THE RISK-NEED-RESPONSIVITY MODEL REVISITED

Using Biosocial Criminology to Enhance Offender Rehabilitation

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During the past four decades, researchers and practitioners working in corrections have shifted from a "nothing works" to a "what works" orientation. Emphasizing the importance of adopting evidence-based interventions, Andrews and Bonta have argued that efforts to rehabilitate offenders should adhere to a number of specified principles of effective intervention, three of which—risk, need, and responsivity—are considered the most critical. These principles were derived from Andrews and Bonta's theory of the psychology of criminal conduct, which underscores the necessity to link correctional practice to empirically defensible theories of offending. The vast majority of research has provided evidence of the effectiveness of the risk-need-responsivity model; however, far less attention has been given to expanding its theoretical foundation. Given the wealth of evidence supporting biosocial explanations of criminal behavior, we consider potential avenues for enhancing the risk-need-responsivity model through the integration of key findings from biosocial research.

Keywords: biosocial criminology; need; rehabilitation; responsivity; risk; treatment

In 1974, Robert Martinson published his classic essay in which he reviewed evaluations of treatment programs. He asked the provocative question, "Does Nothing Work?" (Martinson, 1974, p. 48). He then wondered whether research showed that "*we haven't the faintest idea about how to rehabilitate offenders and reduce recidivism*" (p. 48, emphasis in original). He did nothing to assuage doubts about the ineffectiveness of rehabilitation (Cullen, 2013). In fact, his work was the final nail in the coffin for the rehabilitative ideal, which also was under attack for giving the state unfettered discretionary power—which

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judges used to discriminate and parole boards used to coerce inmate conformity (Cullen & Gilbert, 1982). A consensus emerged that rehabilitation was a good idea gone bad.

Ironically, however, Martinson's essay provided rehabilitation advocates with a glimmer of hope. Martinson transformed the debate of offender treatment into an empirical contest (Cullen, 2013). Following the publication of his essay, it was common for opponents simply to cite his article and say, "See, nothing works." But what if research could be compiled that showed that Martinson's appraisal was not accurate—or, in the least, no longer accurate? (see Palmer, 1975). Notably, a group of Canadian psychologists—led most notably by the late Donald Andrews, James Bonta, and Paul Gendreau—took aim at Martinson's nothing works claim (Cullen & Jonson, 2011).

Their rebuttal took two approaches. First, they sought to provide "bibliotherapy for cynics" by compiling numerous examples of effective treatment programs (see Gendreau & Ross, 1979, 1987). They initially conducted narrative reviews, but then eventually turned to meta-analysis of an extensive body of studies (Andrews, Bonta, & Hoge, 1990; Andrews, Zinger, et al., 1990). They found that overall, rehabilitation reduced recidivism (see also Gendreau, Little, & Goggin, 1996; Gendreau, Smith, & French, 2006; Lipsey & Cullen, 2007; Lipsey & Wilson, 1998; Lösel, 1995; Smith, Gendreau, & Swartz, 2009). The key result was that the effects of treatment on reoffending were not homogeneous, but heterogeneous—some programs did not work at all whereas others had large effects. This led to their second strategy: they developed a theory of what constituted "appropriate" treatment—that is, an intervention that was based on sound principles and had a theoretical reason to "work." They would eventually call this approach the Risk-Need-Responsivity model, now known by its acronym, the "RNR model" (Andrews, 1995; Andrews & Bonta, 2010; Andrews, Zinger, et al., 1990; Gendreau, 1996).

By any account, the RNR model has been wildly successful. It has been supported empirically (see, for example, Andrews & Bonta, 2010; Gendreau et al., 2006; Smith, Gendreau, & Swartz, 2009) and, more importantly, is now used across North America, if not beyond. It is clearly the dominant treatment paradigm and based on conceptual coherence, empirical support, and implementation guidance, this status is richly deserved (Cullen & Jonson, 2012; Ogloff & Davis, 2004; Polaschek, 2012). The difficulty, however, is that no theory should be viewed as a finished product—as having achieved sacred status and thus beyond improvement (Cullen, 2012). The Canadians themselves continue to refine their risk instruments and to explore the applicability of the RNR approach to new settings—such as its utility in probation officer meetings with their supervisees (see Bonta et al., 2011). Critics have also suggested that rehabilitation programs should not focus only on reducing offender deficits (risk factors), but on building on the strengths that offenders bring into treatment (Porporino, 2010). Although lacking much empirical data, advocates of the "Good Lives Model" are persuasive in arguing for this latter perspective (Ward & Maruna, 2007).

The point is that the field of correctional treatment will be enhanced by rival treatment models (if they can be shown to be effective) and future efforts to develop the RNR model further. The risk of hegemony is that a model can become stale and entrenched. It can reach a glass ceiling at which further improvements become blocked by a rigid allegiance to the original model. In this context, our essay is an attempt to take the RNR model in a direction that heretofore has not been explored: the relevance of biological factors or processes in the delivery of treatment. As we will note, Andrews and Bonta (2010) reviewed biological risk factors in their work. However, they stop short of integrating these insights into their RNR model. Our project is to take up this challenge.

