Fall 12-15-2022

Traumatic Brain Injury and Psychopathy in Incarcerated Men and Women

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TRAUMATIC BRAIN INJURY AND PSYCHOPATHY IN INCARCERATED MEN AND WOMEN

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DISSERTATION

Submitted in Partial Fulfillment of the
Requirements for the Degree of

Doctor of Philosophy

Psychology

The University of New Mexico
Albuquerque, New Mexico

December, 2022

ACKNOWLEDGMENTS

My heartfelt gratitude goes to my advisor and mentor Marco Del Giudice – I sincerely appreciate that you have prioritized promoting my success as an individual, an academic, and an independent researcher. Thank you for your kindness, your patience, and your belief in me. I am honored I had the chance to learn from such a brilliant scholar.

Thanks are due to my secondary advisor Kent A. Kiehl. Thank you for working with me in an efficient and respectful way. Thanks to Davin Quinn for serving on my dissertation committee and for valuable insights into the medical aspect of this project.

Steven Gangestad deserves special thanks – you are the reason why I initially had the opportunity to further my academic career in Evolutionary Psychology and I am extremely grateful for you warmly welcoming me in Albuquerque and at UNM.

Geoffrey Miller – you have taught me valuable lessons on how to navigate the academic world and being treated as an equal in it. Thank you for the respect, trust, and belief you expressed towards me.

I further want to express my genuine gratitude to Craig S. Neumann – it has been a pleasure to collaborate with you and learn from you. Your dedication to support students' success and assist in any step along the way is impressive – thank you. Gerard Clarke, thank you for your valuable help during these last two years – and your friendship.

Rikk Murphy, thank you for your enthusiasm and your continued time and energy making people's life in the department easier and more enjoyable, it means a lot.

Romina Angeleri, I want to thank you for your caring spirit and for making me feel at home in Albuquerque.

I will always be grateful for having met so many inspiring people throughout my time in the land of enchantment. I want to wholeheartedly thank my friends without whom I would not be the person I am today; Seth Merkley, Anette Mertens, Ben Winchester, Richard Rael, Michaella Bennett, Jacob Spinks, Warner Wolf, Andrew Segura, Kevin Macken, Aaron McCrea, Kim Hartman, Taylor Banks, Swenja Rosenwinkel, Uwe Mayer, Nina Speer-Keary, Jennifer Kurth, Vlada Pototskaia, and Zak de Gorgue.

Lastly, but above all: My deepest gratitude is due to my family for their everlasting support and love; mum, dad, Alain, Sabine, Julia, and Sophie.

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ABSTRACT

Traumatic brain injury (TBI) is one of the most suffered injuries with detrimental effects on the individual's health, personality, and behavior. Overlap exists between TBI sequelae and symptoms of psychopathy. Both conditions are especially prevalent in incarcerated populations which makes studying their interrelation critical. Two studies examined the relationship between history of TBI (TBI+ vs. TBI-) and psychopathy (via the Hare Psychopathy Checklist-Revised; PCL-R) in adult incarcerated men and women at correctional facilities in New Mexico and Wisconsin. Study 1 included 342 women, study 2 included 1049 men. Measurement invariance was evident for TBI+ and TBI- for both studies. TBI+ showed higher PCL-R scores for both men and women alike, indicating higher psychopathic traits compared to those without a history of TBI. These studies are the first ones to link TBI and psychopathy in adult individuals. Implications for prevention and treatment are discussed, and directions for future research are suggested.

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CHAPTER 1

General Introduction

Traumatic Brain Injury

The term traumatic brain injury (TBI) is defined as "an alteration in brain function, or other evidence of brain pathology, caused by an external force" (Menon et al., 2010). With an estimated 2.8 million people annually sustaining a TBI (Taylor et al., 2017) and associated medical costs of $76.5 billion in the United States alone (Finkelstein et al., 2006) and over $400 billion globally (Maas et al., 2017), TBI has become a major global public health challenge (Coronado et al., 2012; Faul et al., 2010). TBI is one of the leading causes of death in children and adolescents in the United States (Thurman et al., 1999) with 50,000 people in the United States dying from TBIs annually, 1.1 million people receiving treatment in emergency departments and 235,000 Americans being hospitalized as a result of TBI (Corrigan et al., 2010). TBIs have detrimental effects on people's cognition, behavior, and personality (Langlois et al., 2006; Maas et al., 2008; Sloan et al., 2007). Due to the large number of people affected by TBIs and not only its short- but also long-term effects, TBI has been referred to as the silent epidemic (Coburn, 1992). In 2006, 1.7% of the United States population lived with a disability that was a result of a TBI (Langlois et al., 2006). TBI is a growing problem with adverse effects on the injured as well as on society.

Clinical research studies have reported changes in individuals' personalities after experiencing a TBI (Barrash et al., 2000; Max et al., 2001; Norup & Mortensen, 2015). For instance, in a study of TBI patients and their significant others, 59.1% rated their partner as having changed personality one year post-injury, with the most notable changes reported for neuroticism, extraversion, and conscientiousness (Norup & Mortensen, 2015). Another study noted personality change in 59% of those with severe

TBI and 5% in those with mild or moderate TBI in children and adolescents between the ages of 5 and 14. In those affected, emotional lability, aggression, and disinhibition were the most commonly reported personality trait changes (Max et al., 2001).

