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Biosocial Factors and Their Influence on Desistance

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Executive Summary

This paper will examine desistance from crime from a biosocial perspective and provide a guide for new initiatives in evidence-based correctional policy and practice. It will offer recommendations to increase both our understanding of desistance through new research and the effectiveness of correctional rehabilitative efforts with biologically informed processes.

The recommendations are grounded in two central themes that connect biosocial research to desistance research. First, a growing body of interdisciplinary research on brain development and maturation provides tremendous insights into the desistance process from adolescence to adulthood. In turn, desistance research and correctional policy and practice must recognize and address conditions that interfere with the desistance process through their effect on neuropsychological functioning and stress system response. Second, recommendations for integrating biosocial research into risk assessments and treatment plans aim to further promote desistance. Rehabilitative efforts that include biological risk, needs, and responsivity factors will be critical in creating and administering biosocially informed treatment plans.

To date, there has not been a systematic approach to merging biosocial research into correctional practice. Therefore, many of the recommendations focus on the development and implementation of biosocially informed approaches to desistance. Although presented separately for researchers and practitioners, these recommendations will require significant collaboration between the two groups to advance knowledge and promote desistance in both theory and practice.

For Researchers

1. Researchers interested in taking a biosocial approach when studying desistance should conceptualize and operationalize desistance as a developmental process and consider an individual's developmental period (i.e., youth, adolescence, adulthood) in that process.

2. Interdisciplinary research on desistance is needed, as brain development affects the production of hormones, neurotransmitters, and enzymes that naturally change over time and are tied to behavioral change.

3. Further research is needed on how biological risk factors, particularly the "critical two" (i.e., neuropsychological functioning and stress system response), affect desistance.

4. A more thorough understanding is needed of how adverse environments and risky lifestyles (e.g., substance abuse, traumatic brain injury, and the impoverished environment of imprisonment) interfere with a normative developmental path by resulting in neuropsychological deficits throughout the life-course.

5. Bioethicists should be consulted when developing biosocial approaches and initiatives in correctional policy and practice to safeguard against the perception of unethical practices.

For Practitioners

1. Practitioners should focus on incremental changes in cognition and behavior over time through enhancement plans instead of — or in addition to — treatment plans.[1]

2. Research partnerships with state and federal corrections systems should continue to explore ways to mitigate the negative impact that conditions of imprisonment have on neuropsychological functioning and stress system response by (1) improving the diets of people who are incarcerated and increasing their amount of daily exercise and sleep, (2) encouraging prosocial interactions with intimate others through increased visitations, and (3) limiting noise pollution, toxin exposure, and overcrowding in jails and prisons.

3. Researchers and practitioners should develop and implement risk assessments that integrate biological risk factors. They should move beyond deficit-based approaches and include strengths-based methods to promote desistance.

4. Researcher-practitioner partnerships are needed to study the effectiveness of programs geared toward restoring or improving neuropsychological deficits and their impact on desistance, particularly programs that use cognitive remediation, mindfulness training, nutritional supplements, and medications to treat underlying mental illness and substance use problems.

    a. There is a need to develop and assess the effectiveness of individualized cognitive remediation plans and mode of delivery (e.g., traditional, video games, serious gaming) on the desistance process among a correctional population.

    b. Mindfulness training should be expanded to teach individuals how to change their views of themselves, as identity and self along with cognitive transformations are important explanations of desistance.

    c. Correctional facilities should obtain individuals' baseline nutritional profiles to identify deficiencies and create an individualized nutritional plan that promotes cognitive functioning and increases capacity to successfully participate in cognitive-based treatment programs.

    d. Comprehensive medical care and medicines should be available to those in community and institutional corrections who have underlying mental illness and substance use problems.

5. Practitioners, in collaboration with researchers, should incorporate baseline measures of stress system response via heart rate, skin conductance, and stress hormones and enzymes (e.g., cortisol, alpha amylase) to better inform risk assessments and match individuals with rehabilitation programs that are best suited to their needs.

    a. New initiatives promoting a more active role in one's own treatment could involve training individuals on how to recognize physiological cues that correlate with antisocial behavior (e.g., increased heart rate or skin conductance) and ways to regulate stress, such as mindfulness training.

6. Additional research is needed to determine whether the effectiveness of cognitive behavioral therapy (CBT) differs by an individual's biopsychosocial profile (i.e., neuropsychological functioning and stress system response) and whether enhancement options targeting other known risk factors (e.g., substance abuse) prior to, or in conjunction with, CBT could further promote desistance.

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[1] An enhancement approach seeks to improve a client's baseline behavioral measure, while a treatment plan seeks to correct a behavior (typically measured dichotomously as a "yes or no" for the presence of the behavior, such as recidivism).

Biosocial Factors and Their Influence on Desistance

The Desistance Process From a Biosocial Lens

The field of criminology, which is rooted in sociology, has traditionally been reluctant to incorporate knowledge from other scientific disciplines to help understand the onset, maintenance, and desistance of criminal behavior. Yet scientific advancements made in the natural and biomedical sciences using sophisticated technologies, methodologies, and statistical approaches have demonstrated that genetic and biological factors influence nearly all human behaviors (Polderman et al., 2015), including criminal and antisocial behaviors (Rhee & Waldman, 2002).

Over 15 years ago, notable criminologist John P. Wright wrote that "the biological sciences have made more progress in understanding crime over the last 10 years than the social sciences have in the last 50" (Robinson, 2004, as cited in Wright et al., 2008, p. 326). This statement — perhaps an exaggeration — resonates today as we have yet to see a concerted and systematic approach to incorporating biosocially informed research into practice. By focusing primarily on environmental and psychological factors and excluding known biological and genetic factors that affect behavior, the criminal justice system may be suppressing its ability to fully benefit from its correctional efforts. If criminal justice is to be truly evidence based, then it is time to fully integrate knowledge and expertise from scholars across disciplines and work together toward the common goal of understanding and promoting desistance.

Although scholars have studied desistance from different perspectives for decades, there is continued debate on how best to conceptualize and operationalize its occurrence. On one hand, desistance can be viewed as a distinctive event that occurs at some point over the course of an individual's life (Maruna, 2001). When viewing desistance this way, researchers measure the absence or cessation of offending. The amount of time required to capture desistance as an "event" and validate that an individual has desisted has no clear-cut boundary among criminologists. However, once achieved, the event is considered "static" or permanent (Maruna, 2001).

On the other hand, a growing number of scholars have suggested that desistance should be viewed as a developmental process (Bushway, Thornberry, & Krohn, 2003). This perspective considers incremental changes in offending behavior and amelioration in associated traits over time as part of a "dynamic" process rather than a static occurrence. Researchers can capture this process by measuring reductions in criminal behavior and improvements in associated risk and protective factors over time. In general, both positions on desistance have implications for how best to move forward in research and practice.

The biosocial perspective is well suited to studying desistance as a developmental process that can occur naturally over time or be encouraged via rehabilitative efforts. The developmental process viewpoint has important implications for practitioners as they implement desistance-encouraging programs and for researchers as they continue to study desistance. Researchers, for example, should take into consideration an individual's developmental period — that is, youth, adolescence, or adulthood — when studying desistance in conjunction with the effects of life events that have the potential to interfere with a normative developmental path.

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[2] These indicators may include criminal-justice-related and non-criminal-justice-related outcomes.

Likewise, practitioners may want to depart from (or add to) a traditional treatment approach in favor of an enhancement approach to correctional interventions (Chew, Douglas, & Faber, 2018). With an enhancement approach, service providers focus on improvements to the clients' baseline measurements in critical developmental areas.[2] Traditional treatments, on the other hand, are specifically intended to correct certain behaviors (Shniderman & Solberg, 2015). This distinction is critically important: The enhancement approach is a dynamic process addressing specific deficiencies or strengths for continuous improvement, while traditional treatment is designed to achieve a lasting or permanent change in behavior and typically measures the presence or absence of a behavior (for example, recidivism) in a "yes or no" fashion. Again, if practitioners view desistance as a developmental process for most people who engage in crime, then enhancement efforts that move beyond "yes or no" questions on recidivism are an important next step toward capturing desistance. In practice, these enhancement efforts can be measured to monitor individual progress in the desistance process over time using both criminal-justice-related and non-criminal-justice-related outcomes.