THE RNR MODEL OF OFFENDER REHABILITATION

The principles of effective intervention identified by Andrews and Bonta (2010) provide evidence-based guidelines for policy and practice in corrections. The three most critical principles—risk, need, and responsivity—form the core aspects of the RNR model of offender rehabilitation. The strength of the RNR model is derived from its theoretical foundation in the psychology of criminal conduct (PCC). The PCC has taken a comprehensive approach to understanding individual differences in antisocial behavior; however, its creators have emphasized the critical importance of its continued growth based on emerging scientific advances (Andrews & Bonta, 2010). Before considering the findings of recent research that may inform further developments in this area, a brief overview of the RNR model and the PCC is provided.

RISK, NEED, AND RESPONSIVITY

The risk principle is comprised of two key elements: predicting recidivism and matching offenders to the appropriate level of treatment (Andrews, Zinger, et al., 1990). As an initial step in providing rehabilitative services, practitioners are advised to systematically evaluate each offender's risk for continued involvement in crime using a validated assessment tool. Risk assessments capture both static and dynamic risks to which an offender has been exposed. Static risks are those factors that cannot be changed through intervention (e.g., criminal history); however, dynamic risk factors are malleable (e.g., antisocial attitudes). A person's overall risk for recidivating can be quantified based on the presence of static and dynamic factors, and he or she should then be matched to the appropriate level of treatment (Andrews, Bonta, & Hoge, 1990). Those with the highest risk for recidivism should be targeted for more intensive programming, and those with low levels of risk should receive less intensive services. Although risk assessments continue to be refined through rigorous research (Andrews, Bonta, & Wormith, 2006; Bonta, 1996), recent meta-analyses have revealed that modern assessment tools (e.g., the Level of Service Inventory–Revised, the Level of Service/Case Management Inventory) can enhance efforts to predict recidivism and case management (Andrews, Bonta, & Wormith, 2004; Gendreau, Goggin, & Smith, 2002; Smith, Cullen, & Latessa, 2009).

The need principle builds upon the risk principle, and specifies that rehabilitative services should target dynamic risk factors to reduce recidivism (Andrews & Bonta, 2010). Dynamic risks are sometimes referred to as "criminogenic needs," and the most potent include antisocial personality pattern, antisocial attitudes and values, antisocial associates, and substance abuse (Andrews et al., 2006). Reducing these, as well as other criminogenic needs, should serve as goals for treatment. Moreover, they should be regularly reassessed to monitor progress toward rehabilitation and to make any necessary adjustments in treatment plans.

The responsivity principle specifies the effective modes of treatment delivery, and includes general and specific components. General responsivity emphasizes the importance of using cognitive behavioral approaches to change behavior and reduce recidivism (Andrews & Bonta, 2010). Cognitive behavioral therapy (CBT) has come to be recognized as one of the most effective intervention strategies for criminal offenders (Andrews, Zinger, et al., 1990; Lipsey & Cullen, 2007; Lipsey, Landenberger, & Wilson, 2007; Lipsey & Wilson, 1998; Smith, Gendreau, & Swartz, 2009). Specific programs may differ in some

regards, but those grounded in CBT generally work to help offenders identify antisocial thoughts and feelings, replace them with prosocial cognitions, and minimize cognitive deficits that may impede successful rehabilitation (Vaske, Galyean, & Cullen, 2011). Specific responsivity extends the responsivity principle by further recognizing the importance of acknowledging individual differences that may limit success in treatment (Andrews & Bonta, 2010). For example, an offender with low motivation may not respond well to treatment efforts. His or her case manager may need to take steps to increase motivation prior to targeting other criminogenic needs.

THE PCC

The PCC has served as the scientific vessel by which the RNR model has reached its current status as the dominant approach for rehabilitating offenders. It unites perspectives from psychology and criminology, and prioritizes an understanding of individual differences in criminality that is empirical, theoretically sound, and bears a high potential for practical application. Andrews and Bonta (2010) maintained that the knowledge gained through the development and testing of theory should be useful to practitioners and others interested in preventing and reducing crime.

The perspective explicitly endorsed by the PCC is a general personality and cognitive social learning (GPCSL) approach (Andrews & Bonta, 2010). The basic premise underlying this perspective is that a given behavior is acquired, maintained, or modified through antecedent and consequent controls. Antecedents serve as queues or "triggers" by signaling the consequences that will follow a behavior. Consequences are the rewards or costs for exhibiting a particular behavior, which influence the likelihood of the behavior being repeated. The GPCSL approach is highly advantageous in that it permits a broad range of factors to be examined with respect to their influence on criminal behavior, and it simultaneously provides a rationale for designing prevention and intervention programs (Andrews & Bonta, 2010). Antecedents and consequences that lead to criminal behavior can be situated in any aspect of one's life, and can be manipulated to extinguish undesirable behaviors and replace them with prosocial behaviors.

Although the GPCSL approach in the PCC is compatible with several theories of offending, research to date has found psychodynamic, control, and social learning theories to be of the greatest utility in identifying specific risks and needs among offenders (Andrews, Zinger, et al., 1990). At the same time, the PCC also maintains that a comprehensive understanding of criminal behavior can only be achieved through a continual pursuit of knowledge—one that is open to the potential contributions of any empirical developments (Andrews & Bonta, 2010). Although the importance of biosocial research in understanding criminal conduct has been recognized in the PCC, such findings have yet to be fully integrated into the RNR model.

