International Journal of Law and Psychiatry 65 (2019) 101437

Contents lists available at ScienceDirect

International Journal of Law and Psychiatry

journal homepage: www.elsevier.com/locate/ijlawpsy

Neuroscience and mental state issues in forensic assessment

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ABSTRACT

Neuroscience has already changed how the law understands an individual's cognitive processes, how those processes shape behavior, and how bio-psychosocial history and neurodevelopmental approaches provide information, which is critical to understanding mental states underlying behavior, including criminal behavior. In this paper, we briefly review the state of forensic assessment of mental conditions in the relative culpability of criminal defendants, focused primarily on the weaknesses of current approaches. We then turn to focus on neuroscience approaches and how they have the potential to improve assessment, but with significant risks and limitations.

1. Introduction

> The increased preoccupation with testing reflects two cultural tendencies in American society: the actuarial mind-set, reflected in the prevailing approach to problems of potential risk, and the related tendency to reduce these problems to biological or medical terms (p. 9) (Nelkin & Tancredi, 1989).

These cultural tendencies are nowhere more influential than in testing related to the criminal law and efforts to determine culpability and control criminal behavior. Advances in the neuroscience of brain-behavior relationships, in particular, have altered how criminal law approaches the concept of culpability (Slobogin, 2017). Most relevantly, neuroscience evidence related to the identification of mental illness, its causes and phenotypes, and the ways in which at least some mental illnesses affect cognitive functioning and behavior, continues to push courts to consider the relative culpability of criminal defendants (Allen, Vold, Felsen, Blumenthal-Barby, & Aharoni, 2019; Chandler, 2015; de Kogel & Westgeest, 2015; Farahany, 2016). In turn, this requires that forensic examiners improve their approaches, evidence and scientific bases for forming opinions, and turn their focus to functional impairments and away from diagnostic labeling.

In this paper, we review the state of forensic assessment of mental conditions as they relate to culpability and sentencing, focused primarily on the weaknesses of the current approaches. Forensic experts have taken a superficial and misleading approach to determining a defendant's mental state, an approach that is over-reliant on clinical interviewing and almost always without regard for the role of bias and systematic error. We describe three systematic errors which can undermine the reliability of clinical interviews: cultural overshadowing, confirmation bias, and expectation bias. We next consider whether the current approaches to forensic assessment adequately contextualize information obtained from a defendant, and then turn to focus on a neuroscience approach to understanding behavior and how neuroscience has the potential to improve assessment.

We also consider the changing understanding of mental illness and how neuroscience is pushing law towards a functional capacity model and away from diagnostic labeling. An approach that thoroughly documents the neurodevelopmental trajectory as well as the symptoms and functioning associated with the specific manifestation in the defendant, and that recognizes the limitations of diagnostic categorization has great potential to better elucidate a defendant's behavior and functioning, but it may also challenge the law's approach to culpability. Finally, we consider how the increasing influence of neuroscience in the courts also poses ethical dilemmas regarding how it is used and when it goes beyond the limits of being reliable and valid. As Nelkin and Tancredi point out: “Interpreting any test involves drawing on a set of assumptions about the accuracy and reliability of the instruments and the validity of the theories relating biological conditions to their expression...” (p. 38) (Nelkin & Tancredi, 1989). To address this, we focus on some examples of how neuroscience has been used, or proposed for use, in the prediction of future behavior and lie detection.

2. Limitations of current assessment approaches

Neuroscience should be broadly conceptualized. It is the study of the brain and the nervous system, which seeks to understand how neurons grow and connect, what typical and atypical development and functioning look like, how disease and injury change brain function, and how to use this science to develop an understanding of behavior

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https://doi.org/10.1016/j.ijlp.2019.03.006
Received 25 March 2019; Received in revised form 27 March 2019; Accepted 28 March 2019
Available online 02 April 2019

(Neuroscience, n.d.). This broad definition of neuroscience is best able to address the key questions of how people function in, and make meaning of, the world; how they perceive and make sense of their immediate setting and context; why and how they act in response to these social and contextual stimuli; the processes that underlie perception, cognition, functioning, and behavior; and the complex interplay of genetic risks and life experience which shape decision-making and behavior. Understanding and explaining this complexity of functioning and behavior, how cognition and experience shape ways in which people make sense of the moment, the range of options perceived available to respond and act, and the executive functioning tools to weigh, determine, initiate, and carry out a course of action, are all within neuroscience's purview (Garland, 2004; Maroney, 2006).

As a result, neuroscience offers a way to understand behavior which fundamentally challenges the legally critical, but mistaken, notion of character-based decision-making, offering in its place a complex, context-specific decisional cognitive process that drives behavior. Most often, neuroscience evidence will be relevant to sentencing issues rather than sanity, but depending on the specific facts of each case, it may play a role at any stage of the adjudication (Chandler, 2015; Slobogin, 2017). This broad definition is also the way in which courts are increasingly being asked to make sense of behavior and functioning, as well as culpability (Denno, 2015; Farahany, 2016).

Currently, the assessment of the motivations and causes of behaviors and the determination of whether a person has an appreciation of the likely outcome of his/her actions, are limited and generally non-scientific. The standard approach relies primarily on interviewing the defendant. No direct tests of mental state or causation of behavior are available, typically leaving the assessment to inferences drawn from interviews with the accused (APA, 2013; Glancy et al., 2015). In sum, the current practice involves talking to the defendant, with little attention to recognizing and avoiding biases or to collecting and interpreting all available collateral evidence.

2.1. Ask the defendant

Clinical interviewing is a key component of formulating opinions and diagnoses related to mental condition and culpability (Miller, 2013). Skilled evaluators ask questions that elicit the thinking processes as understood by the interviewee. Open-ended questions allow defendants to explain and interpret their own actions, offering their own perspective on what they did and why. Closed questions may challenge a specific statement that the evaluator views as inconsistent with other facts.

The limits of relying on a person to self-describe his/her own mental state are obvious. The United States Supreme Court made this point explicitly in the case of *Rompilla v. Beard* (545 U.S. 374 (2005)), which overturned a death sentence because the trial counsel was determined to be ineffective, in part, for basing the argument in mitigation almost entirely on statements by the defendant and the defendant's family. The Court opinion stated: “No reasonable lawyer would forgo examination of the file thinking he could do as well by asking the defendant or family relations whether they recalled anything helpful or damaging in the prior victim's testimony” (p. 389). The same reasoning should apply to clinical assessment in all criminal cases.

2.2. Evaluator bias

In addition to the limited scope of information which can be obtained from clinical interviewing, a critical failing of the standard approach to forming opinions is the lack of consideration for, and control of, evaluator bias. This bias can be both explicit and implicit, and it is worsened in the case of an ahistorical, non-contextual assessment (Iudici, Salvini, Faccio, & Castelnuovo, 2015), even when evaluators believe they are bias-free (Neal & Brodsky, 2016). For example, in a United States federal capital case, an evaluator repeatedly asked the defendant during a psychiatric interview why he took his jacket off prior to shooting someone. The evaluator considered this act to be strong evidence of planning and intentionality because, to the evaluator, it demonstrated a plan to keep the victim's blood off the defendant's jacket. In fact, this line of questioning reflects a type of evaluator bias that is rarely discussed: the evaluator applying meaning to the defendant's actions rather than ascertaining the defendant's true mental state at the time.

This situation most often occurs when goal-directed behavior is misunderstood to be intentional behavior. On the surface, these two types of behavior may look similar: removing one's jacket. The difference lies in the cognitive processes underneath the act: intentional acts necessarily include the process of weighing and deliberating the course of action, consideration of intended outcomes and alternatives courses, and adaptation, during the course of the action, based on new information, stimuli, and feedback. Goal-directed behavior may appear similar in the act itself, but does not involve the same cognitive processes.