Contemporary Explanations for Desistance

Some researchers have suggested that nearly all individuals, including those who persistently offend, will desist from crime at some point in their life (Hirschi & Gottfredson, 1983). To demonstrate this contention, scholars point to the well-established relationship between age and crime. Known universally as the "age-crime curve," this phenomenon demonstrates that a cohort's peak in offending is during adolescence, with a gradual decline in criminal behavior in adulthood.

Scholars most often study the relationship between aging and criminal behavior during the transitional period from adolescence to adulthood from sociological and psychological perspectives (Laub & Sampson, 2001). Sociological explanations of the decline in crime with age include experiencing common life events, such as finding stable employment or getting married (Laub & Sampson, 2001), engaging in civic responsibilities such as voting and paying taxes (Uggen & Manza, 2004), and possessing positive citizenship values (Farrall & Calverley, 2006).

Psychological explanations, on the other hand, tend to focus on the role that personality characteristics play in the desistance process. For example, personality traits linked to criminal behavior — known as the "big 5" (neuroticism, agreeableness, conscientiousness, openness to new experiences, and extraversion) — tend to develop and mature over time, while other traits, such as thrill seeking and impulsivity, tend to decline in early adulthood (Bloningen, 2010; Farley, 1986). Psychological theory further suggests that individuals may mature out of crime through a process of psychosocial maturation (Cauffman & Steinberg, 2000). That is, changes in elements of psychosocial maturity from adolescence to young adulthood — namely temperance (e.g., impulse control), perspective (e.g., concern for others, future orientation), and responsibility (e.g., resisting peer influence) — lead to changes in antisocial and criminal behavior (Cauffman & Steinberg, 2000).

Recent work by Rocque and Welsh (2015) integrates sociological, psychological, and biological factors to better explain the desistance process. Specifically, their perspective integrates five domains of maturation that affect desistance: civic maturation, psychosocial maturation, adult social role maturation, cognitive transformation/identity maturation, and neurocognitive maturation (Rocque & Welsh, 2015). This highlights how sociological and psychological causal mechanisms may co-occur with biological and developmental changes.

Steinberg (2008) proposes understanding the age-crime curve through a dual systems model that connects the development of two neurobiological systems during adolescence — the cognitive control system and the socioemotional system — which are associated with a surge in risky behaviors. Specifically, the dual systems model proposes that the peak in criminal and risky behaviors observed in adolescence is the result of the heightened reactivity of a person's socioemotional system, which seeks excitement, along with his or her immature cognitive control system (e.g., underdeveloped prefrontal cortex). Indeed, an individual's biology, particularly as it relates to brain development, may influence changes in offending behavior from adolescence to adulthood.

Brain Development

Research on brain development and maturation provides even greater insight into the pattern of desistance taking place from adolescence to adulthood (Restak, 2001). From a developmental perspective, desistance may be considered part of a neuromaturational process influenced primarily by normative changes in brain structure and function and the production of hormones and levels of neurotransmitters. These biological changes occur as juveniles mature into adults (Collins, 2004).

For example, testosterone levels vary across one's life. The first spike occurs in males during the second trimester of pregnancy; this surge in testosterone organizes the male brain in preparation for the second surge, which occurs during puberty. Both sexes then experience a peak in testosterone around 18 to 19 years old, with a steady decline throughout the remainder of adulthood. Specifically, testosterone levels begin to decrease in males by about 1% each year after the age of 30, while women begin to experience a decline in testosterone during menopause (Sternbach, 1998).

Testosterone levels are often associated with aggression, behaviors related to social dominance, and reduced levels of fearfulness (van Honk, Peper, & Schutter, 2005; Yildirim & Derksen, 2012). Reviews of the relevant literature provide a great deal of support for the proposed interaction between testosterone, social environments (e.g., abuse, peers, socioeconomic status), and genetic or biological conditions (e.g., hypothalamic-pituitary-adrenal axis, serotonin) on antisocial behaviors across the life-course (Yildirim & Derksen, 2012). Taken together, the increase in testosterone levels during puberty may help explain the onset of criminal behavior in early teenage years. However, the waning levels of testosterone production over time may not be as clearly related to the decline in criminal activity during late adolescence and early adulthood that the age-crime curve suggests. Rather, environmental and genetic conditions may moderate testosterone's influence on criminal behavior and the desistance process (Yildirim & Derksen, 2012).

Age-related changes in levels of excitatory and inhibitory neurotransmitters from adolescence to adulthood also affect antisocial and criminal behaviors. For example, studies have shown that the production of dopamine and norepinephrine begins to decrease in early adulthood (Rogers & Bloom, 1985). These neurotransmitters have excitatory properties[3] and have been associated with various forms of aggressive and antisocial behavior (Soderstrom et al., 2001). The age-related decline in dopamine system functioning that occurs between youth and middle age may help explain the decline in criminal activity with age. Numerous studies have also demonstrated that average levels of serotonin tend to increase during this transitional period from late teenage years to early adulthood (Collins, 2004). Serotonin is an inhibitory neurotransmitter that regulates both moods and emotions. Lower average levels of serotonin are linked to antisocial behavior and other emotional dysregulation associated with criminal and violent engagement (Moore, Scarpa, & Raine, 2002).

The serotonin metabolite 5-hydroxyindoleacetic acid (5-HIAA) is perhaps the most studied neurochemical as it relates to antisocial behavior. A meta-analysis by Moore, Scarpa, and Raine (2002) found significantly lower levels of 5-HIAA in groups of antisocial individuals compared to individuals in the nonantisocial group. Importantly, the only moderating effect found on this relationship was age, where groups of antisocial individuals younger than age 30 exhibited a larger negative effect size compared to older groups. This age effect — demonstrating that levels of serotonin metabolite 5-HIAA exert a stronger effect on antisocial behavior among younger populations — may further explain age-related declines in crime in young adulthood.

Neurodevelopmental research has also demonstrated that, on average, the human brain takes approximately 25 years to reach full maturity (Giedd et al., 1999). The final region of the brain to fully develop is the prefrontal cortex, which houses the brain's executive functions, including impulse control, attention (focus), working memory, and cognitive flexibility. As executive functions strengthen over time as part of a normative developmental process, most individuals will "mature out" of engaging in antisocial and criminal activities, as illustrated by the age-crime curve. Many studies have found that deficits in executive functions, however, are associated with a host of behavioral problems, including antisocial and criminal behavior (Steinberg, 2008). For example, a meta-analysis of 126 studies by Ogilvie and colleagues (2011) reported a significant and robust relationship between executive dysfunction and

[3] This means that they increase the likelihood that a neuron will fire an action potential.

antisocial behavior. Studies have also shown a significant relationship between executive dysfunction and repeat offending, suggesting that deficits in executive functioning may also interfere with the desistance process (Hancock, Tapscott, & Hoaken, 2010).

As previously noted, executive functioning is highly correlated with an individual's stage of neurological development. Most adolescents follow the normative developmental path, which involves many biological changes from adolescence to adulthood and results in a transition to desistance without much — if any — intervention. Juveniles who do not successfully desist, however, are likely those who have dysfunctional neurobiological systems, either from birth or acquired throughout the life-course as the result of adverse environments or risky lifestyles.

Persons who persistently and violently offend, then, are likely not following a normative developmental path, and their likelihood of desistance may require interventions that are biosocially informed. Thus, as it pertains to the desistance process, it is important for researchers and practitioners to know an individual's biopsychosocial profile[4] to distinguish between people whose criminal behavior is defined as "adolescent-limited" and those considered "life-course persistent," as their risk levels and needs may differ drastically.

Adolescent-Limited and Life-Course-Persistent Individuals

The psychology literature has defined adolescence as a time period marked by the process of maturation that begins at puberty and ends at some point in early adulthood (Sisk & Foster, 2004). This transitional period between youth and adulthood is filled with biological and social environmental changes that affect behaviors, including those deemed antisocial and criminal.

Nearly 30 years ago, Terrie Moffitt (1993) developed the most biologically informed theory of criminal and deviant behavior in the criminological literature when she proposed the existence of two main types of people who offend: "adolescent-limited" and "life-course-persistent." Specifically, Moffitt categorized those who offend, primarily in nonviolent ways, for relatively short periods of time during the teenage years and then desist from crime in early adulthood as adolescent-limited. Those who offend persistently throughout their life-course, on the other hand, begin to exhibit antisocial and criminal behaviors early in the life-course and continue along this trajectory throughout adulthood.