Three primary factors may explain why efforts to incorporate knowledge from biosocial research have been limited. First, the original formulation of the theories endorsed by the PCC did not incorporate biological influences. It should be noted, however, these theories are now being reexamined in light of the findings from biosocial research (e.g., Fox, 2017; Vaske, 2015). Second, biological factors are generally viewed as distal influences that are static in nature, and a greater focus has been placed on social factors based on the rationale that "the environment is the immediate source of control over behavior" (Andrews & Bonta, 2010, p. 161). An abundance of evidence now shows, however, that behavior is influenced

by a complex mixture of biological and social factors. Third, the PCC also promotes the ethical and humane treatment of offenders, and cautions against pursuing policies and practices founded upon biological determinism that dominated the past. However, these ethical views are consistent with those expressed by modern scholars, who also argue further that rehabilitation can be enhanced by incorporating key findings of modern biosocial research (Barnes, 2014; Beaver & Schwartz, 2016; Moffitt, 2013; Rocque & Welsh, 2015). These recent shifts in criminology provide an opportunity to incorporate biosocial research into the PCC and the RNR model.

KEY FINDINGS FROM BIOSOCIAL CRIMINOLOGY

Since the inception of the PCC and the RNR model, a tremendous amount of scholarship has been devoted to investigating the degree to which biological factors account for individual differences in criminal behavior. This body of research has provided a wealth of evidence of the importance of genetic factors, neurological development and functioning, and other aspects of human physiology in understanding variation in antisocial behavior (Raine, 1993, 2002, 2008). These advances in psychology, criminology, and several other related disciplines may prove to be fertile grounds from which insights can be cultivated to further develop the PCC and the RNR model.

GENES

Scholarly interest in genetic factors that contribute to variation in antisocial behavior has grown enormously in recent decades. Depending on the aim of the study, research into genetic influences on a trait or behavior takes one of two broad approaches. The first approach is known as behavioral genetics, which is designed to estimate the magnitude of genetic and environmental sources of variance in a phenotype (Baker, Tuvblad, & Raine, 2010; Tuvblad, 2015). These studies require a sample of pairs of individuals of varying degrees of genetic relatedness, which is often achieved through observations of adoptees, siblings, and/or twins. Evidence from behavioral genetic research has consistently shown that approximately half of the variance in antisocial behaviors can be attributed to heritable factors and half to environmental influences (Burt, 2009; Miles & Carey, 1997; Moffitt, 2005a; Rhee & Waldman, 2002; Waldman & Rhee, 2006). A number of correlates of troublesome behaviors have also been shown to be heritable (Plomin, 2004), and recent research has suggested that the relationships between risk factors and behavioral problems may be partially due to shared genetic and environmental origins in risks and outcomes (Boisvert, Boutwell, Vaske, & Newsome, 2014; Newsome, Boisvert, & Wright, 2014).

The second approach to investigating the role of genes in the development of antisocial behavior is referred to as molecular genetics. These studies investigate the role of specific genes in shaping behavior (Baker et al., 2010). Molecular genetic studies do not require samples of related individuals; however, they do require the availability of data that involve the collection of DNA samples to ascertain one's genotype. This area of research has identified a number of genes that are associated with antisocial behavior including MAOA, DAT1, DRD1, DRD2, DRD4, COMT, and 5-HTT (Beaver, 2009; Tuvblad, 2015).

It is important to note that, for many complex traits, an individual's genotype does not completely determine whether a particular phenotype is expressed. The expression of a gene is commonly influenced by the conditions to which one is exposed, and two theoretical

frameworks have been instrumental in guiding this emerging body of research. The dual-risk model has been the dominant perspective, and asserts that some polymorphisms (i.e., variants of a gene) increase sensitivity to the effects of some adverse experiences (Rutter & Silberg, 2002; Sameroff, 1983). Under this model, individuals who possess a "risky" genotype are considered to be at a heightened risk for adverse outcomes, particularly when exposed to specific negative life events.

A more recent theoretical development offers an alternative view—differential susceptibility theory (DST; Belsky, 1997, 2005). DST proposes that, rather than presuming that particular genotypes work only to increase vulnerability, some genotypes may be associated with a greater plasticity (i.e., malleability) in both adverse and supportive rearing environments (Belsky, Bakersmans-Kranenburg, & van IJzendoorn, 2007). When the environment is beneficial, outcomes will be more positive for individuals who possess genotypes associated with plasticity; however, these same individuals are also likely to experience the worst outcomes when conditions are adverse. The theory also predicts that individuals who do not inherit genes associated with plasticity will be less affected by their environments—whether those environments are good or bad (Belsky et al., 2007). Although this area of research is relatively new, recent meta-analyses provide support for DST and suggests that individuals with plasticity alleles are susceptible to positive and negative experiences (Bakermans-Kranenburg & van IJzendoorn, 2011; van IJzendoorn & Bakermans-Kranenburg, 2015; van IJzendoorn, Belsky, & Bakermans-Kranenburg, 2012).

