Second, the meta-analysis was not conducted on ASPD offenders, but instead, those with Psychopathy Checklist–Revised (PCL-R; Hare, 2003) defined psychopathy—a construct held by a small subset of persons with ASPD. It is essential that these two disorders are examined separately because research has shown that those with psychopathy present unique clinical and neurological characteristics (De Brito & Hodgins, 2009). Third, ASPD has been related to high rates of comorbidity with other personality disorders that have their own unique neurological deficits (De Brito & Hodgins, 2009). Disentangling differential diagnoses (or limiting claims only to comorbid ASPD and psychopathy) and their neuroanatomical correlates were not considered, nor were lifestyle factors that may impact early EF development.

In a meta-analysis of 126 studies ($N = 14,786$) by Ogilvie, Stewart, Chan, and Shum (2011), antisocial groups performed significantly worse on EF measures than controls. Although there was a robust association between EF deficits and ASPD, specific domains of EF deficits could not be examined reliably due to methodological variation across studies. The authors also acknowledged the limitation of not having well-defined boundaries between ASPD traits and its diagnosis, and thus cautioned against interpreting differences in EF performance across the ASPD spectrum. Another limitation presented was the difficulty in controlling for factors that may moderate the association between ASPD and EF such as attention deficit hyperactivity disorder and substance abuse.

Research since 2011 has illuminated the relationship between ASPD and EF further. Schiffer et al. (2014) studied the neural correlates of EF in a sample of offenders with ASPD compared with controls. Offenders with ASPD had significantly lower response times (but more errors) to incongruent stimuli and higher scores on attentional impulsivity, suggesting that ASPD may be related to cognitive instability and to a lack of tolerance for complexity. There was also reduced activation in frontocortical (i.e., left dorsal anterior cingulate region, right dorsolateral prefrontal cortex, and pre/postcentral gyrus) and subcortical (i.e., left putamen, left thalamus) neural structures related to cognitive control, attention, language, and emotional processing. These findings suggest that offenders with ASPD may have a reduced capacity to internalize error processing and subsequently modify their behavior effectively. EF deficits,

specifically inhibitory control and planning problems, have been found for those with ASPD in adult correctional samples (Meijers, Harte, Meynen, & Cuijpers, 2017; Zeier, Baskin-Sommers, Hiatt Racer, & Newman, 2012), and longitudinal childhood to adolescent samples (Hawes et al., 2016). This section provided a critical review of neuropsychological research on EF among those with ASPD, but we now consider ASPD from a forensic psychological perspective.

Offender Risk/Need Assessment and the Risk/Need/Responsivity Model

History of Risk Assessment

Offender risk assessment has evolved considerably over the past 40 years. This includes at least four discrete phases, described by some as generations (Bonta & Andrews, 2017; Andrews, Bonta, & Wormith, 2006). The pioneered first-generation risk assessments relied on using the professional judgment of risk by rigorously trained clinicians. Research has consistently revealed that these determinations were not accurate and that in general, clinical professionals were relatively poor prognosticians for two reasons. First, informal and unverifiable data were used to inform decision-making, and second, offender characteristics not empirically related to criminal behavior were attended to and given excess worth. Some have suggested that the advantage of professional judgment allowed unique cases to be targeted and treated by clinician expertise, and for the flexible reevaluation of risk in light of new information. Still, the overarching body of evidence has shown that professional judgment is poor at risk prediction (Grove, Zald, Lebow, Snitz, & Nelson, 2000).

The second generation of risk assessments implemented a quantitative approach that drew upon fixed, or "static," risk variables to derive an actuarial risk judgment. Meta-analyses have shown that actuarial methods unequivocally outperform professional judgment of recidivism by a significant margin. Over the subsequent years, the field of forensic psychology witnessed the development of actuarial measures that range in their target population and predicted outcome. Its limitations, however, are that second-generation risk assessments have little or no theoretical basis and that they are comprised exclusively of static, typically historical, variables. Consequently, theoretically based criminogenic factors are not addressed and neither are changes that occur throughout treatment that may moderate recidivism risk (dynamic risk variables).