Although the term life-course-persistent may seem to imply offending throughout the entire life-course, that is rarely the case, as most individuals will eventually desist from crime prior to their death (Hirschi & Gottfredson, 1983). It has been argued that Moffitt's (1993) proposed dichotomous view of offending may be an oversimplification of the actual variation seen in antisocial and criminal trajectories, as individuals may not simply fall into one of only two categories (Piquero, 2008; Ezell & Cohen, 2012). Her theoretical propositions, however, are empirically supported in that there are similarities and differences between those who offend at a low rate and desist early and those who offend at a high rate and desist late.

Importantly, Moffitt's (1993) underlying mechanisms for distinguishing these two groups are biologically based. For those who are adolescent-limited, Moffitt (1993) identified the "maturity gap" — she recognized that juveniles are biologically mature, but society has not yet given them the roles and responsibilities of adults. To exert their independence, adolescents may act out and engage in antisocial and criminal behaviors, sometimes mimicking the behaviors of their life-course-persistent peers. These adolescent-limited individuals are said to commit nonviolent forms of delinquency only as teenagers; they desist as opportunities become available to obtain mature status (e.g., graduation, employment, marriage). Moffitt's (1993) work contended that the peak offending seen in the age-crime curve is driven by adolescent-limited individuals.

Research findings on brain development support the concept of adolescent-limited offending. That is, as the brain matures over time, executive functions strengthen and levels of neurotransmitters change. As such, adolescents

[4] A biopsychosocial profile may be obtained by including neuropsychological and physiological tests, as well as biosocially informed questionnaires, to already developed assessments to better inform distinctions between (1) low-risk individuals who are following a normative path based on brain development and (2) individuals who have neurodevelopmental dysfunctions that resulted from genetics or prenatal environments or were acquired throughout the life-course.

may "mature out" of crime and delinquency, requiring little to no formal intervention from the criminal justice system. Again, adolescence also roughly coincides with the stage of life where stable employment, marriage, and civic responsibilities become more common. Full-time employment and family responsibilities limit opportunities to engage in delinquency and thereby promote the desistance process from a sociological perspective. For this group of adolescent-limited individuals, then, practitioners should help promote brain maturation by strengthening neuropsychological and executive functioning and minimizing conditions that could create or exacerbate risk (Meijers et al., 2015). The next section will further discuss this desistance-encouraging approach for those who are adolescent-limited.

Life-course-persistent individuals, on the other hand, make up a relatively small proportion of the population — between 5% and 10% of all males (Moffitt, 1993). According to Moffitt (1993), this type engages in a variety of antisocial behaviors throughout the life-course, starting at a young age and continuing through adolescence and into adulthood. Because their antisocial behaviors are relatively stable throughout their life-course, Moffitt (1993) focused on biological and social factors present at the earliest moments in life to explain this pattern of offending. She specified that a child with neuropsychological deficits, who is born to parents who are ill-equipped to handle the child, will be at an increased likelihood of following the life-course-persistent offending pathway. This explanation is also consistent with brain development research, as numerous studies have demonstrated that not everyone follows a normative brain developmental path (Collins, 2004). As Moffitt (1993) pointed out, there are individual differences in neuropsychological functioning that are detectable early in life. This may occur as the result of genetic or prenatal environmental conditions that may set the stage for future development.

For example, studies have shown that neurological conditions, such as attention-deficit/hyperactivity disorder (ADHD), are significant predictors of life-course-persistent offending (Young, 2007). Individuals diagnosed with ADHD, a childhood developmental disorder, tend to display behaviors within the categories of inattention, hyperactivity, and impulsivity (Young, 2007). Most symptoms decline with age, but about 90% of those diagnosed with ADHD will continue to exhibit symptoms into adulthood (Willoughby, 2003). Individuals with ADHD also tend to exhibit other mental health and behavioral problems, including conduct disorder, antisocial personality disorder, and delinquency (Barkley, Murphy, & Fischer, 2008).

The neurological underpinnings of ADHD center primarily on neuropsychological deficits and underarousal of the autonomic nervous system. For example, electroencephalogram studies, which capture electrical activity between brain cells, have shown slow activity brain waves in children with ADHD (Loo & Barkley, 2005). This pattern of brain wave activity indicates low levels of arousal. Individuals with ADHD are more likely to experience boredom and to seek stimulation and excitement, often through risky and criminal acts (Pratt et al., 2002). This level of underarousal — coupled with brain immaturity — results in impaired inhibitions and heightened excitability, which may be significant risk factors for persistent violent offending. Better understanding of neurological indicators of life-course-persistent offending like ADHD is important, as it influences various aspects of overall well-being and functioning in society and may affect the desistance process.

Although neuropsychological deficits may stem from genetic risk or prenatal environments, they can also be acquired throughout the life-course as the result of adverse environments or risky lifestyles. There are various environmental factors that could contribute to the onset of neuropsychological deficits, including substance use and abuse; traumatic brain injury; trauma, abuse, and neglect (e.g., adverse childhood experiences); and impoverished environments (e.g., low-socioeconomic status neighborhoods; environmental toxins such as lead, asbestos, and contaminated water). When one or more of these environmental factors disrupt brain development, cognitive and behavioral functioning can be seriously altered and lead to antisocial behavior and prolonged involvement in crime (Ogilvie et al., 2011). These acquired neuropsychological deficits may help explain why some adolescents without preexisting neuropsychological deficits, who otherwise should have followed the adolescent-limited pathway by desisting from crime in early adulthood, continue their involvement in crime through adulthood. Understanding the role that acquired neuropsychological deficits have on the desistance process is an important next step for researchers and practitioners. Although many environmental factors have the potential to affect healthy brain functioning, this paper focuses on three specific conditions: substance abuse, head injuries (e.g., traumatic brain injury), and the impoverished environment of imprisonment.

Substance Abuse

Substance abuse has long been recognized as a significant risk factor for antisocial and criminal behavior. According to the National Center on Addiction and Substance Abuse (2010), approximately 65% of the correctional populations in state and federal facilities meet the criteria for substance use disorder. The growing opioid crisis in America has further exacerbated the problem within the criminal justice system. A growing number of individuals involved in the justice system are using prescription pain killers, heroin, and synthetic opioids (e.g., fentanyl), putting them at an increased risk for recidivism (Belenko, Hiller, & Hamilton, 2013). There is mounting evidence to suggest that the relationship between neuropsychological deficits and substance use is reciprocal. That is, individuals with neuropsychological dysfunctions may be more likely to engage in substance use, and that substance use, in turn, may lead to further neuropsychological deficits (Blume & Marlatt, 2009; Clark, Thatcher, & Tapert, 2008).

Research has clearly demonstrated that the development of neuropsychological deficits is linked to the use and abuse of a variety of substances, including alcohol, cannabis, cocaine, methamphetamines, and opioids (Crowe, Cammisuli, & Stranks, 2020; Hall et al., 2018; Gonzalez et al., 2017; Wollman et al., 2017). This is particularly important for adolescents because considerable brain development occurs during this time period. Substance abuse has the potential to put teens at risk for long-lasting cognitive delays and deficiencies and suppress growth in psychosocial maturity (Chassin et al., 2010). For example, studies have shown that individuals with opioid dependence are more likely to exhibit structural brain abnormalities with neuroimaging studies, further demonstrating that those who use opioids have significantly less white and grey matter in their frontal lobes (Wollman et al., 2017). These abnormalities may help explain the neuropsychological deficits exhibited by individuals who use opioids, namely executive dysfunctions in inhibition, cognitive flexibility, working memory, attention, and problem-solving (Baldacchino et al., 2012).

It is well-documented that individuals who have experienced prolonged substance abuse are more likely to engage in antisocial and criminal behavior (Bennett, Holloway, & Farrington, 2008). In fact, substance abuse is listed as one of the "big five" criminogenic needs that correctional programs should target to promote desistance (Andrews, Bonta, & Wormith, 2006). Popular programs such as Alcoholics Anonymous and Narcotics Anonymous, however, often apply a "one size fits all" approach and do not address the neuropsychological dysfunctions often associated with substance use and criminal behavior (Woody, 2014). This is important as studies have shown that cognitive improvements can occur after abstaining from substances (Forsberg & Goldman, 1987). The rate of cognitive recovery, however, varies by individual (Goldman, Klisz, & Williams, 1985). For some, cognitive abilities may improve spontaneously or within a short time frame after the detoxification process, but others may need cognitive remediation to restore cognitive capabilities (Forsberg & Goldman, 1987).