NEUROLOGY

The links between genes, the environment, and behaviors have been hypothesized to be mediated through other biological factors, particularly the structural development and functioning of the brain (Glenn & Raine, 2014; Raine, 2008). As technology has advanced, the number of neuroimaging studies investigating the neurological and neuropsychological foundations of antisocial behavior has increased (Shug et al., 2015). This body of research has shown that abnormalities in terms of structure (i.e., size, shape, or density of regions), function (i.e., activation in regions of interest), and connectivity (i.e., coactivation in regions that represent functional circuits) may be present in the brains of antisocial individuals—particularly those with specific genotypes. For example, one line of research has provided evidence to suggest that individuals who possess the allele associated with low MAOA expression tend to have less gray matter volume in the limbic regions of the brain, hyperactivity in the amygdala during emotion processing tasks, and reduced reactivity in prefrontal regions (Buckholtz & Meyer-Lindenberg, 2008 ; Dorfman, Meyer-Lindenberg, & Buckholtz, 2014; Meyer-Lindenberg et al., 2006). These deficits represent compromised emotional regulation and inhibitory control, and may be particularly likely to occur in individuals who also experience adverse experiences during early stages of development (Buckholtz & Meyer-Lindenberg, 2008; Holz et al., 2016). These findings are consistent with the larger body of literature that has identified neurological differences among offenders in the frontal and temporal lobes, and the limbic system (Glenn & Raine, 2014; Pardini, Raine, Erickson, & Loeber, 2014; Shug et al., 2015; Umbach, Berryessa, & Raine, 2015; Yang & Raine, 2009).

Aspects of neurotransmission, the process by which nerve cells in the brain communicate with one another, also vary between people (Beaver, 2009). Briefly, this process involves sending signals from one cell (i.e., the presynaptic neuron) to another (i.e., the postsynaptic neuron) through biochemicals known as neurotransmitters, such as serotonin or dopamine.

Enzymes are also present in the brain and work to remove excess neurotransmitters. MAOA, for example, is an enzyme responsible for the degradation of serotonin and norepinephrine. When there is an overabundance or deficiency in any of these biochemicals, communication within the brain may be compromised resulting in abnormal cognition, emotion, or behavior. The concentration of these chemicals in the brain is influenced by genetic factors, which is one reason scholars have examined gene–environment interactions as a possible explanation for why some individuals respond to risk factors differently than others (Caspi et al., 2002; Moffitt, 2005b). There is now a substantial body of evidence linking genes related to neurotransmission to antisocial behaviors, as well as several of the risk factors for crime and delinquency (Beaver, 2009; DeLisi, 2009).

ENDOCRINOLOGY AND PHYSIOLOGY

The endocrine system is responsible for the production and secretion of hormones, and works with the brain to regulate a number of physiological activities. Hormones—particularly testosterone and cortisol—have received a considerable amount of scholarly interest in relation to antisocial behavior. Testosterone influences brain functioning and behavior, and is largely involved in masculinizing males during fetal development and again during adolescence (Mazur, 2009). Increased levels of testosterone have been associated with aggression and criminal behavior (Mazur, 2009; Raine, 2002; van Goozen, Fairchild, Snoek, & Harold, 2007; Yildirim & Derksen, 2012). This relationship, however, appears to be moderated by other biological and environmental factors (Yildirim & Derksen, 2012). The hormone cortisol has a different role in the body, and is released by the adrenal glands during periods of heightened stress (van Goozen et al., 2007). The hypothalamic-pituitary-andrenal (HPA) axis mobilizes the physiological responses that take place in the body when an individual encounters a stressful event. Several studies have provided evidence to suggest that lower levels of cortisol, which has been hypothesized to be indicative of a less responsive HPA axis, are associated with antisocial behavior (van Goozen et al., 2007).

Two physiological risk factors related to biological responses to stressors have also been associated with offending: reduced electrodermal activity (EDA) and low resting heart rate (Lorber, 2004; Ortiz & Raine, 2004; Portnoy & Farrington, 2015). Both of these risk factors are believed to be indicators of underarousal of the autonomic nervous system. Individuals with low autonomic arousal may experience reduced fear conditioning, or a compromised ability to learn from adverse experiences. Meta-analyses have revealed that EDA (Lorber, 2004) and low resting heart rate (Ortiz & Raine, 2004; Portnoy & Farrington, 2015) are predictive of antisocial behavior. Although most studies investigating the association between these physiological factors and antisocial behavior have been cross-sectional in nature, some longitudinal studies have suggested that the inclusion of these factors can enhance long-term prediction (Raine, Venables, & Williams, 1990; Vries-Bouw, Pompa, Vermeiren, Doreleijers, van de Ven, & Jansen, 2011). For example, recent findings from the Cambridge Study in Delinquent Development revealed that low resting heart rate at 18 was a significant predictor of antisocial behavior up to age 50 (Jennings, Piquero, & Farrington, 2013).

NUTRITION

Scholarship into the association between nutrition and behavior has received far less attention than other aspects of biology. The available evidence suggests that an individual's diet can influence antisocial behavior across different stages of development (Benton,

2007). For example, poor maternal nutrition during pregnancy has been associated with antisocial outcomes in children once they reach adulthood (Neugebauer, Hoek, & Susser, 1999). Another study found that 3-year-olds who experienced malnutrition were more likely to exhibit more externalizing behaviors in childhood and adolescence (Liu, Raine, Venables, & Mednick, 2004). Recent findings also suggest that higher levels of soft drink consumption are associated with greater levels of aggression and violence among adolescents (Holubcikova, Kolarcik, Geckova, Reijneveld, & van Dijk, 2015; Solnick & Hemenway, 2014). These findings are consistent with an earlier study of incarcerated juveniles who showed significant reductions in antisocial behaviors when soft drinks and foods with high sugar content were removed from their diets and replaced with healthy alternatives (Schoenthaler, 1983).