In a recent review of bias in psychological evaluations, Neal and Grisso reported on the scope and potential effect of this sort of bias and defined it as a type of systematic (rather than random) error (Neal & Grisso, 2014). The idea of bias as a systematic error is helpful in framing how to understand its effects on assessment. Three common forms of the systematic unreliability are cultural overshadowing, expectation bias and confirmation bias. Cultural overshadowing occurs when an evaluator does not see or denies the true biological or psychological condition because of some specific, or set of, socio-cultural characteristics (e.g., poverty, race, gender, immigration status) of the individual being assessed (Friedman, 2017; Woods, Greenspan, & Agharkar, 2011). Cultural overshadowing is common and reflects a tendency to credit simple and immediate observations over structural and distal ones (Link & Phelan, 1995).

Confirmation bias refers to selectively gathering, or selectively discarding, some data as opposed to other data, typically to support a pre-conceived idea or stereotype. An evaluator may have a hunch or hypothesis about the defendant which he or she seeks to confirm to the exclusion of other hypotheses, ignoring contradictory evidence in order to confirm the hunch (Erard, 2016; Neal & Grisso, 2014). Neal and Grisso (2014) continue: “An evaluator's initial hypothesis or hunch might be made based on the evaluator's own personal and political beliefs, exposure to pretrial publicity (e.g., suggestibility and expectancy), or comments from the referral party regarding their hypotheses about the defendant's mental health” (p. 204).

One example of confirmation bias is when an evaluator concludes that a defendant has an antisocial personality disorder (ASPD) based on the pending charge, the alleged criminal conduct, and the fact that evaluation is taking place in jail. For example, a forensic examiner opined that the defendant had ASPD despite symptoms of a psychotic disorder (which is a rule out provision for the diagnosis under the DSM scheme). The defendant was unable to self-report fully his own history of diagnosis and treatment, leaving the examiner unaware that the he had first been diagnosed with that psychotic disorder at age eight and had been medicated for it for more than 15 years. Similarly, she developed no evidence to support a diagnosis of ASPD, but reached that opinion nonetheless. Her opinion was rejected by a more senior evaluator in the same agency soon after on the ground that no evidence supported the ASPD diagnosis. The first evaluator simply confirmed what was immediately before her: a defendant charged with a violent offense was presumed to have ASPD.

Expectation bias refers to the way in which the examiner's beliefs and views misleadingly and systematically shape the interview and assessment. This may be most obvious in situations where an examiner assumes a motive to lie, that a defendant will feign or malinger because of his/her status as a defendant. For example, in a capital case in which the defendant was eventually ruled to be Intellectually Disabled by the court, the prosecution expert conducted eleven stand-alone and

embedded measures of malingering and feigning symptoms, seeking to disprove the defense expert's evidence of substantially impaired cognitive functioning. The defendant passed all 11 measures. Despite that, the prosecution expert opined that the defendant was malingering cognitive impairment because of a small variation in subtest scores on a repeated measure (that is, the expert noted that the scores on a test which was given once by the defense expert and a second time by the prosecution expert differed slightly). Despite voluminous research on malingering and its assessment, the prosecution expert's expectation that the defendant must be malingering led him to develop his own method of reaching that conclusion when the standard methods did not support his expectation.

Similarly, an examiner's assumptions about a defendant's criminal beliefs and attitudes, often based on implicit and explicit race and cultural stereotypes, lead to expectation biases. Although rarely explicitly stated now, such internalized beliefs may be expressed by characterizing a group to which the defendant belongs as having certain views and attitudes. For instance, whites have been found to hold implicit and explicit beliefs about African Americans and Latinos being more prone to criminal behavior (Ghandnoosh, 2014). This has implications for cross-racial assessment and can be a form of expectation bias.

2.3. Collateral evidence

Almost all evaluators make use of collateral sources of information when forming opinions. Yet, the scope of that collateral information is commonly limited (Heilbrun, 2001; Otto & Heilbrun, 2002). Such limited collateral evidence enhances the risk of misunderstanding behaviors and increases the influence of biases, thereby inflating the influence of systematic errors. Behavior occurs in a specific context, which necessarily means that the cognitive processes leading to that behavior also occur in a specific context (De Los Reyes et al., 2015; Martel, Markon, & Smith, 2017). Even a complex act that requires extensive planning must still be initiated and carried out at the planned time and in the planned place, and the intent to do so must be maintained throughout. Currently, little regard is given to context and environment when assessing cognition and behavior.

Advances in neuroscience and new understandings of how behavior manifests itself require substantial improvements in forensic assessment. As reviewed above, the current practice relying primarily on clinical interview and incomplete collateral source material no longer meets scientific standards of reliability and validity, if it ever did (Woods, Freedman, & Greenspan, 2012). Fundamentally shaped by systematic errors, current assessment practices are failing to keep up with the best approaches to which psychological and psychiatric sciences ascribe.

3. Neuroscience informed approaches to assessment

Pioneering work on brain development led the Supreme Court of the United States to bar the execution of juveniles [*Roper v. Simmons*, 543 U.S. 551 (2005)], followed by a ban on mandatory life sentences in prison without parole for juveniles who did not commit homicide [*Graham v. Florida*, 560 U.S. 48 (2010)]. In these cases, the Supreme Court found that juveniles are poor decision-makers, less mature, more easily led and influenced by others, less able to understand the consequences of their actions, and more impulsive (Steinberg, 2013). As a consequence, the Court found that the U.S. Constitution requires that juveniles be treated differently than adults, regardless of the offense committed. The Court adopted an age cut-off of 18 years old for determining the beginning of adulthood, a bright line not supported by the science which indicates that maturation is not complete until well in the mid-20's and is marked by individual variation (Denno, 2006). More recently, following the scientific development, a circuit court in Kentucky extended the holding of *Roper* to bar the death penalty for those under age 21 [*Kentucky v. Bredhold*, Case no. 14-CR-161 (2017)].

3.1. Comprehensive, multigenerational social history

In contrast to the limited collateral material that is typically made available to forensic evaluators, a comprehensive multigenerational social history is both fundamental and critical in all cases. Developing this bio-psychosocial history, which should span at least three generations and often covers five or more, takes time and extensive resources, but it is the first step for any competent and reliable assessment (Dudley & Leonard, 2008). All of the information gathered through the development of the bio-psychosocial history will not be reliable, of course, and clinical judgment is still required to assess and evaluate the convergence and divergence of the evidence developed. While still allowing for subjective interpretation, the systematic process of obtaining the information from multiple sources, both from records and interviews, is more transparent and reliable because corroboration of any given piece of significant history can be cross-validated from multiple sources as well as evaluated over life course.

The bio-psychosocial history establishes developmental and trajectory evidence, clinical substantiation, and evidentiary corroboration, and it is the foundation for recognizing cognitive and functional deficits manifested in daily life (Haney, 2008; Holdman & Seeds, 2008; Wayland, 2008). As neuroscience technology increasingly permits the presentation of neuroimaging that may show deviations from normal (usually in size or function of the region of interest), the meaningfulness of such testimony is increasingly dependent on demonstrating the real-world import of those findings (Gur, Gur, Gur, & Gur, 2016; Slobogin, 2017). That is, as brain imaging becomes more common, it is increasingly important to directly tie the structural and functional deficits to real-world impairments. The best approach to doing so is through the development of bio-psychosocial history and the specific examples of impairments uncovered by it. For example, frontal lobe impairment visualized through neuroimaging is more compelling and comprehensible when examples of behaviors that predate the offenses can be identified and presented. Thus, a defendant with such a frontal lobe impairment who has an established history of being unable to complete multi-step tasks or to adjust when routine activities are disrupted by minor changes in the environment provides important context to the neuroimaging evidence.

In this way, the bio-psychosocial history frames and elucidates the story of the lived experience of the defendant, focusing attention on the path that led to the disordered behavior and establishing the context in which that behavior occurred. It also reduces the chance of competing expert opinions by tethering the neuroscience to specific examples from the defendant's life (Gkotsi, Gasser, & Moulin, 2018). Comprehensive social histories document developmental, prodromal, and pre-syndromal markers, present support for the presence and importance of cognitive and functional impairments, and tell the story of how they shaped the defendant's life experience.