The third-generation risk assessments are different from their predecessors in that they evaluate offender *risk* and *need* using a theoretically driven framework. Effectively, the addition of criminogenic *need* allowed for the assessment of dynamic (changeable) dimensions using an underlying explanatory structure that is capable of monitoring improvements and deteriorations overtime, with or without intervention. The Level of Service (LS) instruments (Bonta & Andrews, 2017) are based on these principles and has broad research support for their predictive accuracy across offense types, gender, and antisocial groups.

Fourth-generation offender risk assessments continue to evaluate *risk* and *need*, but also link offender risk assessment and case management using the *RNR* model. The rationale for the addition of *responsivity* comes from the fact that a risk/need assessment is not utilized to its full potential if its results are not translated into clinical practice. Moreover, the *responsivity* principle draws attention to the role of specific individual strengths and weaknesses that may enhance or impede prosocial development, and encourages clinicians to optimize their interventions by accommodating these characteristics in their work with offenders. The Level of Service/Case Management Inventory (LS/CMI; Andrews, Bonta, & Wormith, 2004) is one of the fourth-generation risk assessment tools used across correctional settings and is based on the RNR principles. The efficacy of this tool is attributable in part to its underlying theoretical premise, the contribution of the Central Eight criminogenic risk and need factors for criminal behavior (Bonta & Andrews, 2017).

Structured Professional Judgment (SPJ) is a tradition of risk assessment that emerged from the need to not only predict risk but also assist with the development of violence risk formulation, management, and prevention for individuals. According to Whittington et al. (2013), SPJ may be conceptualized as a unison between clinical judgment and actuarial risk assessment. Risk levels are not assigned in accordance with total scores or normative samples, but rather with clinical discretion. SPJ risk assessments are generally comprised of static and dynamic risk factors that underlie violence. A prime example is the Historical Clinical Risk Management-20 family of tools, which have received considerable support for their reliability and predictive validity (Douglas et al., 2014). In connection to the "generational" framework aforementioned, SPJ may imperfectly thought of as a third- to fourth-generation tool. Many if not all SPJ measures operate independently of criminological theory in contrast to tools such as the LS/CMI.

An understanding and appreciation of criminogenic risk and need serve to inform efforts that are designed to estimate, lessen, manage, and prevent criminal behavior. Its most prominent application is found in the RNR model (Andrews & Bonta, 1994; Bonta & Andrews, 2017). The Central Eight risk and need factors have led to the development of some of the most frequently used and studied risk assessment tools globally, including the LS family of scales (Wormith, 2011). The efficacy of the Central Eight in predicting criminal behavior is well supported across meta-analytic studies (Andrews & Bonta, 1994; Bonta & Andrews, 2017). When the Central Eight has been implemented in risk assessment tools such as the LS scales, its recidivism estimates have been validated across numerous meta-analyses while controlling for ethnicity, age, geographic region, and recidivism type (e.g., Olver, Stockdale, & Wormith, 2014).

Among the Central Eight, Andrews and Bonta (1994; Bonta & Andrews, 2017) have identified four key empirically derived covariates of criminal conduct (criminal history, antisocial attitudes, antisocial associates, and antisocial personality pattern). In other words, antisociality is both multidimensional and one of the best predictors of criminal behavior. Broadly, the Central Eight criminogenic risk and need factors identify the specific domains within this overall construct that require greater attention.

First, history of antisocial behavior relates to the early and consistent involvement in antisocial acts across a range of settings. Second, antisocial personality pattern describes risky pleasure-seeking acts, weak self-regulation, restlessness, hostility, and aggression. Third, antisocial cognition includes beliefs, values, rationalizations, and attitudes that validate criminal and cognitive-emotional conditions of resentment, anger, and defiance. Fourth, antisocial associates involve relationships with criminal peers, removal from anti-criminal peers, and immediate social promotion of crime. Fifth, family and marital factors relate to the presence of nurturance/caring and monitoring/supervision. Sixth, school and work is comprised of poor performance and satisfaction in school or vocation. Seventh, leisure and recreation consist of low degrees of involvement and satisfaction with activities not criminal. Finally, substance abuse is related to the level of abuse both of alcohol and other drugs.