It has been suggested that the association between diet and behavior is due to compromised brain functioning in individuals who fail to meet their nutritional needs (Gesch, 2013; Schoenthaler et al., 1997; Schoenthaler & Bier, 2000). To grow and function normally, humans require regular consumption of macronutrients (i.e., proteins, carbohydrates, fats) and micronutrients (i.e., vitamins and minerals). Deficiencies in these substances can severely alter various aspects of functioning. Following this reasoning, a number of studies have explored whether providing dietary supplements to ensure nutritional requirements are met improves behavior. Using randomized double-blind, placebo-controlled designs, these studies provide evidence to suggest that supplementing the diets of children (Raine, Portnoy, Liu, Mahoomed, & Hibbeln, 2015; Schoenthaler & Bier, 2000), incarcerated adolescents (Schoenthaler et al., 1997), and young adult prisoners (Gesch, Hammong, Hampson, Eves, & Crowder, 2002; Zaalberg, Nijman, Bulten, Stroosma, & van der Staak, 2010) with vitamins, minerals, and essential fatty acids results in significant reductions in antisocial behavior.

INTEGRATING BIOSOCIAL CRIMINOLOGY AND THE RISK-NEED-RESPONSIVITY MODEL

Biosocial research has offered a number of explanations for individual differences in offending that are empirically supported, are theoretically sound, and have a high potential for practical application. These qualities align with the core values of the PCC that serve as the foundation of the RNR model (Andrews & Bonta, 2010), though, the implications of biosocial research for the RNR model have not been fully explicated. Below, current efforts to integrate research from biosocial criminology and correctional rehabilitation are examined, and specific recommendations are offered to identify potential avenues for enhancing the risk, need, and responsivity principles based on the available evidence.

ENHANCING THE RISK PRINCIPLE

Integrating Neurology

Adherence to the risk principle relies on researchers identifying the factors that improve the prediction of recidivism, and requires that practitioners provide more intensive treatment to individuals with the highest risk (Andrews & Bonta, 2010). Emerging evidence suggests that neurological factors, which can be measured directly or indirectly, could be used to improve risk assessment (Aharoni et al., 2014; Aharoni et al., 2013; Steele et al.,

2015). For example, Aharoni et al. (2013) found that reduced activity in the anterior cingulate cortex (ACC), which is found in the limbic system and involved in behavioral regulation, was a significant predictor of rearrest within 4 years of release in a sample of adult male offenders. In a later study, Steele and colleagues (2015) found that neural activity measured with functional magnetic resonance imaging (fMRI) and event-related-potentials (ERP; electrophysiological responses in brain structures generated in response to a stimulus) accurately identified 83% of men who were later rearrested.

Several indirect measures of neurological health and functioning are readily available (e.g., Wechsler Intelligence Scales, Peabody Picture Vocabulary Test–Revised, California Achievement Test, and Cambridge Neuropsychological Test Automated Batteries; Cornet, 2015), and have repeatedly been shown to predict serious and persistent criminal behavior (Moffitt, 2006; Moffitt, Lynam, & Silva, 1994; Ogilvie, Stewart, Chan, & Shum, 2011). It has previously been suggested that information obtained from these assessments could be used by practitioners in the criminal justice system to guide decision making (Hendrix, Doebbeling, & Aalsma, 2012; Hoge, 1999). Furthermore, a history of traumatic brain injury—another indirect measure of neurological health—has been associated with neuropsychological deficits, aggression, and criminal behaviors (Baguley, Cooper, & Felmingham, 2006; Finnanger et al., 2015; Kim, 2002; O'Rourke, Linden, Lohan, & Bates-Gaston, 2016; Williams, Cordan, Mewse, Tonks, & Burgess, 2010).

Recommendation 1: Incorporate indirect measures of neurological functioning into risk assessment. Findings suggest that indirect measures of neurological health (i.e., traumatic brain injuries and neuropsychological assessments) could enhance prediction in the absence of direct measures. Based on the available evidence and the ease with which practitioners can assess them in correctional settings, measures of neurological risk factors may be among the most promising items to consider in attempting to improve risk prediction. Neurological functioning can be evaluated using indirect measures such as formalized tests designed to assess intelligence, verbal skills, and executive functions (Cornet, 2015; Fishbein & Sheppard, 2006; Hendrix et al., 2012; Hoge, 1999). For example, the Go/No-Go task is commonly used to examine one's ability to inhibit responses to various stimuli. There are a number of advantages to using such neuropsychological tasks. First, self-administered tasks would enhance the precision of measures; they do not rely on a single individual's judgment, and the method of administration is consistent each time. Second, many can be self-administered and automatically scored through computer-based assessments (Cornet, 2015). Although it may take more time to complete an assessment overall, self-administered assessments are unlikely to add to the time staff must devote to directly interacting with clients. Third, these assessments can be carried out in institutional or community-based settings, and the necessary equipment can be shared among staff.