The terms TBI, head injury, brain injury, and concussion are sometimes used loosely or interchangeably, and despite the vast clinical research on TBI, there is still substantial ambiguity and discussion surrounding the definition, terminology, and diagnosis of TBI and TBI severity (Sussman et al, 2018).

The prevalence of TBI is particularly high in incarcerated individuals (Hughes et al., 2015) with rates of 46% percent compared to 8.5% in the general population (Durand et al., 2017; Silver et al., 2001), where men are about twice as likely to report a TBI compared to women (Vaughn et al., 2014).

Individuals with a history of TBI exhibit more impulsive, aggressive, and violent behavior, more violent- and non-violent criminal behavior, less self-control, less emotional empathy, and criminal offenders reoffend sooner after release (Fazel et al., 2011; Ray & Richardson, 2017; Schwartz et al., 2017; Vaughn et al., 2014; Williams et al., 2015; Wood & Williams, 2008). Furthermore, people with a history of TBI show comorbidities with mental health disorders such as major depressive disorder (MDD), post-traumatic stress disorder (PTSD) and substance use disorder (SUD) compared to individuals without history of TBI, both in the general population and in prison populations (Schneider et al., 2021; Vaughn et al., 2019).

Psychopathy

Psychopathy is a personality disorder that is characterized by interpersonal, affective and socially deviant traits (Cleckley, 1941; Hare 2003). People with psychopathic traits

exhibit antisocial behavior, a lack of remorse and guilt, impulsiveness, and engage in many short-term marital relationships. Research around this disorder has gained attention over the last few decades and numerous studies show that the development of psychopathy is the result of a complex interplay of genetic, environmental, and social factors (De Brito et al., 2021; Del Giudice, 2018; Walsh & Wu, 2008).

About 1% of the general population of male adults over 18 years of age score above the threshold of psychopathy as determined by the PCL-R whereas an estimated 15-25% of male incarcerated adults show psychopathic traits (Coid et al., 2009; Kiehl & Hoffmann, 2011). This disproportionately high occurrence in prison populations demonstrates a pressing need to study psychopathy in inmates (Hare, 2003).

Within the criminal justice system, prison sentences, the evaluation of treatment options, and potential risk of recidivism are affected by the concept of psychopathy (Anderson & Kiehl, 2014; Beggs & Grace, 2008; Kiehl & Hoffmann, 2011).

Hare Psychopathy Checklist-Revised (PCL-R)

The standard assessment tool to measure psychopathy in prison populations is the Hare Psychopathy Checklist-Revised (PCL-R, Hare, 1991; Hare, 2003). It was originally designed to assess psychopathic traits in adults who were convicted of a crime and was later also validated for non-forensic populations. PCL-R assessment is conducted by trained researchers and mental health professionals through interviews and consideration of available individual medical records. The individual's psychopathic traits are measured through this 20-item instrument using a 3-point rating scale, corresponding to the degree that the trait exists in the individual (0 = nonexistent, 1= partly existent, 2 =

fully existent). The PCL-R has a maximum score of 40 with a threshold for the definition of psychopathy of 30 for men and a typical cutoff for women of 25 (Jackson et al., 2002). The PCL-R has been validated extensively and is used in different populations comparing men and women, in alcohol inpatients, in adolescents, and in clinical settings (Forth et al., 1996; Toupin et al., 1995; Vitale & Newman, 2001; Windle & Dumenci, 1999).

Factor analyses of PCL-R scores have revealed a classification into two main factors, namely interpersonal/affective (Factor 1) and impulsive/antisocial behavior (Factor 2), with an inter-factor correlation of 0.56 in incarcerated individuals (Hare et al., 1991). Factor 1 represents the manipulative, callous side of the psychopath including exploitative use of others, lack of guilt, remorse, and empathy and Factor 2 refers to unstable lifestyle and antisocial behavioral traits (Hare, 1991; Hare et al., 1990; Harpur et al., 1989).

The two factors were later divided further into four distinct facets (Hare, 2003; Hare & Neumann, 2005; Vitacco et al., 2005; see Table 1). Factor 1 (interpersonal/affective) is split into facet 1 (interpersonal) with the items glibness and/or superficial charm, grandiose sense of self-worth, pathological lying, and conning and/or manipulative behavior, and facet 2 (affective) with lack of remorse or guilt, shallow affect, callousness and/or lack of empathy, and failure to accept responsibility for one's own actions. Factor 2 (lifestyle/antisocial) is divided into facet 3 (lifestyle) comprising need for stimulation and/or proneness to boredom, parasitic lifestyle, lack of realistic, long-term goals, impulsivity, and irresponsibility, and facet 4 (antisocial) which lists poor behavioral controls, early behavioral problems, juvenile delinquency, revocation of conditional release, and criminal versatility. Two out of the twenty total items of the

PCL-R did not saturate any of the factors, namely promiscuous sexual behavior and having had many short-term marital relationships (Hare, 2003; Hare & Neumann, 2005).