The Central Eight, specifically antisocial personality patterns, is characterized by the cardinal trait of poor self-regulation, a construct known as self-control in other criminological theories of antisocial behavior (e.g., Gottfredson & Hirschi, 1990). Gottfredson and Hirschi's (1990) theory of self-control is supported as a robust predictor of criminality (e.g., Pratt & Cullen, 2000), and a factor within the EF constellation governed by the prefrontal cortex (Beaver et al., 2007).

Current Era of Risk Assessment

Having provided context for the history of risk assessments and its relation to the Central Eight criminogenic risk and need factors, the present generation of risk assessments are reviewed in greater detail with respect to how they might mitigate recidivism when coupled with intervention. Referring back to Bonta and Andrews (2017), the success of the Central Eight in predicting and curbing recidivism is due in some measure to its applied counterpart, the RNR model. This model takes into account the risk level of the offender and matches it to the appropriate level of treatment services. In other words, higher risk offenders require more extensive intervention than lower risk offenders for a significant reduction in recidivism risk. As discussed previously, factors that elevate risk are the empirically derived antisocial traits listed in the Central Eight. Historically, there have been theoretical and practical resistances to this principle. For instance, labeling theory has cautioned against providing any intervention as it would increase criminogenic risk due to criminal-related identity changes, but has ignored the likelihood that this logic would apply only to low-risk offenders (Schur, 1971). Instead, its argument has been that less intervention would placate general offending, a position that does not align with research that supports the risk reduction efficacy of intervention. A practical concern that supports this stance is that human service agencies tend to prefer working with compliant low-risk offenders as opposed to resistant high-risk offenders. Despite these criticisms, meta-analytic studies support that if implemented properly the principle of risk alone has reduced recidivism (Bonta & Andrews, 2017).

Criminogenic need locates factors within the Central Eight that require intervention. The purpose of this principle is to focus correctional rehabilitation on domains

that have been shown to decrease recidivism, unlike factors outside of criminogenic traits and clinical treatment (although these types of services may be parts of general healthcare). The applied significance of this principle is that it forms intermediate goals of treatment while offenders are detained or under community supervision. Given that most cases do not allow for direct observation of criminal behavior, the only option in working towards recidivism reduction is to augment current aspects of the individual and their situation that are criminally linked. As such, criminogenic need can impact dynamic risk factors whereby change is associated with changes in recidivism probability.

Responsivity promotes the use of cognitive-behavioral intervention and the deliverance of these treatments in a tailored approach that align with the ability and learning style of the offender. The main tenet of responsivity is that the most effective way to manifest change is through cognitive-behavioral treatment such as modeling, reinforcement, role-playing, skill building, and cognitive restructuring specific problems or causes. The specific considerations of responsivity also incorporate subsidiary interventions to suit individual personality type and cognitive styles, such as personality-based systems, insight-oriented therapy, and motivational interviewing. There is mounting evidence in support of this principle within the larger RNR model in reducing recidivism, yet more research is required on the efficacy of interventions across the diverse groups that comprise the offender population (Bonta & Andrews, 2017). The extent to which EF impacts the Central Eight, and by extension its importance to RNR principles, is now addressed.

EF, the Central Eight, and Recidivism

The previous sections established that offenders with ASPD experience EF deficits and that the presence of ASPD traits is a chief factor in recidivism. Harmonizing these two concepts, the overlap between criminogenic risk and need and EF domains logically point towards using EF assessments to refine recidivism estimates and treatment targets in correctional settings. This case will be developed first through a review of research on using EF deficits as risk factors, followed by a theoretical analysis between the Central Eight and EF.