Another possibility is to incorporate data about prior head trauma using brief screeners such as the Brain Injury Screening Index, the Traumatic Brain Injury Questionnaire, or the Ohio State University Traumatic Brain Injury Identification Method (O'Rourke et al., 2016), which can be completed in just a few minutes. Some risk assessments, such as the Ohio Youth Assessment System (OYAS), have already added items to instruments to capture whether juvenile offenders have previously sustained head injuries. To the extent that prediction is found to be improved by adding items that indirectly capture neurological health and functioning, these efforts should be expanded.[1]

Integrating Physiology

Physiological factors are typically considered markers for low autonomic arousal, particularly in response to various stressors. Given that the evidence linking low resting heart rate and antisocial behavior is robust (Ortiz & Raine, 2004; Portnoy & Farrington, 2015), and longitudinal studies have shown that it is predictive of long-term behavioral outcomes (Jennings et al., 2013), its utility in improving risk assessment warrants investigation. The strength of the associations between physiological risk factors and antisocial behaviors also appears to be stronger when the social risks that are typically examined are not present (Raine, 2002). This suggests that failing to include physiological risks—and perhaps other biological factors—may result in an underestimation of offenders' true level of risk for recidivism and misclassification in correctional settings.

Recommendation 2: Incorporate measures of resting heart rate into risk assessments. Resting heart rate is simple to measure; in the most basic strategy, the number of beats per minute can be counted by hand. Many smartphones, which may already be issued to some correctional staff for work purposes, have the capability to capture heart rate and other physiological measures (Cornet, 2015). There are also low-cost devices available to the public to quickly and consistently measure heart rate. Similar to neuropsychological tasks, it is possible to measure resting heart rate in institutional and community settings, and it requires little instruction or effort on behalf of practitioners.

ENHANCING THE NEED PRINCIPLE

Integrating Neurology

The *need principle* specifies that interventions should target dynamic risk factors—those that can be changed through rehabilitative efforts (Andrews & Bonta, 2010). It has been proposed that neurological functioning may be altered during treatment (Vaske et al., 2011). Few studies have tested this proposition, but a recent review of the available evidence does suggest that participation in CBT may be associated with neurobiological changes (Cornet, de Kogel, Nijman, Raine, & van der Laan, 2014a). For example, Lewis and colleagues (2008) found that children who participated in CBT showed reductions in ventral prefrontal cortex activation (a region associated with emotion regulation) and behavioral problems after treatment. A later study also found that children who showed improvement in self-regulation after participating in CBT also showed reductions in activation in the ventral prefrontal cortex, dorsomedial prefrontal cortex, and anterior medial temporal lobe (Woltering, Granic, Lamm, & Lewis, 2011).

Integrating Physiology

Endocrinological and physiological factors can also be altered through rehabilitation. For example, HPA axis functioning may represent a criminogenic risk factor that can be targeted in treatment. Recall that cortisol levels are reflective of HPA axis functioning and responsivity to stress, which may be partially shaped by environmental influences (van Goozen et al., 2007). Prolonged or repeated exposure to stressors can result in HPA axis dysfunction; however, alterations in basal cortisol levels resulting from CBT and behavioral interventions have been reported (Bakermans-Kranenburg, van IJzendoorn, Mesman,

Alink, & Juffer, 2008; Cornet et al., 2014a). Similar results have been found in studies that have examined changes in heart rate variability, skin conductance, and electroencephalogram measures before and after intervention (Francis, Penglis, & McDonald, 2015; McCraty, Atkinson, Tomasino, Goelitz, & Mayrovitz, 1999; Raine et al., 2001). Although limited, research into the effects of treatment on physiological factors indicates that such factors are likely dynamic and perhaps suitable targets for change.

Recommendation 3: Investigate the extent to which biomarkers represent distinct criminogenic needs. Consistent with the PCC, criminogenic needs can only be identified through empirical investigations that provide evidence that particular factors possess two qualities—they must be crime-producing and dynamic (Andrews & Bonta, 2010). The evidence regarding the role of neurological and physiological factors suggests both criteria have been met with respect to these factors. What remains unknown is the extent to which these factors are already captured in previously identified criminogenic needs that may reflect "symptoms" of underlying biological risks. For example, a difficult temperament may be indicative of neurological and/or physiological abnormalities, but targeting symptoms—rather than the cause of the symptoms—may prove to have limited utility. To use a medical analogy, fatigue is a symptom that may be observed when a variety of medical conditions are present. Targeting only fatigue in treatment may be effective for some individuals, but would likely be insufficient for others with more serious conditions. This same logic can be applied with offenders who may have a difficult temperament due to social influences, biological influences, or some combination thereof. In this way, distinct criminogenic needs may be reflected in the same symptoms, and could require different case management and treatment strategies when unique needs are present. An offender with a difficult temperament resulting from poor socialization may show improvements with CBT, while an offender with a difficult temperament resulting from biological influences may have different needs that require a different treatment plan. To the extent that research reveals distinct criminogenic needs based on biosocial research, the targets for interventions may need to be expanded.