Although most clinical and forensic assessments focus on the current manifestation of symptoms, many psychiatric conditions are marked by premorbid and prodromal symptoms that affect behavior and developmental trajectory. For instance, despite similar academic performance in 4th grade, people who later develop schizophrenia may be significantly less likely to complete high school compared to matched healthy controls, despite having not yet developed schizophrenia (Cannon, Jones, Huttunen, et al., 1999). Similarly, those who later develop bipolar disorder tend to have fewer years of education and are less likely to complete college compared to matched healthy controls (Glahn, Bearden, Bowden, & Soares, 2006). This relationship between educational attainment and premorbid psychotic disorders reflects the altered developmental trajectory of those with psychosis prior to the identifiable onset of the illness.

Similarly, some mental illnesses, such as Bipolar Disorder and Schizoaffective Disorder, are defined by changes in symptom

presentation over time. One common diagnostic problem for clinical assessments arise from diagnosing a defendant based on the immediate presentation. In the example of Bipolar Disorder, this often leads to a misdiagnosis of Major Depressive Disorder because the depression is observed whereas the Mania is less frequent in typical Bipolar Disorder presentation (Bopp et al., 2010). Therefore, a competent assessment should investigate the neurodevelopmental trajectory and the course of illness in order to understand the defendant's behavior, functioning, and decision-making.

Multigenerational patterns of symptoms, even when the prior generations have not been diagnosed, provide support for the behaviors and symptoms observed in the defendant. For instance, a parent or grandparent's exposure to trauma may have an effect on the defendant through parenting and/or through epi-genetic changes, and the multigenerational exposure to trauma developed through the multigenerational bio-psychosocial history does not require that the parent or grandparent was diagnosed, but rather that the evaluator developed evidence of the exposure to, and story of, the traumatic event (Koenen, Nugent, & Amstadter, 2008; Moffitt, Caspi, & Rutter, 2005).

Similarly, the comprehensive social history provides evidence essential to culturally competent assessments. Cultural factors are directly relevant to both clinical and forensic determinations. Culture is essential to include in the differential diagnoses of behavior's brain-based factors. The meaning of a diagnosis, and the details of how the symptoms make up that diagnosis, must be explained through the demonstration of what the diagnosis means for the lived experience of people with that condition or illness, and this requires consideration of the defendant's cultural background.

On the other hand, an inadequate social history will thwart the acquisition of a full understanding of the link between brain impairments and everyday functioning. The judicial system's treatment of the individual whose neurobehavioral deficits have not only been misidentified, but also not placed in appropriate familial and social context, is likely to be based on a view that the person has a character or personality disorder (Hall & Sbordone, 1993; MacDonald 3rd et al., 2005; Murphy et al., 2001). A comprehensive social history allows for the documentation of the developmental underpinnings of cognitive deficits. A social history can show that an individual stood out in his own culture and ecology as different and impaired, perhaps resulting from being at high risk for an event such as being born anoxic in a home delivery without access to reliable medical care. Such a perinatal history enhances confidence that the impairments observed later in life are the result of neurodevelopmental insults (Miller et al., 2007; Phillips, 2000).

Similarly, childhood physical and sexual abuse, child maltreatment and neglect, and exposure to violence must be thoroughly documented. Exposure to trauma, which can result in long-term symptoms including dissociation, has been found to have neurological substrates (Anda et al., 2006; Lambert, Sierra, Phillips, & David, 2002) and to change the developmental course, altering brain function and structure (Anda et al., 2006; Schwarz & Perry, 1994). Exposure to trauma during the developmental periods also has been shown to cause long-term changes in endocrine, cardiac, and pulmonary functions (Rasmusson, Schnurr, Zukowska, Scioli, & Forman, 2010; Spitzer et al., 2009). The impact of trauma on cognitive functioning is now part of the mainstream neurobiological understanding of the long-term consequences of childhood physical and sexual abuse. Documentation of chronic trauma is a key component of the comprehensive, multigenerational social history, and must be one component of a competent neuropsychiatric examination (*Porter v. McCollum*, 558 U.S. 30 (2009); *Rompilla v. Beard*, 545 U.S. 374 (2005); *Wiggins v. Smith*, 539 U.S. 510 (2003)).

Another aspect of behavior which can be developed through the biopsychosocial history relates to being raised in neighborhoods with dense poverty, low collective efficacy, and high neighborhood disorder, which are all associated with increased risk of mental disorders and offending rates (Morenoff, Sampson, & Raudenbush, 2001; Sampson, Morenoff, & Raudenbush, 2005). The effects of neighborhoods are not uniform, however, with brain development and function being differentially affected as those structural inequalities interact with individual differences and the differences in poverty between different geographic regions affects brain structure and function unequally (Crossley et al., 2019). Thus, neuroscience can now examine questions as to how the environment manifests in altered brain development at the same time it considers the behavioral consequences of those changes in a specific environmental context over the life course (Farah, 2017).

More than risk factors for criminal behavior or mental illness, neighborhood characteristics are explanatory of functioning and behavior even after controlling for individual and family characteristics. Adverse neighborhood characteristics and victimization increased the risk of psychosis in youth 4.8 times, after controlling for family socioeconomic status, family psychiatric history, and adolescent substance problems (Newbury et al., 2017). A review of research on the independent effects of neighborhoods on mental condition found that 27 out of 29 studies published as of 2006 observed an increased risk of depression, anxiety, distress, and psychosis associated with the structural characteristics of the neighborhoods after controlling for individual characteristics (Truong & Ma, 2006).

This points to the need to develop evidence regarding the social context of behavior and cognitive functioning in order to improve the assessment of defendants. This population-based research points to the significance of the context in which behavior occurs and in which functioning is most importantly assessed. Understanding the cultural, social, and familiar context in which a defendant developed and lived will guide the assessment and interpretation of the results.

3.2. Neurodevelopmental trajectory

Of particular interest for understanding behavior and functioning is the development of executive functions, which encompass a complex set of behaviors and cognitive processes that may be said to define the human experience. These include: forming an intent to act and the initiation of behavior; vigilance to tasks; holding concepts in working memory and information retrieval; strategy development, evaluation, monitoring, and implementation; complex problem recognition and identification of alternative courses of action; resolving conceptual conflicts and cognitive dissonance; response inhibition, including changing or switching sets; abstraction of patterns and concepts, and giving meaning to stimuli in relation to prior experiences; appropriately prioritizing external stimuli (separating signal from noise); and appropriately assessing the emotional valence of stimuli (Freedman & Brown, 2011; Lichter & Cummings, 2001; Miller & Cummings, 2007). These are the functions which underlie behavior and which are too rarely assessed by forensic evaluators.

Executive abilities develop later than other cognitive functions and improve with age well into adulthood, then decline in old age (Best, Miller, & Jones, 2009; Kalkut, Han, Lansing, Holdnack, & Delis, 2009; Keshavan, Kennedy, & Murray, 2004). In healthy children, changes in executive ability are observed in both the very young and at school age, with continuing improvement into late adolescence and early adulthood (Best et al., 2009; Garon, Bryson, & Smith, 2008; Kalkut et al., 2009; Miyake et al., 2000). Neuroimaging studies demonstrate that this early development of executive functioning and synaptogenesis is followed by periods of neural network development, solidifying of connections and myelination, with network efficiency increasing and regions of the brain associated with executive functioning completing formation last (Barkley, 2012; Cummings & Mega, 2003; Tau & Peterson, 2010).