EF as a Recidivism Risk Factor

Although research on the use of EF deficits as risk factors for recidivism among offenders with ASPD is limited, a few studies have shown promising results for their utility. Meijers, Harte, Jonker, and Meynen (2015) reviewed seven studies that examined EF differences between incarcerated offenders and controls on neuropsychological measures. They found that common EF domains were impaired for the violent and not violent offender groups (i.e., attention and shifting), but also uniquely within violent (i.e., shifting and working memory) and not violent offenders (i.e., inhibition, working memory, and problem solving). The overall findings suggested that incarcerated offenders may have difficulty in suppressing antisocial impulses (inhibition), stopping

previously maladaptive behavior (shifting), and working towards complex prosocial goals (working memory). These results also align with the idea of EF having distinct functional areas that share some unitary underlying domain (Miyake et al., 2000).

Seruca and Silva (2015) studied disparities in EF between a sample of recidivists and those who did not recidivate using neuropsychological measures. There were elevated but not significant antisocial trait differences for recidivists compared with those who did not recidivate. When compared with controls, recidivists showed significantly worse performance on Trail Making Tests. Those who did not recidivate had significantly lower scores on Porteus Maze Test (Porteus, 1965) overall, although null findings for this test were reported by others (Meijers et al., 2015). These results suggest that offenders, in general, may have planning deficits (Wormith & Hasenpusch, 1979) and that recidivists, in particular, may have mental flexibility impairments. Others have found similar EF differences in recidivist versus those who did not recidivate and control groups in mental flexibility and planning, which suggests that there is greater frontal lobe dysfunction in those who reoffend (Bergeron & Valliant, 2001; Valliant, Freeston, Pottier, & Kosmyna, 2003). In sum, these findings are evidence for the perseveration of a dysfunctional antisocial lifestyle as a result of EF impairments in modifying behavior despite punishment.

Aside from the issue of small sample sizes, the main limitation of these studies is that neuropsychological measures do not necessarily map onto theoretical constructs that can be compared with criminogenic risk and need. Consequently, there is little description as to how it impacts the assessment and treatment of criminal behavior as per the RNR model. The solution to this problem lies in using the same unit of analysis by comparing theoretical EF models with criminal theory.

The Overlap Between the Central Eight and EF

The four-component model of EF (Garcia-Barrera et al., 2011) has the advantage of being theoretically driven and thus comparable to criminogenic risk and need domains that offer recidivism estimates and treatment targets. The rationale for using this model in EF measures instead of cognitive ability tests is that IQ holds differential associations with EFs and that those with ASPD perform worse on EF measures even after controlling for IQ (Morgan & Lilienfeld, 2000). Although IQ is an insufficient measure of overall EF, some research supports that it is a minor risk factor (e.g., Andrews & Bonta, 1994). The second rationale for using theoretical EF measures is that offender reentry into society presents obstacles that tax EF resources such as gaining housing and employment. These are criminogenic risk factors, which, if not met, elevate recidivism risk. Currently, research indicates that EF predominantly loads onto self-regulation (Garcia-Barrera et al., 2011; Meijers et al., 2015). It follows that theoretical EF measures that assess self-regulation may identify specific criminogenic risk and need factors and provide direction for therapeutic intervention.

The Central Eight and theoretical EF models contain similarities to support the usage of EF assessments in offender risk and treatment formulation. Given the centrality of self-regulation across EFs, the four-component model of EF by Garcia-Barrera

et al. (2011) is a potential EF model from which to examine the Central Eight. The four-component model domains include the creation of plans for efficient problem solving, and the activation and sustainment of self-regulatory attentional control, behavioral control, and emotional control. This EF model relates to the predominant domains of the Central Eight and other influential criminological theories that emphasize self-control; antisocial behavior, personality, cognition, and associates, all include qualities that align with impairments in self-regulatory and problem solving systems. Although this illustrates unitary deficits to EF, discrete EF deficits are more convoluted to outline.