Table 1: Psychopathy Checklist-Revised (PCL-R); Items classified by Factors and Facets (After Hare, 2003; Hare & Neumann, 2005)

Factor 1 (Interpersonal/Affective)

Facet 1 – Interpersonal	Facet 2 – Affective
1. Glibness / superficial charm	6. Lack of remorse or guilt
2. Grandiose sense of self-worth	7. Shallow affect
4. Pathological lying	8. Callous / lack of empathy
5. Conning / manipulative	16. Failure to accept responsibility

Factor 2 (Lifestyle/Antisocial)

Facet 3 – Lifestyle	Facet 4 – Antisocial
3. Need for stimulation	10. Poor behavioral controls
9. Parasitic lifestyle	12. Early behavioral problems
13. Lack of realistic, long-term goals	18. Juvenile delinquency
14. Impulsivity	19. Revocation of conditional release
15. Irresponsibility	20. Criminal versatility

Note. The original items promiscuous sexual behavior (11) and many short-term marital relationships (17) did not load onto any factor.

As the PCL-R was originally designed to study psychopathy in forensic populations, and men are currently and historically incarcerated at much higher rates

compared to women (93.1% vs. 6.9%, Bureau of Prisons Statistics, 2022), psychopathy research has primarily focused on men in the past (Carson & Golinelli, 2013). Only recently have researchers started to study psychopathy in women-only samples in more detail (Wynn et al., 2012).

On average, PCL-R scores are slightly lower in women compared to men, hence the cutoff for determination of psychopathy in women is set to 25 points and 30 points for men (Verona & Vitale, 2006). The PCL-R shows good validity and reliability for the study of female samples (Vitale & Newman, 2001).

The only studies conducted so far on the relationship between psychopathy and TBI were in juvenile incarcerated individuals, revealing higher PCL-R total scores for those who have had a TBI compared to those who did not (Vaughn et al., 2014). With brain development ongoing during childhood and early adolescence, blunt trauma to the head has clear potential to permanently affect neurocognitive function, and indeed there is some empirical evidence for this (Beauchamp et al., 2011; Max et al., 2015).

To this day, no study has examined whether and how a history of TBI affects psychopathy in adult incarcerated individuals, and specifically how PCL-R total scores and PCL-R factor and facet structures differ between groups of individuals with and without a history of TBI. In the past, individuals with a history of TBI have been excluded from data analyses due to the lack of understanding of whether and how TBIs might affect psychopathy (Anderson et al., 2021; Cima & Raine, 2009; Steele et al., 2017). However, inmates with a history of TBI represent a non-negligible part of the inmate population. Colantonio and colleagues report that 50.4% of male inmates and 38.1% of female inmates indicate having had a TBI (Colantonio et al., 2014) compared to

an estimated 12% in the general population (Frost et al., 2013). Therefore, it is necessary and important to study psychopathy in relation to TBI in forensic populations.

Psychopathy and TBI

Some TBI sequelae are similar to the symptomatology of psychopathy. These include traits related to emotion processing and cognition – traits that are mostly represented in the interpersonal-affective traits of Factor 1 of psychopathy.

Individuals with psychopathic traits show low emotional affect, which is shared by some individuals who have had a TBI in the past (Fournier & Verona, 2022). Emotional empathy, emotion recognition, working memory, and reasoning may be impacted in patients following a TBI (De Sousa et al., 2012; Ietswaart et al., 2008; Rosenberg et al., 2014), and they are also present in individuals high on psychopathy (Dawel et al., 2012; Domes et al., 2013). Functional MRI (fMRI) studies indicate differences in blood flow representative of neural activation of certain brain regions that are correlated with both TBI and psychopathy (Jolly et al., 2020). In particular, the prefrontal cortex, amygdala, and paralimbic structures have been well established as some of the brain regions that are linked to psychopathy (Keil & Kaszniak, 2002; for review, see Anderson & Kiehl, 2014) and post-TBI behavioral and personality changes. These brain structures are, amongst others, involved in emotion regulation, facial emotion recognition, self-reflection, and executive functions such as decision-making processes, all of which are relevant in psychopathic behavior.

Further, there is empirical evidence that TBI results in violent, aggressive, and criminal behavior (Vaughn et al., 2019). The same is true for psychopathy; on average,

people scoring high on the PCL-R engage in more violent and aggressive behavior compared to individuals low on psychopathy (Hare, 1999; Serin, 1991) and brain imaging studies also lend support to this effect on a structural level (Wahlund & Kristiansson, 2009). Therefore, the link between TBI and psychopathy in incarcerated populations warrants investigation.

Dataset and Statistical Analyses

Data from adult men and women from correctional facilities in New Mexico and Wisconsin were used for the studies presented herein. Individuals who have had a TBI are compared to those who have not. PCL-R total score, factor and facet scores are calculated and compared between the groups TBI– (no history of TBI) vs. TBI+ (history of TBI). Severity of TBI (mild vs. severe), time of loss of consciousness (LOC) after TBI, and other variables have been shown to affect cognitive and behavioral outcomes differently (Cappa et al., 2011). Hence, these and other additional variables such as age at first TBI, total number of TBIs, mental health disorders, and substance use were included in the analyses.