Neuroscience research thus indicates that forensic assessment requires a consideration for the individual's neurodevelopmental trajectory, including individual variation within normal ranges and deviations from normal trajectory. Because executive functioning underlies and defines the capacity for planning, initiation, weighing

consequences, and adaptability, it should be assessed from the neurodevelopmental perspective. The application of group data (normative data and typical developmental trajectory) to the individual in order to determine deviations from typical development requires careful consideration (Faigman, Monahan, & Slobogin, 2014). Neuroscience evidence should be presented with acknowledgement of its reliability and rates of error.

Additionally, understanding the onset and course of mental illness and behaviors is simply the most relevant and best approach to assessing whether a person is feigning illness or malingering. The current practice largely relies on stand-alone measures of feigning and effort (Berthelson, Mulchan, Odland, Miller, & Mittenberg, 2013; Sollman & Berry, 2011). However, those measures may not be valid and reliable (Bigler, 2011, 2012). Because subthreshold, premorbid, and prodromal states of mental conditions are associated with social, behavioral, and cognitive impairments, assessing when a defendant began to diverge from his/her peer group's trajectory can provide foundational information for determining whether the defendant is currently malingering or whether the endorsement of unusual symptoms or an odd social cognitive presentation are reflected over time and consistent with the life history.

Moreover, while the dramatic breakthroughs in finding specific genes which cause psychiatric illnesses and cognitive impairments remain a distant hope, epigenetics has already brought about a reconceptualization of illness and causation (Gunter, 2015). Epigenetics is the study of how environmental and social exposures are moderated by the individual genome (Koenen et al., 2008; Moffitt et al., 2005). For instance, Post-Traumatic Stress Disorder (PTSD) is a condition which requires a life-threatening event, but not everyone who is exposed to a life-threatening event develops PTSD. Among one set of explanations for this difference are gene variants that appear to be associated with PTSD and related phenotypes (Sipahi et al., 2014; Young, 2017).

From the forensic perspective, the presence of PTSD may be less important than the context of the exposure to a life threatening event, and the symptoms that occur as a result of the exposure may directly affect cognition and behavior whether or not a person has PTSD. For instance, many chronically and severely abused children have PTSD that resolves after a period of time, but they continue to experience and to be affected by long-term symptoms that result from the abuse but manifest themselves in ways other than PTSD (De Bellis & Zisk, 2014; Patterson, Moniruzzaman, & Somers, 2014; Wayland, 2008). Moreover, the intergenerational transmission of trauma means that the offspring of a parent exposed to trauma may develop behavioral symptoms without direct exposure to the traumatic event (Ramo-Fernandez, Schneider, Wilker, & Kolassa, 2015; Yehuda & Bierer, 2009). Symptoms and functioning, rather than diagnostic criteria, have become the crucial question for forensic assessment as neuroscience revises the ways in which diagnostic categorization works (Casey, Oliveri, & Insel, 2014; Cuthbert, 2014).

In sum, multigenerational social history, life course neurodevelopment, and trajectory represent major advances derived from neuroscience research in the last 30 years, and they demonstrate the contours of how neuroscience should redirect assessment from the clinical interview towards a more complex and deeper consideration of function and behavior. While still subject to the vagaries of interpretation, and therefore not beyond the biases identified above, this approach is more robust and the bases for opinions are less dependent on the subjective views of the evaluator and more reliant on a vast array of data points over time. This in turn provides ways to evaluate the reliability and validity of the current opinions and the bases for them.

3.3. Symptoms and functional ability-capacity, not diagnosis

Neuroscience is also influencing the current scientific bases for understanding the determinants and distributions of mental illnesses, cognitive impairments, and behavior. ICD-11, DSM-5, and the NIMH research diagnostic criteria make clear the importance of behaviors, symptoms, and functioning (the phenotypes of mental illness and cognitive impairment) in the assessment of mental conditions. The National Institutes of Mental Health (NIMH) has been pushing for a revision of the current diagnostic scheme for mental disorders to even more explicitly recognize advances in neuroscience (Insel, 2014).

This shift towards symptoms and functional ability arises largely out of population-based, longitudinal research demonstrating how brain development, social and cognitive functioning, and behavior develop and change over time and within settings. This neurodevelopmental trajectory approach to the origin and manifestation of neuropsychiatric illnesses and cognitive impairments holds promise for understanding how and why early life determinants and mechanisms result in illness later in life (Insel, 2010). The neurodevelopmental hypothesis posits that altered, pathological, or delayed maturation of the developing brain shifts the neurodevelopmental trajectory away from the course it would have followed but for the exposures, both genetic and environmental (Kaffman & Krystal, 2012; Meyer & Feldon, 2010; Millan, 2013; Rapoport, Giedd, & Gogtay, 2012).

This approach offers a way to understand how mental conditions arise, affect functioning and behavior, and more broadly re-direct the developmental trajectory. The focus of this neurodevelopmental approach, which is driven by neuroscientific advances, is on both normal and abnormal processes: first understanding the range within which normal development occurs such that deviation from that range can be distinguished; and second, understanding how deviations manifest themselves in psychiatric and neurologic illnesses (Toth & Cicchetti, 2013). In addition, very large epidemiologic studies have identified significant levels of comorbidity and co-occurring conditions which make linking behavior and function to a specific mental illness both complicated and likely unhelpful and unreliable (Plana-Ripoll et al., 2019).

This change in focus from the categorical diagnostic model will require: changes in diagnostic schemes; changes in how forensic examiners undertake assessments and reach reasoned and competent opinions; and changes in how the courts understand and use neuroscience evidence. Life course and developmental trajectory approaches used to understand behavior and functioning reconfigures the accepted approach to mental illness evidence in criminal cases. It is fast becoming an expected component of the standard assessment, making early life risk factors as important as immediate symptom presentation. As with nearly all of the risk factors associated with later life health and behavioral problems, these early life risk factors are not predictive or specific, but do accumulate and increase the chance of poor health and behavioral outcomes (Anda et al., 2006; Barker et al., 2010; Laub & Sampson, 2009; McGrath et al., 2017).

This approach better supports the complexity of real-world assessment, where it can be difficult to parse the “cause” of a specific behavior as resulting from either mental illness or cognitive impairment. The separation of disorders by differential diagnosis is less significant when considering the manifestation in functioning and behavior, allowing for identification of the variation, richness, and interaction between conditions so often observed in forensic cases.

4. Strengths and limits of neuroscience evidence

A recent study of lay people asked to serve as mock jurors reported that brain-based and psychological evidence of an impulse control disorder had a mitigating effect on the harshness of the prison sentence imposed. Such evidence, when presented as untreatable, led to increased sentences of involuntary hospitalization (a form of civil commitment). The authors concluded that lay people give more weight to findings of mental illness when it is neurobiological rather than psychological, suggesting that the neurobiological evidence helped explain behavior and reduce culpability, but that it was also stigmatizing, leading lay people to seek social distance and incapacitation through

involuntary hospitalizations (Allen et al., 2019).

These types of ethical issues can also be seen in some of the early attempts to use neuroscience to predict future behavior and detect lying. In forensic settings, this is the holy grail: to accurately and precisely predict those who will act badly and those who are lying. Functional neuroimaging opened a window of possibilities, promising that the holy grail was within reach, although the approach was often not more sophisticated or scientific than the ancient art of phrenology. In current parlance, this amounts to a claim that there is a criminal brain, an identifiable structure within the brain that singles out criminals (Pustilnik, 2009). Whether now or in the future, those with these brain defects, identified by neuroscience, will commit criminal offenses. The two primary hypotheses that have been offered over many years are disruptions to the fear networks and disruptions to the executive function networks which, when working, modulate behavior (Kiehl et al., 2001; Raine, Lencz, Bihrle, LaCasse, & Colletti, 2000).