First, the early development of skills in lying, stealing, and fighting in risky situations may reflect reduced self-regulation levels in conflict resolution, planning, perspective taking, and emotional regulation. Second, seeking out dangerous and potentially harmful situations for stimulation may relate to poor self-regulation in areas such as problem solving, emotional inhibition and agency, and attentional and behavioral inhibition. Third, antisocial cognitive systems that justify and engender criminal behavior include self-regulation deficits across monitoring and controlling emotions, planning, shifting perspectives towards consequences, and self-management. Fourth, associating with antisocial others reinforce the previous three criminogenic risk factors, provide reward for criminal behavior, and creates difficulty to leave the antisocial peer group. Subsequent self-regulatory and problem solving system impairments observed may also include planning, shifting, emotional control, and behavioral inhibition. The Central Eight psychosocial predictors of crime overlap and hold a multidirectional relationship where any one of the variables can contribute to changes found in another. What emerges from this analysis is that EF deficits in self-regulation and problem solving conceivably underlie the criminogenic risks that increases the probability of recidivism (Bonta & Andrews, 2017; Meijers et al., 2015).

In concordance with the RNR model, EF assessment lends itself to offender intervention by locating and quantifying the degree of EF deficit. Although interventions, such as cognitive-behavioral therapy, readily address EF domains that overlap with criminogenic need, the *degree* of the deficit is not clear to clinicians. Lacking an efficient method to identify deficits is problematic as it drains valuable resources and hinders treatment progress. EF assessments provide the solution where not only domains of impairment can be recognized, the extent of their limitations may be estimated. In addition, EF assessments can highlight areas of potential strength that could be leveraged for optimal rehabilitation outcome. Garcia-Barrera and colleagues (2011) integrated their EF theory into an instrument named the Behavioral Assessment of System for Children (BASC)—a widely used scale that measures externalizing, internalizing, and adaptive abilities of persons aged 2 to 18 years. Although the BASC was designed primarily for youth rather than adults, the principle remains where quantified estimates across different EF domains would assist with streamlining the assessment and treatment process. Broadly, screening for EF strengths and weaknesses aligns with the principle of specific responsivity by providing a portrait of learning and cognitive style so as to tailor intervention to best suit offender need. Together with the utility to inform risk, EF assessment lends itself to the RNR model of offender risk assessment

by providing treatment targets and data that assist in designing interventions that are compatible with individual offenders.

Financial issues may present obstacles for consistent administration of psychological EF assessments. First, there is the consideration of the cost of the assessment tool. Psychologists commonly employ standardized psychometric tools in the assessment of EF, rather than brain imaging technology like physicians. There are several advantages to psychometric assessments over medical imaging as they may be delivered more cheaply, provide portraits of functional deficit (as opposed to structural), and save invasive technology for higher need patients. Next is the cost of competent service providers. Psychometric instruments must be delivered by either a trained psychologist or psychometrist, and interpreted by (or under the supervision of) a psychologist. Neuropsychologists provide an added level of mastery and expertise in the area of cognitive assessment but may also carry an additional price. The necessity of a highly trained psychologist or neuropsychologist means that some agencies may not have the resources to employ sufficient staff to meet demand. Consequently, EF assessments may be performed or offered at a less optimal frequency. Interested readers on cost–outcome research on neuropsychologists are referred to Prigatano and Pliskin (2003).

Conclusions and Further Study

We support the use of EF assessments of offenders with ASPD to refine recidivism risk estimates and intervention plans because of the role that EF plays across criminogenic risk and need factors. The process that led to this conclusion first detailed how neuropsychology research suggests that those with ASPD hold EF impairments across unitary domains with particular deficits in inhibition and modifying behavior in spite of punishment. We then described how forensic research shows that those with ASPD and related traits are at higher risk for recidivism based on principles of criminogenic risk and need. Last, we argue that EF may underlie the Central Eight that predict and manage recidivism via the RNR model. Overall, it was concluded that neuropsychologists should play an important role assisting with the prediction and management of criminal behavior in correctional settings. Newsome and Cullen (2017) proposed further theoretical development of the RNR model by integrating biosocial research. Our analyses of promising neuropsychological contributions to RNR support their contention. Future studies should address the extent to which EF assessments inform risk to reoffend and whether neuropsychological EF interventions decrease offender risk. As overlap between neuropsychology and forensic psychology grows, greater collaboration between clinicians and researchers from both fields will further our understanding of criminal behavior and enhance our practice with offenders.

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