As such, prolonged substance use can have a detrimental impact on a person's brain function while using — and for some, even after abstaining — thereby putting them at risk for continued criminal behavior by acting as a potential barrier to rehabilitative efforts. Additional difficulties associated with substance abuse emerge from studies that have demonstrated that individuals with neuropsychological deficits are less likely to be successful in substance use treatment programs (Blume & Marlatt, 2009). A review of 15 studies examining the desistance process among persons who both commit crime and use drugs further highlights the complex desistance journey for this subpopulation. Specifically, various personal (e.g., cognitive process, individual agency), structural (e.g., treatment, employment), and social (e.g., relationships with family and peers) (Van Roeyen et al., 2017) factors affect the desistance process in those who commit crime and use drugs. To promote desistance, practitioners must first target the substance abuse problem and the various barriers to desistance, followed by concerted enhancement efforts to improve cognitive functioning and behavior. As mentioned, this may be particularly useful for adolescents, as substance use may interfere with their brain maturation and development and have lasting effects if not addressed.

Traumatic Brain Injury

A meta-analytic review of the prevalence of traumatic brain injury in incarcerated groups compared to the general population revealed that more than half of the samples of persons incarcerated reported a history of traumatic brain injury, which is significantly higher than the range of reported traumatic brain injuries (2% to 38.50%) in the general

population (Farrer & Hedges, 2011). The relationship between head injury and offending is likely reciprocal, whereby individuals who commit crimes are more likely to have experienced head traumas resulting from physical abuse as children and physical assaults as teens and adults (Widom, 1989). Head injuries can affect cognitive functioning and behavior, leading to antisocial and criminal involvement and increasing the odds of repeat victimization (Daigle & Harris, 2018). Despite the potential reciprocal nature of the relationship between victimization via head injuries and offending, longitudinal studies have shown that experiencing a head injury is a significant risk factor for the initiation of later involvement in crime (Jackson et al., 2017) and may also interfere with the desistance process (Schwartz, 2019).

This type of neuropsychological deficit may disrupt a person's brain development or functioning and thus affect the desistance process. In fact, studies have shown that individuals who experience severe head traumas are more likely to exhibit neuropsychological dysfunctions in areas of the brain associated with criminal behavior, particularly dysfunctions in executive functioning such as impulse control, attention, working memory, and cognitive flexibility (Dikmen et al., 2009; McAllister et al., 1999; Raskin & Rearick, 1996). If neuropsychological deficits acquired via head trauma are not addressed, they can have long-lasting impacts on cognition and behavior. As such, experiencing a traumatic brain injury not only puts individuals at higher risk for antisocial behavior but also has the potential to act as a barrier to any rehabilitative efforts put forth by the criminal justice system. Given the central role that brain function and structure plays in development and the impact of disruptions to healthy brain development on behavior, it is critical to better understand how sustaining a traumatic brain injury can affect the desistance process, particularly among youth.

Practitioners should be cognizant of any previous traumatic brain injury their clients have suffered as a result of trauma, abuse, sports, accidents, or falls. Although having an official medical diagnosis may be desirable, there are many reasons why someone who has suffered a brain injury may not seek medical treatment (e.g., cost, abuse, unaware of seriousness). As such, practitioners can use self-reported measures to capture these life events. For example, questions about experiencing head and neck injuries with and without losing consciousness, along with associated physical ailments (e.g., nausea, loss of memory), can provide additional information to practitioners about the seriousness of a head injury. Further, it may be beneficial to survey parents, partners, or others on these indicators of head trauma, as research has shown that those who experience head trauma — particularly youth — might not be aware that they have suffered a severe brain injury.

Conditions of Imprisonment

There are certain environmental conditions that can inhibit normative brain development and create cognitive and neurological deficits — and thus, exacerbate criminogenic risk (Meijers et al., 2015). For example, studies have shown that living in impoverished environments, often in urban areas, that are overcrowded and noisy and contain high levels of toxins (e.g., lead) can negatively impact an individual's brain and stress system functioning (Baskin-Sommers & Fonteneau, 2016). Characteristics of impoverished environments can be extended to correctional settings due to limited social interactions, fear of victimization, actual victimization, poor diet, lack of exercise, poor sleep quality, and the experience of segregation or solitary confinement (for some). These conditions of imprisonment are all known risk factors for impairing cognitive growth and functioning and interfering with psychosocial maturity among adolescents; longer exposures have a more detrimental impact (de Kogel, 2019; Dmitrieva et al., 2012; Haney, 2003).

Baskin-Sommers and Fonteneau (2016) identified three structural factors of imprisonment that can exacerbate or create neuropsychological deficits: (1) overcrowding or forced proximity to others, (2) constant noise, and (3) toxins (e.g., lead, asbestos) in jail and prison environments. These environmental factors have also been found to affect the neural mechanisms for stress processing, leading to stress hormone dysregulation (Ising & Kruppa, 2004; Lederbogen et al., 2011), which, in turn, is associated with antisocial and criminal behavior (Platje et al., 2016; Stadler et al., 2008). These conditions of imprisonment, however, often mirror the environmental conditions of the neighborhood from which a person comes. It is possible, then, that the impact of imprisonment may have differential effects on individuals based on their prior neighborhood and family environmental conditions.

In general, it is important to raise awareness on how imprisonment can negatively affect cognitive functioning (e.g., emotion regulation and recognition) and stress system response, and therefore create or exacerbate risk (Umbach, Raine, & Leonard, 2018). State and federal corrections facilities should minimize conditions that interfere with neuropsychological health and stress system functioning. Studies should also examine the relationship between length of exposure and neurobiological functioning, as individuals with the longest sentences may face the greatest neurological challenges upon release if the correctional system does not address these factors.

Research on how imprisonment affects cognitive functioning could help inform the way the criminal justice system handles those who commit crime, particularly adolescents and young adults. As Lila Kazemian (2021) suggests, it is time for officials to consider alternatives to the adult criminal justice system for those between the ages of 18 and 24. The theoretical basis of widespread implementation of young adult courts is rooted in the developmental and brain literature and informed by the correctional rehabilitation literature. Specifically, research has shown that individuals should be matched to appropriate sanctions and treatments based on their level of risk to increase their chances of desisting from crime (Andrews et al., 1990). Emerging adults between the ages of 18 and 24 who are experiencing a normative developmental path are typically low-risk individuals and should, therefore, receive minimal interventions (Andrews, Bonta, & Hoge, 1990). In fact, studies have shown that placing low-risk individuals in high-intensity environments and programs can have more detrimental effects than if nothing had been done with them at all (Lowenkamp & Latessa, 2004).

The accumulated brain development research suggests that imprisoning low-risk individuals who are experiencing a normative brain developmental path may impair cognitive functioning and stress system response and inhibit or delay brain development and psychosocial maturity (Baskin-Sommers & Fonteneau, 2016). For those who are low risk, then, particularly adolescents and young adults, imprisonment should be used as a last resort. On the other hand, for high-risk individuals who must be confined, the correctional system should mitigate the negative impact that imprisonment has on cognitive functioning by reducing risk factors often associated with an impoverished environment. This can include improving their diet; increasing the amount of daily exercise and sleep obtained; encouraging social interactions with intimate others through visitations; limiting segregation and solitary confinement; and limiting noise pollution, toxin exposure, and overcrowding in jails and prisons.

Stress System Response

The way an individual perceives and reacts to stress is associated with antisocial behavior and may help explain variation in the desistance process (Platje et al., 2016; Stadler et al., 2008). An individual's stress system response comprises two biological systems: the autonomic nervous system (ANS) and the hypothalamic pituitary axis (HPA) (Chrousos & Gold, 1992). Measures of low heart rate and reduced skin conductance can indirectly capture underarousal of the ANS. Low base levels of physiological arousal are associated with antisocial behavior (Raine, Venables, & Williams, 1990). Two theoretical explanations help us understand why this is so. First, the sensation-seeking hypothesis states that being underaroused is an unpleasant physiological state in which to be and, as a result, individuals seek stimulation to compensate for their low levels of arousal. Second, fearlessness theory states that low arousal levels may indicate a lack of fear or insensitivity to negative outcomes, such as punishment, resulting in an inability to learn from prior experiences (Raine, Venables, & Williams, 1990).