The idea that structural or functional neuroimaging findings could uncover the criminal brain has been too appealing to be tempered by the limits of the evidence, the lack of scientific rigor, or the moral and ethical doubts attached to the pursuit (Gkotsi & Gasser, 2016). First, most of these studies suffer from selection bias, a lack of representativeness, a lack of norms, a lack of understanding of the range of typical and atypical brain functions and structure, and a host of other science-based problems with the research itself (Button et al., 2013; Eack, Bahorik, Newhill, Neighbors, & Davis, 2012; Orem et al., 2019; Peprah, Xu, Tekola-Ayele, & Royal, 2015; Wahlund & Kristiansson, 2009). In addition, the localization of brain defects (which supposedly identify criminals) is not specific, meaning that such deficits are widely observed in many people with psychiatric and neurological conditions, as well as healthy people, who do not commit crimes.

Second, as has been indicated above, behavior occurs in social context, not inside a person's head. This approach to criminal identification fails the basic safeguard of human rights: that people are able to change, to adjust to circumstances, to learn and adapt, and to be redeemed. Instead, this approach relegates the mind to the brain, as though the physical structure alone can explain the complexity of lived experience, adaptability, complexity, and the interaction of individual experience with social and structural forces.

Moreover, the early belief that functional imaging could uncover liars was based on the belief that brain activation when lying differed from non-lying. But how do you know who is in which group? Mostly, researchers assign people to “play” liars and then treat the findings as though they are liars (Farah, Hutchinson, Phelps, & Wagner, 2014). But with no agreed upon referent, no estimation of error, let alone a gold standard for identifying reliability, these research approaches are seriously flawed.

As neuroscience changes law and courts, it is important to keep in mind its limits as well as its strengths. Many of its limits are human, in that the science may be what it is, the interpretation and meaning-making is where the crisis arises. Forensic evaluators have an ethical and professional duty to acknowledge and address the reliability of the scientific tools they use and the risks for bias in their evaluations. This includes consideration of how normative and group data is applied to the individual and careful consideration of whether the normative data is constructed appropriately and is correctly applied to the specific purpose (Freedman & Manly, 2015).

The science underlying the neuroscience is not without its flaws and weaknesses, especially in the forensic setting. Efforts to describe the brains of “psychopaths” or to develop “lie-detector” neuroimaging persist despite the lack of scientific rigor or evidence that the available technologies could ever answer the questions being posed. The risk of harm from such unfounded testimonies posing as scientific facts is immeasurable to the criminal defendant, to the credibility of our judicial systems, and to the ethical and moral standing of our professions.

Finally, neuroscience poses a significant risk of worsening the stigma towards those with mental illness. As indicated by the mock juror study referenced above, jurors view neuroscience evidence as mitigating, but stigmatizing. Stigma is, of course, not limited to the forensic uses of neuroscience, but the use of neuroscience evidence to categorize and label people may have broad impacts both within the court system and in how people with mental illness are perceived. Neuroscience attributions for mental illness have been found to have a complex consequence on stigma: both increasing support for public services for the mentally ill, at the same time significantly increasing the level of stigma and social distancing, while worsening the belief that the conditions are permanent, that people do not recover, and that medication and treatment lack efficacy (Parcesepe & Cabassa, 2013; Pescosolido, 2013; Pescosolido et al., 2010). The presentation in court of such neuroscience evidence may pose greater risks because fact-finders may judge the defendant's specific offense based on stigmatizing beliefs, impose punishments based on a desire for social distancing and isolation, and because courtroom conclusions have a societal influence.

5. Conclusion

Neuroscience has already changed the understanding of brain-behavior relationships, and therefore the understanding of functioning, capacity, and culpability. The consequence of how an individual's cognitive processes shape behavior, and how bio-psychosocial history and neurodevelopmental approaches provide critical information, which has been largely missing from previous assessments, has also become clearer. Accordingly, the assessments should include more than simply interviewing a defendant and expecting that he/she has the insight to explain his/her own behavior. It must include the development of evidence from collateral sources and examining the multigenerational bio-psychosocial history. A neuroscience-informed neurobehavioral forensic assessment also requires a focus on the complexity of the neurodevelopmental trajectory and the gene by environment interactions. In addition, it requires an assessment of how mental conditions affect symptom presentation, functioning, and behavior. Diagnosis may still be important at times, but it should follow on the detailed assessment of functional impairment and limited capacity. Finally, assessments must take into consideration the context in which behavior occurs and the structural and social forces which shape decision-making and perceived options.

This approach is not a cure-all. Understanding and explaining specific behaviors is a difficult undertaking, and explaining the mental condition of the person engaged in those behaviors at the time the behaviors took place is even more difficult. Yet, the law requires some degree of reliability and rigorous, honest presentation of the strengths and weaknesses of the science being relied upon to form opinions. Despite the dramatic advances understanding the neural bases of cognition and functioning, neuroscience does not yet reliably describe how those processes emerge in a specific environmental context (Poldrack et al., 2018), nor what an individual was thinking, feeling, experiencing, understanding, or intending at a particular moment in time (Freedman & Woods, 2018; Greely & Farahany, 2019).

Neuroscience has already reshaped the standards for assessing behavior and functioning and the way causes of crimes are understood. As the science continues to develop, the law will continue to respond and adapt. Forensic evaluators have an obligation to continue to advocate good science and to perform assessments in accord with standards of good science.

References

Allen, C. H., Vold, K., Felsen, G., Blumenthal-Barby, J. S., & Aharoni, E. (2019). Reconciling the opposing effects of neurobiological evidence on criminal sentencing judgments. *PLoS One, 14*(1), e0210584. https://doi.org/10.1371/journal.pone.0210584.

Anda, R. F., Felitti, V. J., Bremner, J. D., Walker, J. D., Whitfield, C., Perry, B. D., ... Giles, W. H. (2006). The enduring effects of abuse and related adverse experiences in childhood – A convergence of evidence from neurobiology and epidemiology.