Previous studies have not considered whether assessing psychopathy in groups with and without history of TBI measure the same latent construct and hence whether comparing these two groups is statistically valid. This is especially important when one would expect differences between the groups. Therefore, for more rigorous assessment, we included a statistical assessment tool, that is measurement invariance testing to determine whether the two groups (TBI+ and TBI–) represent the same latent construct.

Measurement invariance testing was performed using multiple group confirmatory analysis (MG-CFA).

Hypotheses

Given that TBI and psychopathy show similar outcomes in terms of personality, behavior, and emotional and cognitive traits and that there is evidence of a history of TBI showing higher scores of psychopathy in juveniles, it is hypothesized that PCL-R total scores and PCL-R factor and facet structure differ between TBI+ and TBI- groups in adults as well. For both men and women, it is expected that PCL-R scores are higher in individuals with a history of TBI compared to no history of TBI. No research exists on the specifics of PCL-R factor and facet structures with regards to TBI history. Therefore, analyses examining factor and facet structures will be exploratory.

CHAPTER 2

Traumatic Brain Injury and Psychopathic Traits in Justice-Involved Adult Women

The manuscript “Traumatic Brain Injury and Psychopathic Traits in Justice-Involved Adult Women” has been accepted for publication at the Journal of Personality Disorders on 09/28/2022. Permission for use of the manuscript has been granted by Guilford Press on 10/06/2022.

Cappelle, T., Neumann, C. S., Cook, A. M., Kim, E., Harenski, C. L., Edwards, B. G., Clarke, G. J. B., Decety, J., Kiehl, K. A. (in press). Traumatic Brain Injury and Psychopathic Traits in Justice-Involved Adult Women. *Journal of Personality Disorders*.

Traumatic Brain Injury and Psychopathic Traits

in Justice-Involved Adult Women

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Abstract

Studies have documented associations between traumatic brain injury (TBI) and mental disorders. The relationship between psychopathic personality and TBI remains poorly understood, though both are associated with similar characteristics (e.g., low empathy, aggression, disturbances in social/moral behavior). Yet, it is not clear whether assessment of psychopathic features is influenced by presence versus absence of TBI, and which aspects of TBI may be associated with psychopathic traits. This study examined the psychopathy-TBI association in justice-involved women (N = 341) via structural equation modeling. We tested if measurement invariance of psychopathic traits was evident among those with versus without TBI and which TBI variables (number, severity, age at first TBI) predicted psychopathic features in conjunction with symptoms of psychopathology, IQ, and age. Results provided evidence of measurement invariance, and more women with TBI, compared to those without, met criteria for psychopathy. Younger age of TBI and TBI severity predicted interpersonal-affective psychopathic features.

Keywords: Psychopathy; Traumatic Brain Injury (TBI); PCL-R; Inmates; Measurement invariance; Females.

Introduction

Traumatic brain injury (TBI) is viewed as "complex in texture, massive in scale, full of important research challenges, and largely as unrecognized—or as misunderstood—by the public and most clinicians" (National Academies of Sciences, Engineering, and Medicine [NASEM] 2022, p. xi). The complexity of TBI is perhaps best understood in terms a bio-psycho-social- ecological framework (NASEM, 2022). Non-fatal TBI was estimated in 2016 to have overall healthcare costs over $40 billion (USD) dollars (Miller et al., 2021). Even 'mild' TBI poses considerable risk to the individual and the larger society in which they live (Perry et al., 2016). In addition, many studies have shown that TBI increases risk for mental disorders and antisocial behavior, but it is also the case that previous mental disorders and antisociality can increase risk of TBI (Elbogen et al., 2015; Koponen et al., 2011). Thus, it is reasonable to adopt a reciprocal effects perspective when discussing the association between TBI and mental disorders.

TBI is defined as "an alteration in brain function, or other evidence of brain pathology, caused by an external force" (Menon et al., 2010). Studies have clearly documented an association between TBI and presence of mental disorders (Koponen et al., 2002), particularly depression and anxiety (Scholten et al., 2016). Among individuals with TBI, mental disorders are more prevalent and longer lasting compared to the general population. This holds true across the spectrum of TBI severity from mild to severe (Vaishnavi et al., 2009).

Furthermore, mild TBI either *with* or *without* loss of consciousness (LOC) have similar negative outcomes (Barnes et al., 2018), including symptoms of psychopathology and personality pathology (Kennedy et al., 2015; McHugo et al., 2017;

Perkes et al., 2011; Perry et al., 2016; Schofield et al., 2006). At the same time, some studies suggest TBI *with* LOC may be linked to greater psychiatric disorders (Perry et al., 2016) or cognitive disturbances (Bedard et al., 2020). Finally, both retrospective (Hammond et al., 2019) and prospective studies (Gould et al., 2011) have shown TBI to influence the expression of mental disorders. As noted, a proportion of individuals who suffer TBI display various mental disorders pre-TBI (Koponen et al., 2011), though emergence of novel mental disorders also occurs (Gould et al., 2011; Ponsford et al., 2018), highlighting the reciprocal TBI-psychopathology association.