The second biological system implicated in stress system functioning is the HPA, which regulates the release of cortisol when exposed to stressful stimuli. HPA dysfunction results in a less responsive system. Scholars have hypothesized that individuals with lower cortisol response have difficulty interacting with others and responding to stressful situations appropriately. Typically, nervous system and cortisol responses to stress act as warning signs to individuals in adverse environments, leading them to behave more cautiously. People with dysfunctional stress system responses, however, may show fewer inhibitions and react in ways that are deemed antisocial (van Goozen et al., 2007). Understanding an individual's stress system functioning and ability for fear conditioning may provide additional insight into the likelihood that he or she will successfully desist from crime.

From a correctional rehabilitation standpoint, information on an individual's stress system functioning may help inform his or her capacity to successfully complete enhancement and treatment programs. Rehabilitative efforts that are biologically informed and that are developed and implemented by interdisciplinary teams of researchers and practitioners may be a promising avenue to better facilitate the desistance process. Specifically, correctional rehabilitation can incorporate biosocial research to (1) include biological risk factors in risk assessments, (2) identify and target dynamic biological risks, (3) pinpoint biological barriers to the desistance process, and (4) provide biosocially informed enhancement and treatment options that promote treatment readiness and desistance. To date, however, there has not been a systematic approach to merging biosocial research and practice. Therefore, its true contribution to promoting desistance remains unknown.[5]

Ethical Concerns

There has been documented apprehension to incorporating a biological perspective when discussing persons who commit crime and criminal justice policy and practice (Wright et al., 2008). Further, it has been suggested that any effort to take a biosocial approach to correctional rehabilitation and the desistance process should first identify and address potential ethical concerns (de Kogel, 2019). As such, there are three primary ethical concerns to discuss and, likewise, safeguard against when implementing a biosocially informed approach to correctional rehabilitation.

First, due to criminology's strong sociological tradition, a segment of the criminological community opposes biosocial research, citing the now discredited work by Lombroso (1876). Lombroso proposed a theory of atavism, which suggested that persons who commit crime were evolutionary throwbacks and born that way, leading to today's interpretation of biological determinism. To this day, biosocial critics hold fast that biological theorizing is a "dangerous idea" largely because of the close connections to Nazi justifications of racism, and sexism and eugenics practices in the United States and abroad (Wright & Cullen, 2012). Some critics have gone so far as to label contemporary biosocial criminologists as "neo-Lombrosian." Although there is no denying that biological theorizing has been used in malicious ways in the past — leading to coercive policies and unethical treatment of persons who commit crime, particularly those in vulnerable and disadvantaged groups — that is not what is being proposed today. Acknowledging and learning from this history is critical to moving forward with proposed interventions that are biosocially informed. One way to accomplish this is to include bioethicists as part of the interdisciplinary research-practitioner team and discuss ethical considerations of proposed interventions that seek to integrate a biosocial approach. This would not only benefit the development of programs but also help break down long-standing misconceptions of contemporary biological theorizing in criminal justice research and practice.

Second, there are noted concerns about the distribution of services, particularly in the early stages of implementation when experimental designs are needed to examine the effectiveness of biosocially informed interventions. For instance, in drug trials, there will be individuals in need of treatment who will not receive the treatment if they are participating in an experimental control group. This concern is further exacerbated if the experiment does not, or cannot, follow the random assignment of individuals into treatment and control groups. In other words, researchers and practitioners should make every effort to follow a systematic implementation of a true experimental design, ensuring an equal chance of selection into the treatment group. Additionally, following any experiment, all participants should be given the most effective treatment options. Related to distribution of services, there are also concerns about how practitioners may label individuals. There is the potential to withhold or even deny treatment to individuals if they are labeled as "untreatable" due to practitioners' faulty understanding of biological influences on behavior (i.e., biological determinism). Educating practitioners on how biosocially informed treatments could benefit their clients in the short and long term will be an important next step in correctional rehabilitation.

Finally — and also related to labelling — is the concern of a self-fulfilling prophecy. Persons who engage in crime and the people with whom they have close relationships may question how much control they have over their own behavior. In this case, individuals may self-identify as being "bad" and feel hopeless about their future due to their biological risk. Moreover, people who interact with those identified as having biological risk factors may scrutinize

[5] Costs associated with implementing correctional strategies from a biosocial perspective also remain unknown. Cost-benefit analyses are needed to determine whether the increase in cost, effort, and resources leads to a higher likelihood of achieving the desired outcomes compared to traditional correctional strategies.

all of their behaviors, however minimal. This is particularly important in correctional rehabilitation, as research has found that the concept of identity and self plays a significant role in desistance. According to this perspective, individuals will act in accordance with their view of themselves and their perceived identity. Therefore, it is necessary to educate those who commit crime and the general public on the malleable role that biology plays in behavior.

Taken together, these ethical concerns should not limit the incorporation of biosocial research into the rehabilitative process. Instead, bioethicists, criminologists, and practitioners should recognize and minimize these concerns through conversation (de Kogel, 2019).

Correctional Rehabilitation From a Biosocial Perspective

Current correctional rehabilitative practices mainly adopt a risk-need-responsivity (RNR) model that focuses on demographic, sociological, and psychological risk factors and excludes much of the biosocial literature (Newsome & Cullen, 2017). The RNR model is based on the theoretical foundation outlined in the psychology of criminal conduct literature, which recognizes individual differences in antisocial behaviors but falls short in providing a comprehensive account of the biological influences that could explain such differences.

When the RNR model was developed over 30 years ago, research in the field of criminal justice was heavily rooted in sociological traditions. The area of biopsychosocial criminology was only beginning to receive scholarly attention. Since that time, the biosocial perspective has become more widely accepted in the field, but its application in correctional settings remains underdeveloped.

Moving forward, researchers and correctional practitioners should expand the RNR model to integrate the biosocial perspective and measure its effectiveness at promoting desistance from crime (see Newsome & Cullen, 2017). They can also adopt a strengths-based approach that goes beyond improving deficits to focus on an individual's strengths that encourage the desistance process.

Risk Assessment — Creating a Biopsychosocial Profile

Despite the volumes of research that have conclusively demonstrated that both genetic and biological factors affect nearly all human behaviors (Polderman et al., 2015), including criminal and antisocial behavior (Rhee & Waldman, 2002), the development of risk assessments that are biologically informed remain absent.

Risk assessments are an important tool used to match individuals with appropriate levels of treatment, determine the likelihood of recidivism, and assign treatment regimens (Latessa & Lovins, 2010). Developing risk assessment tools that integrate biological risk factors is an important next step in correctional rehabilitation, as it has the potential to increase the efficiencies of risk prediction. It will also help inform practitioners' choices via biopsychosocial profiles, which would provide better insight on where, when, and how to provide interventions and when to abstain. Currently, the biosocial literature suggests including measurements of the following biological indicator categories into risk assessments: brain function and structure, neuropsychological deficits (e.g., executive functions), hormone levels (e.g., cortisol, testosterone), neurotransmitter levels (e.g., serotonin, dopamine), and autonomic nervous system functioning (e.g., heart rate, skin conductance), as well as genetics more broadly.

Genetic risk is perhaps the most controversial of the biological factors to incorporate when predicting the onset, maintenance, and desistance of antisocial behavior. Although some court cases have incorporated genetic information as mitigating factors (e.g., monoamine oxidase A (MAOA), an enzyme encoded by the MAOA gene), correctional rehabilitative efforts have yet to fully integrate the role that genes play in explaining behavior, in part due to the perceived ethical concerns mentioned above. The long-standing misnomer that biology is destiny has been discredited through years of epigenetic research, which demonstrates that environmental conditions greatly influence how genes are functionally expressed (Champagne, 2010). In other words, someone may be at genetic risk for certain maladaptive behaviors, but environmental conditions will affect the likelihood that he or she exhibits those behaviors.

At this time, findings from contemporary molecular genetic research should be used with caution when developing risk assessments. Criminal behavior is thought to be a polygenic phenotype, meaning that hundreds, or perhaps thousands, of genetic polymorphisms can combine in additive or multiplicative ways to influence antisocial behaviors. Thus, specific genetic variants tend to exert (very) small direct effects on behavior, and the research is mixed as to when and how specific genes affect antisocial and criminal behavior. This is largely due to the complexity of genetic expression in various environmental conditions, as well as the combination of genetic polymorphisms with environmental factors that are too numerous to pinpoint for risk assessments at this time. Rather, knowing an individual's genetic risk on key genetic variants may be better used to determine the environmental conditions that could best promote desistance, a topic of discussion further detailed below.