European Archives of Psychiatry and Clinical Neuroscience, 256(3), 174–186. https://doi.org/10.1007/s00406-005-0624-4.
APA (2013). Specialty guidelines for forensic psychology. *The American Psychologist, 68*(1), 7–19. https://doi.org/10.1037/a0029889.
Barker, D. J., Gelow, J., Thornburg, K., Osmond, C., Kajantie, E., & Eriksson, J. G. (2010). The early origins of chronic heart failure: Impaired placental growth and initiation of insulin resistance in childhood. *European Journal of Heart Failure, 12*(8), 819–825. https://doi.org/10.1093/eurjhf/hfq069.
Barkley (2012). *Executive functions: What they are, how they work, and why they evolved.* New York: The Guilford Press.
Berthelson, L., Mulchan, S. S., Odland, A. P., Miller, L. J., & Mittenberg, W. (2013). False positive diagnosis of malingering due to the use of multiple effort tests. *Brain Injury, 27*(7–8), 909–916. https://doi.org/10.3109/02699052.2013.793400.
Best, J. R., Miller, P. H., & Jones, L. L. (2009). Executive functions after age 5: Changes and correlates. *Developmental Review, 29*(3), 180–200. https://doi.org/10.1016/j.dr.2009.05.002.
Bigler, E. D. (2011). Effort – What is it, how should it be measured? *Journal of the International Neuropsychological Society, 17*(4), 751–752. https://doi.org/10.1017/S1355617711000555.
Bigler, E. D. (2012). Symptom validity testing, effort, and neuropsychological assessment. *Journal of the International Neuropsychological Society, 18*(4), 632–640.
Bopp, J. M., Miklowitz, D. J., Goodwin, G. M., Stevens, W., Rendell, J. M., & Geddes, J. R. (2010). The longitudinal course of bipolar disorder as revealed through weekly text messaging: A feasibility study. *Bipolar Disorders, 12*(3), 327–334. https://doi.org/10.1111/j.1399-5618.2010.00807.x.
Button, K. S., Ioannidis, J. P. A., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S. J., & Munafò, M. R. (2013). Power failure: Why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience, 14*, 365. https://doi.org/10.1038/nrn3475.
Cannon, M., Jones, P., Huttunen, M. O., et al. (1999). School performance in finnish children and later development of schizophrenia: A population-based longitudinal study. *Archives of General Psychiatry, 56*(5), 457–463. https://doi.org/10.1001/archpsyc.56.5.457.
Casey, B. J., Oliveri, M. E., & Insel, T. (2014). A neurodevelopmental perspective on the research domain criteria (RDoC) framework. *Biological Psychiatry, 76*(5), 350–353. https://doi.org/10.1016/j.biopsych.2014.01.006.
Chandler, J. A. (2015). The use of neuroscientific evidence in Canadian criminal proceedings. *Journal of Law and the Biosciences, 2*(3), 550–579. https://doi.org/10.1093/jlb/lsv026.
Crossley, N. A., Alliende, L. M., Ossandon, T., Castaneda, C. P., Gonzalez-Valderrama, A., Undurraga, J., ... Bressan, R. (2019). Imaging social and environmental factors as modulators of brain dysfunction: Time to focus on developing non-Western societies. *Biol Psychiatry Cogn Neurosci Neuroimaging, 4*(1), 8–15. https://doi.org/10.1016/j.bpsc.2018.09.005.
Cummings, J. L., & Mega, M. S. (2003). *Neuropsychiatry and behavioral neuroscience.* Oxford, New York: Oxford University Press.
Cuthbert, B. N. (2014). The RDoC framework: Facilitating transition from ICD/DSM to dimensional approaches that integrate neuroscience and psychopathology. *World Psychiatry, 13*(1), 28–35. https://doi.org/10.1002/wps.20087.
De Bellis, M. D., & Zisk, A. (2014). The biological effects of childhood trauma. *Child and Adolescent Psychiatric Clinics of North America, 23*(2), 185–+. https://doi.org/10.1016/j.chc.2014.01.002.
De Los Reyes, A., Augenstein, T. M., Wang, M., Thomas, S. A., Drabick, D. A., Burgers, D. E., & Rabinowitz, J. (2015). The validity of the multi-informant approach to assessing child and adolescent mental health. *Psychological Bulletin, 141*(4), 858–900. https://doi.org/10.1037/a0038498.
Denno, D. W. (2006). The scientific shortcomings of roper v. Simmons. *Ohio State Journal of Criminal Law, 3*, 379–396.
Denno, D. W. (2015). The myth of the double-edged sword: An empirical study of neuroscience evidence in criminal cases. *Boston College Law Review, 56*(2).
Dudley, R. G. J., & Leonard, P. B. (2008). Supplementary guielines for the mitigation functionin of defense teams in death penalty cases: Imagining mitigation: Getting it right: Life history investigation as the foundation for a reliable mental health assessment. *Hofstra Law Review, 36*(3), 963–988.
Eack, S. M., Bahorik, A. L., Newhill, C. E., Neighbors, H. W., & Davis, L. E. (2012). Interviewer-perceived honesty as a mediator of racial disparities in the diagnosis of schizophrenia. *Psychiatric Services, 63*(9), 875–880. https://doi.org/10.1176/appi.ps.201100388.
Erard, R. E. (2016). If it walks like a duck: A case of confirmatory Bias. *Psychological Injury & Law, 9*(3), 275–277. https://doi.org/10.1007/s12207-016-9262-6.
Faigman, D. L., Monahan, J., & Slobogin, C. (2014). Group to individual (G2i) inference in scientific expert testimony. *The University of Chicago Law Review, 81*(2).
Farah, M. J. (2017). The Neuroscience of socioeconomic status: Correlates, causes, and consequences. *Neuron, 96*(1), 56–71. https://doi.org/10.1016/j.neuron.2017.08.034.
Farah, M. J., Hutchinson, J. B., Phelps, E. A., & Wagner, A. D. (2014). Functional MRI-based lie detection: Scientific and societal challenges. *Nature Reviews Neuroscience, 15*, 123. https://doi.org/10.1038/nrn3665https://www.nature.com/articles/nrn3665#supplementary-information.
Farahany, N. A. (2016). Neuroscience and behavioral genetics in US criminal law: An empirical analysis. *Journal of Law and the Biosciences, 2*(3), 485–509. https://doi.org/10.1093/jlb/lsv059.
Freedman, D., & Brown, A. S. (2011). The developmental course of executive functioning in schizophrenia. *International Journal of Developmental Neuroscience, 29*(3), 237–243. https://doi.org/10.1016/j.ijdevneu.2010.11.003.
Freedman, D., & Manly, J. J. (2015). *Use of normative data and measures of performance validity and symptom validity in assessment of Cognitive function.* National Academies Press. Retrieved from http://iom.nationalacademies.org/reports/2015/psychtesting.aspx#sthash.rObQidey.dpuf.