Population-based studies have also examined the link between TBI and mental disorders, with one study reporting a dose-response relationship between mental disorder and TBI severity (Sariaslan et al., 2016) and another finding no influence of severity (Orlovska et al., 2014). Interestingly, these two studies differed with respect to the age groups that showed the greatest risk of mental disorder after TBI. Sariaslan et al. (2016) found that TBI between the ages 20-24 posed the greatest risk of mental disorder, while Orlovska et al. (2014) reported that TBI between ages 11-15 was associated with greatest risk of mental disorder. Given the absence of definitive research thus far, severity and age of TBI should be examined further to understand the link between TBI and mental disorder.

Another factor besides age that may influence the effects of TBI is biological sex. For instance, research suggests that men and women differ in neural connectivity post-TBI (McGlade et al., 2015) and potentially other neurobiological factors (Valera et al., 2021). In addition, it appears that men are more likely to display externalizing and women internalizing psychopathology post-TBI (McGlade et al., 2015; Scott et al.,

2015). However, most TBI studies have focused on men given their higher overall odds of such injury (Feigin et al., 2013), even though women are more vulnerable to TBI due to intimate partner violence (Valera et al., 2021).

Personality changes can also occur with TBI in terms of increased disinhibition, apathy, and problematic social behaviors (Blair & Cipolotti, 2000; Norup & Mortensen, 2015; Spikman et al., 2013) as well as aggression and affective lability (Max et al., 2001; Tateno et al., 2003).

These personality changes may be related to damage to the orbitofrontal and ventromedial prefrontal cortices (Adolphs et al., 2000; Critchley et al., 2000) – areas often implicated in TBI (McAllister, 2011), as well as the neurobiology of psychopathic personality (Kiehl, 2006). Lesions in these brain areas are associated with aggression, irresponsibility, and lack of concern for social/moral rules (Blair & Cipolotti, 2000; Ciaramelli et al., 2007; Eslinger & Damasio, 1985). Babbage et al. (2011) found that even moderate TBI was linked with low empathy and other studies identified emotion perception deficits (de Sousa et al., 2010; Williams & Wood, 2010; Wood & Williams, 2008). As it turns out, these sequalae of TBI are also characteristics seen in individuals with psychopathic personality (De Brito et al., 2021), thus raising the question of whether TBI and psychopathy have a shared underlying neurobiology. For instance, research on the effects of TBI suggest that there are detectable disturbances in white matter integrity, even with mild TBI (Dailey et al., 2018) and the neurobiological processes associated with TBI may play a role in increasing risk of mental disorder (McAllister, 2011).

Similarly, psychopathy is associated with disturbances in white matter integrity

(Hoppenbrouwers et al., 2013; Maurer et al., 2020; Vermeij et al., 2018; Wolf et al., 2015). And yet, little research has examined the strength of the empirical association between TBI and psychopathy. It is far too early to say whether aspects of TBI account for psychopathic traits or the reverse, and thus, at this point, it would be prudent to assume any such association is reciprocal.

TBI is not only associated with changes in personality but also increased likelihood of personality disorders (Koponen et al., 2002), particularly antisocial personality disorder (ASPD; Koponen et al., 2011). Psychopathy is closely related to ASPD, though not synonymous with it, given the former involves far more profound disturbances in empathy, as well as greater risk for violence and criminal behavior (Olver et al., 2020). One relevant study reported elevated psychopathic traits among primarily justice-involved juvenile men with TBI (Vaughn & Salas-Wright, 2014). Results from this study also indicated that adolescents with TBI (vs. those without) displayed more delinquency, substance use, and psychological distress, along with victimization experiences. Recently, Vaughn and colleagues (Olson & Vaughn, 2021) reported results for justice-involved juveniles (both genders), with TBI predicting increases in callous- unemotional and impulsivity traits while controlling for a range of sociodemographic factors.

Justice-involved persons are at high risk for TBI (Frost et al., 2013; Schneider et al., 2021) and history of TBI is linked to increased risk for future criminal behavior (Elbogen et al., 2015), even when controlling for other critical variables such as family factors and substance abuse (Fazel et al., 2011). Nevertheless, the relationship between TBI and antisocial behavior is complex and a host of premorbid TBI factors are

involved (Elbogen et al., 2015). Increased longitudinal risk for criminal arrest after TBI appears to be particularly robust when there is premorbid substance abuse and prior criminal behavior (Elbogen et al., 2015), both of which are linked to psychopathic personality (Neumann & Hare, 2008).

The Hare Psychopathy Checklist-Revised (PCL-R; Hare, 1991; Hare, 2003) counts as the gold standard to assess psychopathy in prison populations. The psychopathy construct has been validated via statistical modeling. Specifically, a four-factor model has shown good fit across a range of sample types and assessment approaches (Neumann et al., 2015). The four factors reflect interpersonal (*conning, deceitful*) and affective (*callousness, remorseless*) personality traits, along with deviant behavioral lifestyle (*impulsive, reckless*) and antisocial/developmental features (*early behavioral problems, poor behavioral control, aggression*). These four factors can be represented in terms of two broad domains reflecting interpersonal-affective traits (Factor 1) and social deviance (Factor 2), and there is a wealth of literature on Factor1 and 2 (Hare & Neumann, 2008).