ENHANCING THE RESPONSIVITY PRINCIPLE

Fulfillment of the responsivity principle requires that treatment providers adopt theoretically based and empirically supported rehabilitation strategies, such as CBT (i.e., general responsivity), and minimize individual barriers to treatment (i.e., specific responsivity; Andrews & Bonta, 2010). Biosocial research offers the potential to enhance the responsivity principle through identifying evidence-based treatment strategies that can be used to expand services beyond CBT and identifying specific responsivity issues that have not previously been considered.

Integrating Neurology

Recent research suggests that neurological factors may influence specific responsivity. For example, two recent studies found that measures of ERPs were predictive of treatment dropout for inmates who participated in a voluntary substance abuse treatment program (Fink et al., 2016; Steele et al., 2014). Studies have also shown that indirect measures of neurological functioning predict success in treatment, leading some to suggest that it may be a specific responsivity factor that must be addressed prior to participation in other

treatment initiatives such as CBT (Cornet, de Kogel, Nijman, Raine, & van der Laan, 2014b; Cornet, van der Laan, Nijman, Tollenaar, & de Kogel, 2015; Fishbein & Sheppard, 2006).

Integrating Physiology

There is also evidence to suggest that factors relating to physiology and endocrinology may be important to consider with regard to responsivity. Cortisol levels have been shown to predict success in treatment for children in psychotherapy for disruptive behavior disorder (van de Wiel, van Goozen, Matthys, Snoek, & van Engeland, 2004) and adolescents in multisystemic therapy (Schechter, Brennan, Cunningham, Foster, & Whitmore, 2012; Winiarski et al., 2016). In a recent review of the literature, Cornet and colleagues (2014a) found that individuals with lower skin conductance, resting heart rate, and basal cortisol levels showed less improvement after participation in CBT. Overall, individuals who had higher levels of arousal were more likely to benefit from treatment. Taken together, these findings provide some evidence to suggest that abnormalities in physiological reactions to stressors may be responsivity factors that should be targeted prior to participation in components of treatment that target cognition (van Goozen & Fairchild, 2008).

Integrating Nutrition

Nutritional factors may represent another opportunity to enhance the RNR model. Evidence suggests that behavioral problems are associated with nutritional deficiencies and consumption of unhealthy products (Holubcikova et al., 2015; Jackson, 2016; Liu, Raine, Venables, & Dalasi Mednick, 2004; Solnick & Hemenway, 2014), and that dietary changes or supplements can improve behavior (Gesch et al., 2002; Raine et al., 2016; Raine et al., 2015; Schoenthaler et al., 1997; Schoenthaler & Bier, 2000; Zaalberg et al., 2010). While the evidence that nutritional supplementation can be beneficial in modifying behavior continues to grow, the specific mechanism responsible for this association has not been clearly identified. One possibility that has been proposed is that nutritional supplementation reduces neurological risk factors associated with offending, such as deficiencies in prefrontal brain functioning (Raine et al., 2016; Raine et al., 2015). To the extent that diet and nutrition influence cognitive functioning, it is further possible that individuals may face obstacles in gaining the benefits of CBT when nutritional deficiencies exist. Based on these findings, it is possible that inadequate nutrition, higher consumption of unhealthy foods, or both may be factors that impact risk, needs, or responsivity for some offenders. Continued research on the links between nutrition and behavior—and its role in intervening with offenders—could prove useful in expanding the RNR model.

Recommendation 4: Supplement CBT with evidence-based interventions to reduce barriers to treatment relating to neurological and physiological factors. Should research reveal distinct biological criminogenic risk, need, and responsivity issues, researchers and practitioners will need to further examine whether existing treatment approaches need to be expanded to include additional strategies to address biological risks and needs. It has previously been suggested that two treatment strategies may have the potential to improve outcomes among individuals who exhibit behavioral problems: mindfulness-based treatment (MBT) and nutritional supplements (Dafoe & Stermac, 2013 ; Gillespie, Mitchell, Fisher, & Beech, 2012; Himelstein, 2010; Raine, 2013; van Goozen & Fairchild, 2008; Vaughn, 2016; Whitten, 2013; Witkiewitz

et al., 2014). These approaches are largely benign, affordable, and easy to implement in a variety of settings.

Empirical support for the effectiveness of MBT in treating a number of maladaptive conditions has grown in recent years (Khoury et al., 2013). Briefly, mindfulness-based approaches emphasize a focused awareness on the present moment—including the thoughts, emotions, and bodily sensations that may arise in a given situation—and methods for enhancing self-awareness, attention, and self-regulation (Whitten, 2013). Investigations into the effects of practicing mindfulness have revealed that it can increase brain density (Hölzel et al., 2011; Lazar et al., 2005) and functioning (Chiesa & Serretti, 2010; Davidson et al., 2003; Whitten, 2013) in regions responsible for emotion (i.e., limbic system) and executive functions (i.e., prefrontal cortex). In other words, practicing mindfulness appears to alter the brain in ways that are likely to alter behavior. There is also some evidence to suggest that MBT approaches may effect HPA axis functioning, as measured by cortisol levels, when used to manage stress; however, this body of research remains somewhat mixed (O'Leary, O'Neill, & Dockray, 2016).