Freedman, D., & Woods, G. W. (2018). The developing significance of context and function: Neuroscience and law. *Behavioral Sciences & the Law, 36*(4), 411–425. https://doi.org/10.1002/bsl.2351.
Friedman, S. H. (2017). Culture, bias, and understanding: We can do better. *The Journal of the American Academy of Psychiatry and the Law, 45*(2), 136–139.
Garland, B. (2004). American Association for the Advancement of Science. In M. S Frankel (Ed.). *Neuroscience and the Law: Brain, Mind, and the Scales of Justice*. New York: Dana Press.
Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin, 134*(1), 31–60. https://doi.org/10.1037/0033-2909.134.1.31.
Ghandnoosh, N. (2014). *Race and punishment: Racial perceptions of crime and support for punitive policies.* Retrieved from, Washington, DC.
Gkotsi, G. M., & Gasser, J. (2016). Neuroscience in forensic psychiatry: From responsibility to dangerousness. Ethical and legal implications of using neuroscience for dangerousness assessments. *International Journal of Law and Psychiatry, 46*, 58–67. https://doi.org/10.1016/j.ijlp.2016.02.030.
Gkotsi, G. M., Gasser, J., & Moulin, V. (2018). Neuroimaging in criminal trials and the role of psychiatrists expert witnesses: A case study. *International Journal of Law and Psychiatry*. https://doi.org/10.1016/j.ijlp.2018.05.007.
Glahn, D. C., Bearden, C. E., Bowden, C. L., & Soares, J. C. (2006). Reduced educational attainment in bipolar disorder. *Journal of Affective Disorders, 92*(2–3), 309–312. https://doi.org/10.1016/j.jad.2006.01.025.
Glancy, G. D., Ash, P., Bath, E. P., Buchanan, A., Fedoroff, P., Frierson, R. L., ... Zonana, H. V. (2015). AAPL practice guideline for the forensic assessment. *The Journal of the American Academy of Psychiatry and the Law, 43*(2 Suppl), S3–53.
Greely, H. T., & Farahany, N. A. (2019). Neuroscience and the criminal justice system. In J. Petersilia, & R. J. Sampson (Vol. Eds.), *Annual review of criminology. vol. 2. Annual review of criminology* (pp. 451–471).
Gunter, T. D. (2015). Behavioral genetics and the forensic mental health provider: An overview. *Behavioral Sciences & the Law, 33*(5), 598–606. https://doi.org/10.1002/bsl.2208.
Gur, R. C., Gur, O. M., Gur, A. E., & Gur, A. G. (2016). A perspective on the potential role of neuroscience in the court. *Fordham Law Review,* 85.
Hall, H. V., & Sbordone, R. J. (1993). *Disorders of executive functions: Civil and criminal law applications.* Winter Park, FL: PMD Publishers Group.
Haney, C. (2008). Supplementary guielines for the mitigation functionin of defense teams in death penalty cases: Imagining mitigation: Evolving standards of decency: Advancing the nature and logic of capital mitigation. *Hofstra Law Review, 36*(3), 835.
Heilbrun, K. (2001). *Principles of Forensic Mental Health Assessment.* Secaucus, NJ, USA: Kluwer Academic Publishers.
Holdman, S., & Seeds, C. (2008). Supplementary guielines for the mitigation functionin of defense teams in death penalty cases: Imagining mitigation: Cultural competency in capital mitigation. *Hofstra Law Review, 36*(3), 883–892.
Insel, T. (2010). Rethinking schizophrenia. *Nature, 468*(7321), 187–193. https://doi.org/10.1038/nature09552.
Insel, T. (2014). The NIMH research domain criteria (RDoC) project: Precision medicine for psychiatry. *American Journal of Psychiatry, 171*(4), 395–397. https://doi.org/10.1176/appi.ajp.2014.14020138.
Iudici, A., Salvini, A., Faccio, E., & Castelnuovo, G. (2015). The clinical assessment in the legal field: An empirical study of bias and limitations in forensic expertise. *Frontiers in Psychology, 6*, 1831. https://doi.org/10.3389/fpsyg.2015.01831.
Kaffman, A., & Krystal, J. J. (2012). New frontiers in animal research of psychiatric illness. In F. H. Kobeissy (Vol. Ed.), *Psychiatric disorder: Methods and protocols. vol. 829. Psychiatric disorder: Methods and protocols* (pp. 3–30).
Kalkut, E. L., Han, S. D., Lansing, A. E., Holdnack, J. A., & Delis, D. C. (2009). Development of set-shifting ability from late childhood through early adulthood. *Archives of Clinical Neuropsychology, 24*(6), 565–574. https://doi.org/10.1093/arclin/acp048.
Keshavan, M. S., Kennedy, J. L., & Murray, R. (2004). *Neurodevelopment and schizophrenia.* Cambridge, U.K, New York, NY, USA: Cambridge University Press.
Kiehl, K. A., Smith, A. M., Hare, R. D., Mendrek, A., Forster, B. B., Brink, J., & Liddle, P. F. (2001). Limbic abnormalities in affective processing by criminal psychopaths as revealed by functional magnetic resonance imaging. *Biological Psychiatry, 50*(9), 677–684.
Koenen, K. C., Nugent, N. R., & Amstadter, A. B. (2008). Gene-environment interaction in posttraumatic stress disorder: Review, strategy and new directions for future research. *European Archives of Psychiatry and Clinical Neuroscience, 258*(2), 82–96. https://doi.org/10.1007/s00406-007-0787-2.
de Kogel, C. H., & Westgeest, E. J. M. C. (2015). Neuroscientific and behavioral genetic information in criminal cases in the Netherlands. *Journal of Law and the Biosciences, 2*(3), 580–605. https://doi.org/10.1093/jlb/lsv024.
Lambert, M. V., Sierra, M., Phillips, M. L., & David, A. S. (2002). The spectrum of organic depersonalization: A review plus four new cases. *The Journal of Neuropsychiatry and Clinical Neurosciences, 14*(2), 141–154.
Laub, J. H., & Sampson, R. J. (2009). *Shared beginnings, divergent lives.* Harvard University Press.
Lichter, D. G., & Cummings, J. L. (2001). *Frontal-subcortical circuits in psychiatric and neurological disorders.* New York: Guilford Press.
Link, B. G., & Phelan, J. (1995). Social conditions as fundamental causes of disease. *Journal of Health and Social Behavior,* 80–94.
MacDonald, A. W., 3rd, Carter, C. S., Kerns, J. G., Ursu, S., Barch, D. M., Holmes, A. J., ... Cohen, J. D. (2005). Specificity of prefrontal dysfunction and context processing deficits to schizophrenia in never-medicated patients with first-episode psychosis. *The*