The prevalence of psychopathy is substantially higher in justice-involved populations, compared to the general population (Neumann & Hare, 2008), and the same pattern holds for TBI (Frost et al., 2013; Shiroma et al., 2012). Among justice-involved samples of women, the estimates of TBI range from 55-70% (Farrer & Hedges, 2011; Schneider et al., 2021; Shiroma et al., 2012). As noted, psychopathology predisposes risk for TBI and TBI predisposes risk for psychopathology (McAllister, 2011). Since psychopathic personality has a robust association with disturbances in empathy, social/moral behavior, as well as aggression and violence (De Brito et al.,

2021; Neumann & Hare, 2008; Olver et al., 2020), the occurrence of TBI may increase risk for violence among individuals with pre-morbid psychopathic features, in line with previous research (Elbogen et al., 2015).

Given that psychopathy and related personality pathology are associated not only with impulsivity and aggression (e.g., Jackson et al., 2007; Kjærvik & Bushman, 2021; Olver et al., 2020), but also with disturbances in empathy and social/moral behavior, and similarly for TBI (Rao et al., 2009; Roy, Vaishnavi et al., 2017), we expected a positive association between psychopathy and TBI. Moreover, a novel test of this association would be to document it in women. Since men, compared to women, present with higher levels of psychopathic traits in offender (Hare, 2003) and non-offender samples (Neumann et al., 2021), examination of TBI in samples of women can be informative. Evidence of higher psychopathic features in women with TBI would further establish an association between TBI and psychopathic personality. However, before comparisons of psychopathic traits can be made between individuals with versus without TBI, it is critical to establish that such assessments can be carried out in an unbiased and precise manner.

While research on TBI and mental disorders documents a positive (reciprocal) association, most studies employ relatively basic statistical approaches and do not formally account for measurement error (i.e., manifest vs. latent variable approaches). Since error can attenuate and bias results, advanced statistical approaches, such as structural equation modeling (SEM), can provide more precise estimates of the TBI-psychopathy association. Critically, no TBI comparison studies have employed statistical approaches to ensure that fundamental measurement bias is not an issue.

Before investigators can confidently assess the association of mental disorders among those *with* (+) versus *without* (-) TBI, it is essential to assess whether specific measurement parameters are equivalent among the TBI (+/-) groups. Furthermore, many studies simply compare individuals with TBI to those without TBI, and therefore miss the opportunity to examine how more dynamic TBI variables (e.g., TBI severity, age at first TBI) might be linked with different psychopathic trait domains.

Item-level analyses of psychological inventories are essential to understand how individuals respond to or are rated on items that are empirically tied to theoretical latent constructs (Reise, 1999). For psychopathy scales, item-level latent variable models provide quantitative information on how well items discriminate individuals with different degrees of psychopathic propensity (Roy et al., 2021). In addition to showing that items discriminate equally well among groups of individuals (e.g., TBI + vs -), it is critical to determine if a given trait score for two different groups represents that same level of the underlying latent trait (e.g., psychopathic personality). Technically, this is the case when the item threshold (i.e., extremity or difficulty) parameters are also statistically equivalent across groups. There is good evidence that the item discrimination and threshold parameters for many psychopathy assessments are equivalent across genders (Bolt et al., 2004; Neumann et al. 2012) and race/ethnicity (Jackson et al., 2007; Olver et al., 2018). Yet, to our knowledge, no study has examined whether presence of TBI might influence the assessment of psychopathic traits among justice-involved samples, where over half are estimated to have a history of TBI. To do so, it is important to determine whether the latent (PCL-R) item parameters differ between groups of individuals with and without history of TBI. If parameter

equivalence is evident, we can then say that differences in PCL-R trait expression as a function of TBI status are true and meaningful.

As part of our ongoing research on TBI and psychopathy across a range of samples, the current study used SEM with a large sample of justice-involved women assessed for psychopathic personality, history of TBI (+/-), presence of major mental disorders, and IQ. Multiple group confirmatory factor analysis (MG-CFA) was conducted to test for measurement invariance of the psychopathy assessment among the TBI groups. We expected evidence of measurement invariance and that a greater proportion of TBI+ cases would meet criteria of psychopathy (PCL-R $\geq$ 25), compared to TBI- cases, based on the evidence that TBI is associated with a range of mental disorders, including antisocial personality disorder.

Next, we specified a SEM with age of TBI, number of TBIs and TBI WHO severity of TBI as predictors of psychopathic propensity, in conjunction with current age, IQ, and mental disorder symptoms (anxiety, depression, substance use), since they too are empirically associated with TBI (Elbogen et al., 2015). Given the dearth of research on psychopathy and TBI, it is difficult to provide specific SEM hypotheses, other than we expected a positive association between TBI severity and psychopathic traits. Moreover, open questions remain as to which domains of psychopathic traits might be correlated with TBI, which TBI variables might provide the most robust association and whether age of TBI onset might also be (inversely) linked to psychopathic traits. For instance, TBI is elevated in justice-involved samples, along with elevated levels of aggression and impulsivity. And since psychopathy is also associated with aggression and impulsivity, it is likely that the association between TBI and

psychopathy would not be specific to Factor 2 traits (especially among women). On the other hand, based on the neurobiology of TBI and psychopathy (e.g., white matter disturbances), and that both are associated with disturbances in empathy and social/moral behavior, one might speculate that aspects of TBI should be associated with interpersonal-affective (Factor 1) traits.