Given the increased use and evidence demonstrating the effects of MBT, some scholars have begun investigating its effectiveness among offender populations, specifically (Himelstein, 2011; Himlestein, Hastings, Shapiro, & Heery, 2012; Samuelson, Carmody, Kabat-Zinn, & Bratt, 2007; Shonin, Van Gordon, Slade, & Griffiths, 2013). These studies have generally shown positive effects overall, but few have been carried out with a high degree of methodological rigor (Shonin et al., 2013). As more research among criminal subsamples becomes available, it will be important to consider whether and how it can be used to supplement CBT.

Regarding nutrition, a central issue to consider is the feasibility of using nutritional supplements to enhance treatment. While research suggests it can aid in improving behavior, the application may be impacted by the population receiving services or the context within which services are delivered. Many of the studies that have investigated the links between nutrition and behavior have relied on juvenile samples (Liu et al., 2004; Raine et al., 2016; Raine et al., 2015; Schoenthaler et al., 1997), or adults who were incarcerated (Gesch et al., 2002; Zaalberg et al., 2010). It is plausible that youths or incarcerated individuals may be more likely to consume supplements because parents or practitioners assume the responsibility of acquiring and administering them. Clearly, this does not negate the effectiveness of the intervention, but it does present the possibility that case managers in community-based settings may need to ensure their clients understand the potential benefits of using supplements. In this way, a review of the importance of nutrition may need to be added to treatment curricula. Moreover, funding may be needed to provide access to supplements for individuals who are otherwise unable to secure them.

Integrating Genetics

An offender's genotype has been shown to influence how he or she responds to social risk factors and, more recently, responsivity to treatment. Recall that the theory of differential susceptibility predicts that individuals who possess genes associated with higher susceptibility will be more heavily influenced by both positive and negative experiences (Belsky, 1997, 2005); This reasoning suggests that individuals who are adversely impacted by risk factors to the greatest extent also have the potential to gain the greatest benefits from treatment. A

recent meta-analysis of 22 randomized controlled experiments that included the collection of genotypic data found support for differential susceptibility to treatment (van, IJzendoorn & Bakermans-Kranenburg, 2015). More specifically, significant intervention effects were observed in the group of individuals who carried susceptibility genes ($r = .33$, $p < .01$), while effects were nonsignificant among individuals who did not carry susceptibility genes ($r = .08$, $p = .12$). In addition to providing evidence to suggest that one's genotype may be a specific responsivity factor, findings also suggest that failing to consider individual differences in susceptibility may limit the success of less susceptible individuals in treatment settings (Bakermans-Kranenburg & van IJzendoorn, 2015). This is not to say that offenders with lower susceptibility cannot be rehabilitated, but it is possible that the delivery of treatment may need to be adjusted for these individuals. For example, individuals who are less responsive may require a different dosage of treatment before the effects can be detected.

Recommendation 5: Disseminate biosocial research findings to practitioners and policy makers. A wealth of research now exists linking biological factors to antisocial behavior (Lorber, 2004; Moffitt, 2005a; Ogilvie et al., 2011; Ortiz & Raine, 2004; Portnoy & Farrington, 2015; Raine, 2002, 2008; Rhee & Waldman, 2002; Yang & Raine, 2009). Emerging evidence has also shed light on how biological factors can be changed through rehabilitative efforts such as CBT (Bakermans-Kranenburg et al., 2008; Cornet et al., 2014a; Francis et al., 2015; McCraty et al., 1999; Raine et al., 2001; Woltering et al., 2011), and how biological factors may influence treatment outcomes (Bakermans-Kranenburg & van IJzendoorn, 2015; Cornet et al.,2014a, 2014b; Cornet et al., 2015; Fink et al., 2016; Fishbein & Sheppard, 2006; Steele et al., 2015; Steele et al., 2014; van IJzendoorn & Bakermans-Kranenburg, 2015). Taken together, these findings add a new layer of support for rehabilitation as a correctional philosophy. It is clear that the causes of criminal behavior are complex and not simply a matter of free will—an assumption that underlies more punitive strategies. Moreover, the evidence that CBT produces biological changes not only adds to the vast literature in favor of rehabilitation but also provides a more refined understanding of the underlying mechanisms by which rehabilitation works. Disseminating biosocial research findings offers practitioners and policy makers a more comprehensive understanding of offending, and may be a useful strategy for fostering greater empathy for offenders and support for rehabilitative policies and practice.

CONCLUSION

In conclusion, the RNR model has become the dominant strategy for intervening in the lives of offenders (Gendreau et al., 2006; Smith, Gendreau, & Swartz, 2009), but it is necessary to continue refining the model in light of new research (Andrews & Bonta, 2010). Similarly, evidence from biosocial scholarship has made important contributions to understanding the causes of criminal behavior, but fundamental questions regarding its practical relevance remain unanswered (Barnes, 2014; Beaver & Schwartz, 2016; Sullivan & Newsome, 2015). Examining the role of biological factors in effectively intervening with offenders may prove to be a useful strategy for advancing both areas of inquiry.

NOTE

1. It is important to note that particular biological factors may predict recidivism, but fail to increase the predictive validity of an assessment tool, particularly when the biological factor is captured through alternative items on the assessment (e.g.,

impulsivity). These and other relevant factors must be examined as new items are considered for inclusion risk assessment instruments.

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