American Journal of Psychiatry, 162(3), 475–484. https://doi.org/10.1176/appi.ajp.162.3.475.
Maroney, T. A. (2006). Emotional competence, rational understanding, and the criminal defendant. *American Criminal Law Review*, 43.
Martel, M. M., Markon, K., & Smith, G. T. (2017). Research review: Multi-informant integration in child and adolescent psychopathology diagnosis. *Journal of Child Psychology and Psychiatry, 58*(2), 116–128. https://doi.org/10.1111/jcpp.12611.
McGrath, J. J., McLaughlin, K. A., Saha, S., Aguilar-Gaxiola, S., Al-Hamzawi, A., Alonso, J., ... Kessler, R. C. (2017). The association between childhood adversities and subsequent first onset of psychotic experiences: A cross-national analysis of 23 998 respondents from 17 countries. *Psychological Medicine, 47*(7), 1230–1245. https://doi.org/10.1017/s0033291716003263.
Meyer, U., & Feldon, J. (2010). Epidemiology-driven neurodevelopmental animal models of schizophrenia. *Progress in Neurobiology, 90*(3), 285–326. https://doi.org/10.1016/j.pneurobio.2009.10.018.
Millan, M. J. (2013). An epigenetic framework for neurodevelopmental disorders: From pathogenesis to potential therapy. *Neuropharmacology, 68*, 2–82. https://doi.org/10.1016/j.neuropharm.2012.11.015.
Miller, B. L., & Cummings, J. L. (2007). *The human frontal lobes : Functions and disorders* (2nd ed.). New York, NY: Guilford Press.
Miller, L. (2013). Psychological evaluations in the criminal justice system: Basic principles and best practices. *Aggression and Violent Behavior, 18*(1), 83–91. https://doi.org/10.1016/j.avb2012.10.005.
Miller, S. P., McQuillen, P. S., Hamrick, S., Xu, D., Glidden, D. V., Charlton, N., ... Vigneron, D. B. (2007). Abnormal brain development in newborns with congenital heart disease. *The New England Journal of Medicine, 357*(19), 1928–1938. https://doi.org/10.1056/NEJMoa067393.
Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*(1), 49–100. https://doi.org/10.1006/cogp.1999.0734.
Moffitt, T. E., Caspi, A., & Rutter, M. (2005). Strategy for investigating interactions between measured genes and measured environments. *Archives of General Psychiatry, 62*(5), 473–481. https://doi.org/10.1001/archpsyc.62.5.473.
Morenoff, J. D., Sampson, R. J., & Raudenbush, S. W. (2001). Neighborhood inequality, collective efficacy, and the spatial dynamics of urban violence. *Criminology, 39*(3), 517–559. https://doi.org/10.1111/j.1745-9125.2001.tb00932.x.
Murphy, F. C., Rubinsztein, J. S., Michael, A., Rogers, R. D., Robbins, T. W., Paykel, E. S., & Sahakian, B. J. (2001). Decision-making cognition in mania and depression. *Psychological Medicine, 31*(4), 679–693.
Neal, T. M. S., & Brodsky, S. L. (2016). Forensic Psychologists' perceptions of Bias and potential correction strategies in forensic mental health evaluations. *Psychology, Public Policy, and Law, 22*(1), 58–76. https://doi.org/10.1037/law0000077.
Neal, T. M. S., & Grisso, T. (2014). The cognitive underpinnings of bias in forensic mental health evaluations. *Psychology, Public Policy, and Law, 20*(2), 200–211. https://doi.org/10.1037/a0035824.
Nelkin, D., & Tancredi, L. (1989). *Dangerous diagnostics: The social power of biological information.* New York: Basic Books.
Neuroscience, S.f. n.d. Retrieved from https://www.sfn.org/about/about-neuroscience
Newbury, J., Arseneault, L., Caspi, A., Moffitt, T. E., Odgers, C. L., & Fisher, H. L. (2017). Cumulative effects of neighborhood social adversity and personal crime victimization on adolescent psychotic experiences. *Schizophrenia Bulletin*. https://doi.org/10.1093/schbul/sbx060.
Orem, T. R., Wheelock, M. D., Goodman, A. M., Harnett, N. G., Wood, K. H., Gossett, E. W., ... Knight, D. C. (2019). Amygdala and prefrontal cortex activity varies with individual differences in the emotional response to psychosocial stress. *Behavioral Neuroscience, 133*(2), 203–211. https://doi.org/10.1037/bne0000305.
Otto, R. K., & Heilbrun, K. (2002). The practice of forensic psychology: A look toward the future in light of the past. *American Psychologist, 57*(1), 5–18. https://doi.org/10.1037/0003-066X.57.1.5.
Parcesepe, A. M., & Cabassa, L. J. (2013). Public stigma of mental illness in the United States: A systematic literature review. *Administration and Policy in Mental Health, 40*(5), 384–399. https://doi.org/10.1007/s10488-012-0430-z.
Patterson, M. L., Moniruzzaman, A., & Somers, J. M. (2014). Setting the stage for chronic health problems: Cumulative childhood adversity among homeless adults with mental illness in Vancouver, British Columbia. *BMC Public Health, 14*, 350. https://doi.org/10.1186/1471-2458-14-350.
Peprah, E., Xu, H., Tekola-Ayele, F., & Royal, C. D. (2015). Genome-wide association studies in Africans and African Americans: Expanding the framework of the genomics of human traits and disease. *Public Health Genomics, 18*(1), 40–51. https://doi.org/10.1159/000367962.
Pescosolido, B. A. (2013). The public stigma of mental illness: What do we think; what do we know; what can we prove? *Journal of Health and Social Behavior, 54*(1), 1–21. https://doi.org/10.1177/0022146512471197.
Pescosolido, B. A., Martin, J. K., Long, J. S., Medina, T. R., Phelan, J. C., & Link, B. G. (2010). "a disease like any other"? A decade of change in public reactions to schizophrenia, depression, and alcohol dependence. *The American Journal of Psychiatry, 167*(11), 1321–1330. https://doi.org/10.1176/appi.ajp.2010.09121743.
Plana-Ripoll, O., Pedersen, C. B., Holtz, Y., Benros, M. E., Dalsgaard, S., de Jonge, P., ... McGrath, J. J. (2019). Exploring comorbidity within mental disorders among a Danish National Population. *JAMA Psychiatry*. https://doi.org/10.1001/jamapsychiatry.2018.3658.
Poldrack, R. A., Monahan, J., Imrey, P. B., Reyna, V., Raichle, M. E., Faigman, D., & Buckholtz, J. W. (2018). Predicting violent behavior: What can neuroscience add? *Trends in Cognitive Sciences, 22*(2), 111–123. https://doi.org/10.1016/j.tics.2017.11.003.
Pustilnik, A. C. (2009). Violence on the brain: A critique of neuroscience in criminal law. *Wake Forest Law Review, 44*, 183.
Raine, A., Lencz, T., Bihrle, S., LaCasse, L., & Colletti, P. (2000). Reduced prefrontal gray matter volume and reduced autonomic activity in antisocial personality disorder. *Archives of General Psychiatry, 57*(2), 119–127 (discussion 128–119).
Ramo-Fernandez, L., Schneider, A., Wilker, S., & Kolassa, I. T. (2015). Epigenetic alterations associated with war trauma and childhood maltreatment. *Behavioral Sciences & the Law, 33*(5), 701–721. https://doi.org/10.1002/bsl.2200.
Rapoport, J. L., Giedd, J. N., & Gogtay, N. (2012). Neurodevelopmental model of schizophrenia: Update 2012. *Molecular Psychiatry, 17*(12), 1228–1238. https://doi.org/10.1038/mp.2012.23.
Rasmusson, A. M., Schnurr, P. P., Zukowska, Z., Scioli, E., & Forman, D. E. (2010). Adaptation to extreme stress: Post-traumatic stress disorder, neuropeptide Y and metabolic syndrome. *Experimental Biology and Medicine, 235*(10), 1150–1162. https://doi.org/10.1258/ebm.2010.009334.
Sampson, R. J., Morenoff, J. D., & Raudenbush, S. (2005). Social anatomy of racial and ethnic disparities in violence. *American Journal of Public Health, 95*(2), 224–232. https://doi.org/10.2105/AJPH.2004.037705.
Schwarz, E. D., & Perry, B. D. (1994). The post-traumatic response in children and adolescents. *The Psychiatric Clinics of North America, 17*(2), 311–326.
Shonkoff, J. P., & Phillips, D. A. (2000). From Neurons to Neighborhoods: The Science of Early Childhood Development. Washington D.C: National Academy Press.
Sipahi, L., Wildman, D. E., Aiello, A. E., Koenen, K. C., Galea, S., Abbas, A., & Uddin, M. (2014). Longitudinal epigenetic variation of DNA methyltransferase genes is associated with vulnerability to post-traumatic stress disorder. *Psychological Medicine, 44*(15), 3165–3179. https://doi.org/10.1017/s0033291714000968.
Slobogin, C. (2017). Neuroscience nuance: Dissecting the relevance of neuroscience in adjudicating criminal culpability. *Journal of Law and the Biosciences*. https://doi.org/10.1093/jlb/lsx033 (lsx033-lsx033).
Sollman, M. J., & Berry, D. T. R. (2011). Detection of inadequate effort on neuropsychological testing: A meta-analytic update and extension. *Archives of Clinical Neuropsychology, 26*(8), 774–789. https://doi.org/10.1093/arclin/acr066.
Spitzer, C., Barnow, S., Völzke, H., John, U., Freyberger, H. J., & Grabe, H. J. (2009). Trauma, posttraumatic stress disorder, and physical illness: Findings from the general population. *Psychosomatic Medicine, 71*(9), 1012–1017. https://doi.org/10.1097/PSY.0b013e3181bc76b5.
Steinberg, L. (2013). The influence of neuroscience on US supreme court decisions about adolescents' criminal culpability. *Nature Reviews. Neuroscience, 14*(7), 513–518. https://doi.org/10.1038/nrn3509.
Tau, G. Z., & Peterson, B. S. (2010). Normal development of brain circuits. *Neuropsychopharmacology, 35*(1), 147–168. https://doi.org/10.1038/npp.2009.115.
Toth, S. L., & Cicchetti, D. (2013). A developmental psychopathology perspective on child maltreatment. *Child Maltreatment, 18*(3), 135–139. https://doi.org/10.1177/1077559513500380.
Truong, K. D., & Ma, S. (2006). A systematic review of relations between neighborhoods and mental health. *Journal of Mental Health Policy and Economics, 9*(3), 137–154.
Wahlund, K., & Kristiansson, M. (2009). Aggression, psychopathy and brain imaging - review and future recommendations. *International Journal of Law and Psychiatry, 32*(4), 266–271. https://doi.org/10.1016/j.ijlp.2009.04.007.
Wayland, K. (2008). Supplementary guielines for the mitigation functionin of defense teams in death penalty cases: Imagining mitigation: The importance of recognizing trauma throughout capital mitigation investigations and presentations. *Hofstra Law Review, 36*(3), 923.
Woods, G. W., Freedman, D., & Greenspan, S. (2012). Neurobehavioral assessment in forensic practice. *International Journal of Law and Psychiatry, 35*(5–6), 432–439. https://doi.org/10.1016/j.ijlp.2012.09.014.
Woods, G. W., Greenspan, S., & Agharkar, B. S. (2011). Ethnic and cultural factors in identifying fetal alcohol spectrum disorders. *Journal of Psychiatry & Law, 39*(1), 9–37,37.
Yehuda, R., & Bierer, L. A. (2009). The relevance of epigenetics to PTSD: Implications for the DSM-V. *Journal of Traumatic Stress, 22*(5), 427–434. https://doi.org/10.1002/jts.20448.
Young, G. (2017). PTSD in court II: Risk factors, endophenotypes, and biological underpinnings in PTSD. *International Journal of Law and Psychiatry, 51*, 1–21. https://doi.org/10.1016/j.ijlp.2017.02.002.

Cases Cited:

Graham v. Florida, 560 U.S. 48.
Kentucky v. Bredhold, Case no. 14-CR-161.
Moore v. Texas, 581 U.S. __.
Morissette v. United States, 342 U.S. 246.
Rompilla v. Beard, 545 U.S. 374.
Roper v. Simmons, 543 U.S. 551.