Methods

Procedure

Participants were recruited via word of mouth and fliers; research staff went to units in the prison to present the study to inmates and distribute fliers. All participants provided written informed consent prior to enrolment. Participants were financially compensated at a rate proportional to work assignments at their facility. Study procedures were approved by the Ethical and Independent Review Services and University of New Mexico Institutional Review Boards.

Protocol assessments were conducted in a private office at the prison facility and administered by trained research staff. All research staff underwent extensive training and supervision before independently interviewed participants.

Participants

The current study involved 341 incarcerated women with a mean age of 37.06 years (8.51 SD), all of whom were serving sentences in New Mexico and had volunteered for NIH funded research (1R01AA026290-01A1; 5R01MH109329-02; R01NS118075; 1R56DA026505; 1R01MH085010-01A1; 1R01DA020870-01). The ethnic breakdown

was as follows: 32.8%, White non-Latino, 46.3% Latino, 10% American Indian/Alaska Native, 8.2% Black, and 2.6% individuals who indicated other ethnic backgrounds. All participants included in this study met the following inclusion criteria: age between 18 and 65, fourth grade reading level or higher, standard IQ score of 70 or higher (as determined by the Wechsler Adult Intelligence Scale (WAIS-III; Wechsler, 1997), and no history of psychotic disorder (self) or a 1st-degree relative. History of psychotic disorder (self) was assessed via the Structured Clinical Interview for DSM Disorders (SCID-IV; First et al., 1997), administered by trained research staff and supplemented by institutional records, or by self- report (1st degree relative).

Measures

Psychopathy was assessed using the Psychopathy Checklist-Revised (PCL-R; Hare, 2003), an expert-administered, semi-structured interview with extensive file review to provide collateral information for scoring participants on 20 items. Each item is rated on a three-point scale: 0 = no evidence, 1 = some evidence, and 2 = pervasive evidence in many domains of an individual's life. Out of a maximum of 40 points, a score of 30 or higher is the recommended cutoff for a diagnosis of psychopathy for men and a score of 25 is recommended for women (Jackson et al., 2002). These traits are further divided into two major factors.

Factor 1 represents interpersonal (facet 1) and affective (facet 2) traits such as grandiosity, glibness, and lack of empathy and remorse. Factor 2 involves lifestyle (facet 3) and antisocial/developmental traits (facet 4) including impulsiveness and overt lifetime antisocial behavior (Hare & Neumann, 2008). Interviews were conducted by

staff with extensive PCL-R and related assessment training and supervision. For our planned MG-CFA, we employed item level data to test for measurement invariance. For our planned SEM, we employed mean item PCL-R facet scores (i.e., total facet score divided by the number of items for a given facet). Thus, we used dimensional facet scores that ranged from 0-2. Facet mean item scores (SDs) were, interpersonal 0.42 (0.38), affective 0.75 (0.47), lifestyle 1.12 (0.44), antisocial 1.24 (0.46).

Diagnoses for mental disorders were based on criteria from the Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders (DSM) IV-TR Axis I disorders – Patient Edition (SCID-I/P; First, 1997) or from the Structured Clinical Interview for DSM-5 – Research Version (First et al., 2015). All assessors were extensively trained and vetted during supervised and videotaped sessions. For the mental disorder variables, mean scores were computed for presence of any depression or anxiety disorder based on the ratings 0=none, 1=subthreshold, 2=threshold. All potential substance use disorders (SUD) were rated with 0=none, 1=abuse, 2=dependence. Given that we used composite scores for theses variables we employed continuous decimal scores (from 0-2). Thus, we were able to keep the SUD, mood, anxiety disorder variables as close to the same score range as the mean PCL-R facet scores to avoid having variables with large discrepancies in variance, which can potentially sway the results (Bentler, 1995). Together, these variables allowed us to employ maximum likelihood estimation for our planned SEM. Our overall goal was to model continuous mental disorder scores in line with a dimensional approach for representing psychopathology.

Mean scores (SD/Range) for the composites were: depression 1.14 (0.18/1.5),

anxiety 1.11 (0.21/1.67), and substance use disorders 1.68 (0.30/1.63). As would be expected, given the relatively low prevalence of mood and anxiety disorders, the mood and anxiety composites, respectively, showed positive skew (.759, 2.45), though not surprisingly given high prevalence of SUD in justice-involved samples, the SUD composite was nearly normally distributed (.166).

IQ was estimated using the vocabulary and matrix reasoning sub-tests using either the Wechsler Abbreviated Scale of Intelligence (Wechsler, 2011), or the Wechsler Adult Intelligence Scale III (Wechsler, 1997).

The TBI variables (age at first TBI, number of TBIs, WHO severity of TBI) were collected by trained researchers either via the post head injury symptoms questionnaire that was modified from the Rivermead Post Concussion Symptoms Questionnaire (King et al., 1995), or by using an internally created TBI questionnaire.[1] Both questionnaires were uniform in terms of the specific items pertaining to TBI (i.e., ever had, number, severity of TBI, age(s) of TBI, loss of consciousness, and nature of post-TBI symptoms) so that TBI severity could be operationalized. The Rivermead questionnaire does ask about more post-TBI symptoms, though these specific questions were not used in the present study. The internal TBI questionnaire was administered for only a minority of cases.[2] In this questionnaire, TBI was counted if it resulted in loss of consciousness (see Supplementary Materials for both questionnaires). For all later timepoints for most participants (94%+), history of TBI was assessed via the Rivermead

[1] See supplementary materials for a copy of the modified Rivermead and internal questionnaires.