For now — and as a first step to integrating biosocial research into practice — the goal should be to develop and employ biologically informed risk assessment instruments that are noninvasive and relatively inexpensive for measuring well-established biological risks, namely neuropsychological deficits and the characteristics of an individual's stress system response. This will require substantial collaboration between researchers and practitioners to advance knowledge of "what works" in applied desistance research that is biosocially informed. For example, they should make a concerted effort to include indicators geared toward distinguishing between (1) adolescent-limited individuals following a normative developmental path, (2) individuals who have acquired a neuropsychological deficit as the result of adverse environments or risky lifestyles throughout their life-course, and (3) life-course-persistent individuals who display neuropsychological deficits from an early age and fall at the extreme end of the distribution on direct and indirect measures of cognitive and executive functioning. The desistance process will very likely differ based on a person's biopsychosocial profile, thereby necessitating a more individualized approach to intervention efforts.

Biopsychosocial risk assessments developed by interdisciplinary teams should enable practitioners to identify specific biological deficits, better assess individual risk levels, and more effectively match individuals to programs. This individualized approach may start by including neuropsychological and physiological tests and biosocially informed questionnaires to already developed risk assessments. In turn, more efficiently aligned treatment assignments based on an individual's biopsychosocial profile will likely facilitate improved behavior, thereby increasing the likelihood of desistance from crime.

Needs Assessment — Target Neuropsychological Deficits

The needs principle states that rehabilitative efforts should focus on dynamic risk factors to reduce recidivism (Andrews & Bonta, 2010). The distinction between dynamic and static risk factors is particularly important when discussing biological risk, as there is a tendency to argue that biology is a static risk factor. Again, this is simply not the case — genetic and biological risk should be considered dynamic and contingent upon environments. Studies have also shown that participation in cognitive behavioral therapy (CBT) can change an individual's neurobiology; this, in turn, leads to changes in behavior, providing further evidence for the malleability of biological risk factors (Cornet et al., 2014). Targeting specific biological needs can potentially promote desistance, particularly when there is an understanding of the individual's stage of development. The traditional "big five" criminogenic needs are antisocial personality, antisocial attitudes, antisocial values, antisocial associates, and substance abuse (Andrews, Bonta, & Wormith, 2006). From a biosocial perspective, however, the "big five" could be complemented by the "critical two," namely neuropsychological functioning and stress system response. Programs that specifically target these two dynamic criminogenic biological needs will likely be more successful in reducing recidivism (Cornet et al., 2014).

As mentioned, neuropsychological deficits are robust and consistent predictors of life-course-persistent offending (Ogilvie et al., 2011). They have been linked to dysfunction in brain function and structure that emerges early as the result of genetics or prenatal environments, or they can be acquired throughout the life-course based on lifestyle and exposure to adverse environments. We need to better understand the impact that these early and acquired neuropsychological deficits have on the desistance process. Examples of executive and cognitive dysfunctions correlated with criminal behavior include inhibition, working memory, attention, and cognitive flexibility, as well as impulsivity, deficiencies in social cognition and problem solving, impulsive decision-making, absence of goal-setting behavior, and poor interpersonal skills (Shniderman & Solberg, 2015).

Targeting cognition and behavior via rehabilitative efforts that are biosocially informed is multifaceted. Interdisciplinary teams of researchers and practitioners can address neuropsychological deficits in several noninvasive and relatively inexpensive ways, including through cognitive remediation, mindfulness training, supplements to address nutritional deficits, and medications (Bootsman, 2019). These mechanisms can also enhance treatment readiness by improving or restoring individuals' neuropsychological capabilities. In many cases, this will be required for more traditional intervention programs to be successful (e.g., CBT).

Cognitive Remediation

Cognitive remediation is a therapeutic training program that, when employed regularly, can improve brain functioning. For example, a review of the research on the effectiveness of cognitive remediation strategies for those who have suffered traumatic brain injury has shown that attention and self-regulation retraining is most effective when coupled with performance feedback and reinforcement (Benedict, 1989).

In general, this type of neuropsychological (re)training should focus on identifying and targeting specific neuropsychological deficits, primarily those associated with executive functioning and emotion regulation (Baskin-Sommers & Fonteneau, 2016). As such, the rehabilitative and desistance goals of cognitive remediation are to help individuals develop or improve specific cognitive skills that are associated with behavioral problems. Although the concept of cognitive remediation remains popular among practicing psychologists, its application in correctional settings has been primarily through cognitive behavioral programs, such as Aggression Replacement Training (Goldstein, Glick, & Gibb, 1998) and Reasoning and Rehabilitation (Ross & Fabiano, 1985). New initiatives should take an individualized approach to cognitive remediation by targeting specific neuropsychological deficits.

One way to achieve this goal is to update current needs assessments to include neuropsychological dysfunctions as a dynamic criminogenic need to target via cognitive remediation trainings. Researchers should measure and study the cognitive skills being acquired or improved upon during trainings to establish their generalizability to other environments and maximize training effectiveness. There is preliminary evidence to suggest that neuropsychological trainings, such as Attention to Context training and Affective Cognitive Control training, are effective when properly matched to individuals (Baskin-Sommers, Curtin, & Newman, 2015). The type of cognitive training needed should depend on the individual's unique neuropsychological needs, underlying behavioral problems, and stage of development.

Further, the mode of delivery for neuropsychological training can be individualized — from traditional individual and group sessions to more advanced computer-based training. The mode of delivery may affect the intervention's effectiveness based on certain factors and conditions experienced by the individual receiving the training. The cognitive training program should also increase in difficulty across sessions to promote neural changes that will translate to behavioral changes that transcend environments (Poldrack & Gabrieli, 2001). It will be critical to develop individualized cognitive remediation plans and study how cognitive training programs and mode of delivery (e.g., traditional, video games, serious gaming) affect the desistance process among a correctional population.

Mindfulness Training

Mindfulness training teaches individuals to focus on the present moment rather than on the past or future. Learning to be mindful enables a person to identify thoughts, emotions, and physiological feelings in an objective way, which builds capacity to counteract the effects of a negative environment (Baer, 2003). That is, individuals are trained on how to become more attentive to their own thoughts and emotions without acting on them, thereby promoting increased self-regulation (Baer, 2003). Studies have shown that mindfulness training can improve self-awareness, attention, and emotional- and self-regulation (Auty, Cope, & Liebling, 2017). For example, a meta-analysis conducted by Auty, Cope, and Liebling (2017) found that yoga and mindfulness meditation programs in prison had positive effects on the psychological well-being and behavioral functioning of those incarcerated.

Neuropsychological studies have shown that mindfulness training can alter or improve brain functions in regions responsible for emotion and executive functions (Tang, Hölzel, & Posner, 2015). For example, mindfulness training has demonstrated the ability to enhance prefrontal cortex functioning, particularly in the anterior cingulate cortex and the orbitofrontal cortex areas of the brain. Research on mindfulness has also identified improvement in amygdala

functioning as well as enhanced connectivity across the hemispheres of the brain (Tang, Hölzel, & Posner, 2015). Further, it has been suggested that mindfulness training can influence heart rate and improve stress system response when exposed to adverse environments (de Kogel, 2019). That is, mindfulness training allows individuals — who begin to experience physiological responses to an environmental trigger — to dissociate themselves from their feelings and thoughts and avoid reacting in harmful ways. In the long run, this has the potential to change the way people view themselves as they learn to control their emotions and behaviors.

The concepts of identity and self along with cognitive transformations are important factors to consider when discussing cognitive explanations of desistance from crime. This perspective emphasizes the importance of self-views and identity as ways to explain desistance. Theories of desistance from this framework suggest that individuals will act in accordance with their view of themselves and their perceived identity (Giordano, Cernkovich, & Rudolph, 2002; Paternoster & Bushway, 2009). For example, Giordano and colleagues (2002) identified four types of interrelated cognitive transformations that must occur to promote behavioral change: (1) a willingness to change, (2) "hooks for change" (i.e., prosocial opportunities for change), (3) changes in the way people view themselves and their self-identity, and (4) changes in antisocial attitudes. Paternoster and Bushway (2009) also provided an identity-based theory of desistance in their description of the "feared self." They suggested that shedding a self-identity grounded in criminal behavior in favor of a more conforming self-identity is a key factor in changing behavior. Both approaches hold that desistance is likely to occur as the result of changes in the way individuals think of themselves and that changing an individual's thought process and viewpoint can lead to changes in behavior.

From a biosocial perspective, individuals' cognitive abilities, which may be dependent on their current stage of development and life experiences, can shape their view of themselves and their identity. For example, for those following a normative brain developmental path, desistance may be considered part of a natural maturation process influenced primarily by normative changes in brain structure and function from adolescence to early adulthood (Collins, 2004). During this time period, individuals also develop and redefine their self-image. Mindfulness training may help increase self-awareness and encourage cognitive maturation by changing their self-view and identity from a "bad kid" to a "successful adult" as they mature and are exposed to new opportunities to further promote desistance. For those with early or acquired neuropsychological deficits, however, their cognitive deficiencies may interfere with their ability to change their perspective of themselves (as well as the prosocial opportunities available to them). Mindfulness training, then, would help this group strengthen the areas of the brain responsible for attention and emotions, teaching them how to objectively evaluate their feelings and raise their level of self-awareness in an effort to change behavior and the way they perceive themselves over time.

Adding mindfulness training to individual treatment plans that are biosocially informed can help promote the desistance process. Programs such as Mindfulness-Based Cognitive Therapy have incorporated mindfulness training into their CBT (Segal et al., 2002), as have intervention efforts that focus on stress reduction, such as Mindfulness-Based Stress Reduction (Samuelson et al., 2007). Adding mindfulness training to correctional strategies seems promising, as studies have shown that increased attention to thoughts, feelings, and bodily sensations can lead individuals to change behaviors (Dafoe & Stermac, 2013). The next step is to link mindfulness training with identity and self, along with cognitive transformations, by further encouraging individuals to change the way they perceive themselves.

Nutritional Supplements

The health sciences field has documented and established the relationship between diet, nutrition, and brain health and development (Wahl et al., 2016). There is also evidence of how important nutrition is for brain health as individuals age beyond physical and brain maturity. Thus, another practical approach to improving neuropsychological functioning is through diet and nutritional supplements. Omega-3 fatty acids and micronutrients (e.g., zinc, magnesium), for example, play an important role in brain development and cognitive functioning (Parletta, Milte, & Meyer, 2013). Research has shown that deficiencies in omega-3 fatty acids during critical stages of development may result in fewer serotonergic neurons and synapses and lower levels of serotonin, which are linked to impulsive and antisocial behaviors (Patrick & Ames, 2015).

Research on the diets of persons who are incarcerated and the food served in correctional facilities is somewhat limited. One study by Cook and colleagues (2015) reviewed a 28-day cycle menu in a large county jail in Georgia. They found that those incarcerated received less than two-thirds of the recommended amounts of magnesium; potassium; and vitamins A, D, and E; and more than the recommended amounts of calories (for women), sodium, saturated fats, and cholesterol (Cook et al., 2015). Grains were also overrepresented on the menu, while vegetables, fruits, and dairy were underrepresented, thereby affecting the total nutrient content of their diet and overall health and well-being (Cook et al., 2015).

Emerging research that examined the effects of omega-3 supplements and other vitamins and minerals on adults in prison found that those who were given supplements committed significantly fewer offenses than control groups (Gesch et al., 2002; Zaalberg et al., 2010). These findings suggest that correctional facilities should consider obtaining baseline nutrient profiles[6] for persons who are incarcerated and providing omega-3 supplements and other vitamins and minerals to their daily diet when needed. Nutritional profiles may also provide information about the capacity to participate in neuropsychological training programs, as people may not be able to fully benefit from treatment if they have nutritional deficiencies. Initiatives that identify deficiencies through baseline levels of nutrients and create a nutritional supplement plan to help improve brain functioning — which could lead to changes in cognition and behavior, thus promoting the desistance process — are needed.

Medication

Antisocial behavior has also been linked to altered neurotransmitter and enzyme levels in the brain (e.g., dopamine, serotonin, MAOA) (see Duke et al., 2013). A disruption in brain functioning can occur when neurotransmitter levels (or enzyme activity) are too high or too low. In turn, this can result in abnormal cognition and emotions, behavioral problems, and mental health conditions.

Several randomized controlled trials have shown that psychopharmacological treatments effectively reduce impulsive and aggressive behaviors (Butler et al., 2010; Pappadopulos et al., 2006). For example, selective serotonin reuptake inhibitors increased glucose metabolism in regions of the brain that had been identified as deficient in antisocial and violent populations (New et al., 2004).

Mental health conditions and substance use problems can interfere with an individual's ability to respond to treatment and desist from crime. For example, ADHD, a neurological condition characterized by underarousal and neuropsychological deficits, is a significant predictor of life-course-persistent offending, with symptoms emerging in early childhood and continuing through adulthood. Individuals diagnosed with ADHD have seen improvement in behaviors with medications such as methylphenidate (Ritalin) and other central nervous system stimulants (Connor et al., 2002; Platje et al., 2016). Correctional efforts to promote desistance would benefit from addressing underlying neurological conditions before implementing other treatment options.

Individuals with substance use problems, such as opioid addiction, may also benefit from medications, including methadone, buprenorphine, and naltrexone (Moore et al., 2019). Currently, the criminal justice system does not take a comprehensive or systematic approach to providing medical care or aftercare for substance-using individuals. Rather, facilities typically use an abstinence-only approach or offer Alcoholics Anonymous/Narcotics Anonymous-type programming. Research has shown that medications reduce opioid use, improve cognitive functioning, and reduce recidivism (Moore et al., 2019). As such, practitioners may want to first provide medication-assisted treatment options[7] before enrolling individuals in cognitive-based programming. In other words, an individualized approach to treating underlying mental illness and substance use problems via medication could enhance treatment readiness and the desistance process by restoring or improving neuropsychological and brain functioning.

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[6] This would require obtaining blood samples and could cost up to several hundred dollars per sample. As such, a practical first step may be narrowing testing to specific nutrients known to influence antisocial behaviors when deficient.

[7] There is an associated risk of potentially creating an underground market when incorporating medical treatments for substance abuse in a correctional facility (e.g., replacement drugs such as Suboxone), which could, in turn, lead to violence. Implementation of medical treatments would have to be carefully monitored.

Needs Assessment — Target Stress System Response

From a correctional rehabilitation standpoint, having information on individuals' stress system functioning and ability for fear conditioning may provide insights into their capacity for successfully completing treatment and desisting from criminal behavior. Incorporating baseline measures of heart rate, skin conductance, and stress hormones and enzymes (e.g. cortisol, alpha amylase)[8] could better inform risk assessments and help match individuals with specific rehabilitation programs that are best suited to their needs. For example, studies have found that people with lower resting heart rate, reduced skin conductance, and lower levels of cortisol showed less improvement after participating in CBT (Cornet et al., 2014). Individuals with higher arousal levels, on the other hand, were more likely to benefit from treatment.

Furthermore, ANS functioning may differentiate antisocial types (e.g., psychopathy, impulsive-aggressive, conduct disorder), which could help inform the type of treatment assigned (Bootsman, 2019). For example, those who are hyperaroused and display more reactive aggression may benefit from treatment focused on response inhibition and anger management. Conversely, correctional options that include elements of negative reinforcement may not be effective for individuals with dysfunctional stress systems, as they tend to be insensitive to the negative outcomes of their behavior (van Goozen & Fairchild, 2008).

Physiological tests can measure stress hormones and enzymes (e.g., cortisol, alpha amylase) through saliva and hair samples, and neurological tests can use equipment to measure heart rate and skin conductance (e.g., Neurolog). Wearables[9] that monitor heart rate variability and skin conductance can also be used throughout the day to provide biofeedback to individuals. New initiatives could promote a more active role in one's own treatment, training individuals on how to recognize physiological cues that correlate with antisocial behavior (e.g., increased heart rate or skin conductance) and regulate stress.

Responsivity — General and Specific Biological Considerations

Responsivity refers to how well individuals receive a type of intervention and the corresponding potential for positive results. This broad concept includes both general and specific components, labeled as responsivity factors. General responsivity refers to the idea that programs, such as CBT, will be most effective when they are responsive to changing behaviors and factors known to affect recidivism (Andrews & Bonta, 2010).

Programs based on CBT were developed in the 1980s, a time when psychological perspectives of antisocial behavior dominated the correctional literature. CBT is used worldwide with varying levels of effectiveness (Smith, Gendreau, & Swartz, 2009; Harper & Chitty, 2005). Based on both social learning and cognitive theories, CBT focuses on the initiation and maintenance of antisocial behaviors over time as a result of the learning process from antisocial peers and identifies what and how individuals think, which affects their behavior. The goal is to change their thoughts and behaviors through prosocial modeling, practice, and reward by teaching the participant how to identify "triggers" that lead to antisocial and criminal behaviors; change their criminogenic thinking patterns; and improve their social, coping, and problem-solving skills. The variation in CBT's effectiveness may be a function of an individual's level of neuropsychological functioning and stress system response.

CBT's general effectiveness at reducing antisocial behavior has been attributed to its utility in altering brain structure and function in the regions of the brain responsible for social, coping, and problem-solving skills (Vaske, Galyean, & Cullen, 2011). These regions include the medial prefrontal cortex, the dorsolateral prefrontal cortex, the dorsomedial prefrontal cortex, the ventromedial prefrontal cortex, the orbitofrontal cortex, the cingulate cortex, the insula, and the temporo-parietal junction. Cornet and colleagues (2014) empirically reviewed Vaske and colleagues' (2011) assertion that behavioral and cognitive interventions will cause changes in one's biology and neuropsychology and that changes in one's biology and neuropsychology from treatment will correspond to behavioral changes. The authors found

[8] The typical cost of equipment needed to monitor heart rate and skin conductance (e.g., Neurolog) is about $150. The cost of collecting and processing hormone data is about $20 to $25 per person.

[9] These types of wearable devices typically cost about $120 each.

that "the 11 studies included reveal evidence that specific neurobiological measures including hormones, brain activity, and heart rate variability, show some change in response to intervention with some studies clearly linking neurobiological changes to behavioral improvement" (Cornet et al., 2014, p. 20). This has important implications for the way we think about and implement CBT in correctional settings.

CBT is arguably the most effective option for promoting desistance from a biosocial perspective and should continue to be implemented widely. New initiatives, however, should provide enhancement options prior to or in conjunction with CBT to further promote desistance. As previously stated, these enhancement efforts should strengthen or restore neuropsychological deficits and improve an individual's stress system response. This could include cognitive remediation, mindfulness training, nutritional supplements, or medications.

Specific responsivity, on the other hand, focuses on individual factors that may act as barriers to treatment success. Specific responsivity factors are not necessarily the same as risk and needs factors, but there can be some overlap. For example, molecular genetics research has identified several genetic variants as risk factors for antisocial behavior, particularly genetic variants of neurotransmitter-related genes affecting levels of serotonin and dopamine (Raine, 2014). Although correctional practice may not want to include genetic risk for risk assessment purposes at this time, genes can be recognized as a specific responsivity factor to better understand variation in program effectiveness.

There are two theoretical perspectives on how genes and environments interact to influence behaviors. First, the "dual risk" model suggests that individuals who are at genetic risk are more likely to display antisocial behaviors when they are exposed to high-risk environments. As an example, individuals who are exposed to severe forms of child maltreatment (i.e., environmental risk) and who are carriers of the low-activity MAOA allele (i.e., genetic risk) are significantly more likely to exhibit antisocial and criminal behaviors as a result of the dual risk (Caspi et al., 2002).

The alternative perspective, known as "differential susceptibility" theory, suggests that genetic variants may lead to increased or decreased sensitivity to environmental influences (Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007). This framework argues that some genetic variants have a certain level of plasticity and malleability in that both positive and negative environments can influence behavior in their respective directions for carriers of the malleable genetic variant. For example, if someone with a malleable genetic variant was exposed to an adverse environment, he or she would be at an increased risk of exhibiting negative behavioral outcomes. Conversely, if that same individual were exposed to a supportive environment, he or she would be more likely to exhibit positive behavioral outcomes. Individuals who do not possess the malleable genetic variant will be less likely to be influenced by either positive or negative environmental conditions. As a result, knowing an individual's genetic profile for certain key genetic variants could help determine whether exposure to treatment could have a positive outcome on desistance for those with malleable genes.

A few studies have used randomized controlled trials to determine whether certain treatment programs are more effective for certain individuals based on their genetic makeup (Bakersman-Kranenburg et al., 2008). Most of these studies to date, however, have focused on young children and adolescents (Brody et al., 2009, 2014). For example, the effectiveness of the Strong African American Families Program differed based on participant genotype and appeared to be most effective at reducing problem behaviors for those who carry risk or malleable alleles, specifically at least one copy of the short allele of 5-HTTLPR (Brody et al., 2009) or one or more 7-repeat allele at DRD4 (Beach et al., 2010; Brody et al., 2014). This suggests that people may respond differently to treatment based on their genes and that treatments may be most effective for those at highest genetic risk. As such, correctional practitioners may want to consider an individual's genetic risk profile as a responsivity factor to better understand variability in program effectiveness.

As mentioned, correctional researchers and practitioners may want to consider neuropsychological dysfunctions and stress system response when assessing the effectiveness of treatment programs, particularly programs that focus on improving cognition and reducing stress. Addressing these two critical biological risk factors via interventions — such as cognitive remediation, mindfulness training, nutritional supplements, and medications — may help enhance treatment readiness and promote cognitive and behavioral change leading to desistance.

Strengths-Based Approach

In addition to integrating a biosocial framework in the RNR model, practitioners should consider adopting a strengths-based approach to promoting desistance. It has been well documented that genetic, biological, and environmental factors, including prosocial behaviors, influence nearly all human behaviors (Polderman et al., 2015). Although understanding an individual's biopsychosocial profile has the potential to improve the effectiveness of the RNR model, its application continues to place great emphasis on individual deficits (e.g., neuropsychological deficits and stress system dysfunction). A complementary line of research and correctional practice that focuses on desistance from crime following a strengths-based approach (Ward & Brown, 2004) is greatly needed. In short, it is time to move beyond recidivism-focused approaches that use reoffending as the sole metric of success or failure. Desistance is a process, and enhancement efforts seek to improve various aspects of one's life. As such, interventions should focus on both diminishing risk factors and improving protective factors, such that success can be measured on a continuum rather than a dichotomy.

The Good Lives Model of Offender Rehabilitation (GLM), for example, is a strengths-based rehabilitative approach that aligns with the biosocial framework (Ward, 2002). The GLM complements the RNR model by focusing not only on risk reduction but also on "goods" promotion (e.g., individuals' core values and life priorities). It incorporates the principles outlined in the RNR model and addresses a person's motivation levels in the rehabilitative process (Ward & Maruna, 2007). This comprehensive framework also encourages practitioners to identify the internal factors and external resources needed to promote desistance. Specifically, the GLM considers the person's interests, abilities, and life goals and allows practitioners to develop individualized intervention and meaningful treatment plans and address the criminogenic needs that may interfere with obtaining these "goods." The empirical studies conducted to date have shown that the GLM successfully enhances participant engagement and improves behaviors (Willis & Ward, 2013).

Conclusion

The integration of biosocial research and the application of a biosocial lens have the potential to provide a more comprehensive account of the factors that influence the desistance process. The biosocial lens relies on the inclusion of brain development, neuropsychological functioning, and stress system response research that has specific implications for human behavior.

This paper recommended ways to integrate the biosocial perspective into the study of desistance from a correctional standpoint. Neuropsychological and physiological tests and biosocially informed questionnaires can better identify (1) low-risk individuals who are following a normative path based on brain development, (2) individuals who have neurodevelopmental dysfunctions as a result of genetics or prenatal environments or that have been acquired throughout the life-course, and (3) types and sources of neurobiological limitations and their impact on the desistance process. This information would better inform risk, needs, and potential barriers to the desistance process that may vary based on an individual's stage of development.

This paper calls for refining assessment practices, procedures, and facilities management in correctional settings to recognize the importance of biological risk factors. Interdisciplinary teams of researchers and practitioners could administer low-cost, high-quality, and noninvasive measures of neuropsychological deficits and individuals' stress system response. This will help inform enhancement and treatment options that are biosocially and developmentally informed to promote desistance.

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