[2] Less than 6% of participants (N = 20) were assessed with the internally created questionnaire. Additional analyses indicated no differences in cases with versus without TBI ($x(1)^2 = 0.73$, $p > .05$), as a function of questionnaire, and no differences on the TBI, PCL-R, or mood/anxiety/SUD variables (*p*'s range = .213 to .901).

questionnaire, given continued evidence for its validity (Plass et al., 2019), and was defined as an individual reporting at least one TBI of any severity. In other words, a person had experienced a head injury and provided a positive endorsement of at least 2 (= mild problem) or higher (3 = moderate problem; 4 = severe problem). Mild TBI severity scores were coded with respect to World Health Organization (WHO) criteria for mild TBI (mTBI; Holm, et al., 2005).

Specifically, "Mild TBI is an acute brain injury resulting from mechanical energy to the head from external physical forces. Operational criteria for clinical identification include: (i) 1 or more of the following: confusion or disorientation, loss of consciousness for thirty minutes or less, post-traumatic amnesia for less than 24 hours, and/or other transient neurological abnormalities such as focal signs, seizure, and intracranial lesion not requiring surgery; […] These manifestations of mTBI must not be due to drugs, alcohol, medications, caused by other injuries or treatment for other injuries (e.g., systemic injuries, facial injuries or intubation), caused by other problems (e.g., psychological trauma, language barrier or coexisting medical conditions) or caused by penetrative cerebral injury" (Holm et al., p.140). Participants whose loss of consciousness exceeded thirty minutes or whose post-traumatic amnesia exceeded 24 hours were classified as moderate/severe TBI. In our sample, 43.7% of individuals had a history of TBI and the majority of these met criteria for mTBI (80%). Mean age of first TBI was 19.72 (SD 9.39).[3]

[3] Additional analyses indicated that there were no differences for the age of onset/number of TBIs or the PCL-R variables among the TBI cases with versus without loss of consciousness that exceeded thirty minutes (*p*'s range = .203 to .333). Results were similar for the mood, anxiety, or SUD composites (*p*'s range = .374 to .735)

Statistical Analyses

An SEM approach was employed to compare PCL-R item parameters (loadings, thresholds) across TBI +/- cases, based on the four-factor PCL-R model of psychopathy (Hare & Neumann, 2008). Specifically, MG-CFA was used to examine whether those with TBI history (TBI+) versus without TBI history (TBI-) differed in terms of PCL-R parameters. A strong measurement invariance model was tested such that factor loadings and threshold parameters were fixed for both TBI groups. The invariance model was statistically compared to the same four-factor model that was specified without item parameter constraints. With evidence of measurement invariance (equality of latent item parameters), we can ensure that comparisons of observed (manifest) psychopathy scores are not due to fundamental differences in measurement across the TBI groups (Olver et al., 2018; Walsh et al., 2019). Also, MG-CFA provides comparison of latent means to test if differences in the psychopathy factors exist among the TBI (+/-) groups.

To compare the MG-CFA models, we did not rely on the traditional chi-square difference test since large sample sizes produce significant chi-square values even when the discrepancies between two models are trivial (West et al., 2012). West and colleagues (West et al., 2012) suggest using guidelines laid out by Cheung and Rensvold (2002) to assess statistical differences in model fit. If the change in the comparative fit index (ΔCFI) between one model and a nested, more constrained model is ≤ .01, then the two models do not differ in statistical fit. Recent research (Roy et al., 2021) suggests that use of ΔCFI is reasonable with ordinal data when one has good fitting models such as the four-factor PCL-R model of psychopathy (Neumann et al.,

2015).

Next, an SEM was specified to examine the associations of TBI on psychopathic traits. While analysis of variance (ANOVA) is often employed (Rutherford, 2001), SEM provides a more powerful approach (Cole et al., 1993; Tomarken & Waller, 2005) since SEM formally accounts for measurement error. Therefore, we employed a multi-indicator-multiple-cause model (MIMC; Breitsohl, 2019) to examine the effect of the TBI variables on the latent PCL-R domains. Our SEM was specified such that the TBI variables (age at first TBI, number of TBI, WHO-defined severity of TBI), current age, IQ, and the depression, anxiety, and substance use composites predicted the two broad psychopathy domains (F1 and F2). All predictors were set to freely correlate. For the SEM, scale composites were used for mental disorder variables and psychopathy indicators of the F1 and F2 factors to minimize the number of model parameters and improve the subjects-to-free parameters ratio.

Analyses were conducted using Mplus with robust weighted least squares for item-level data and maximum likelihood estimation for continuous data (Muthén & Muthén, 2010).

Traditional CFI $\geq$ .90 and RMSEA $\leq$ .08 fit cut-offs were used as indicative of acceptable model fit (West et al., 2012). This rationale was used given that model complexity increases the difficulty of achieving conventional levels of model fit (Marsh et al., 2004). We chose to use conventional criteria to avoid falsely rejecting a viable latent variable model.

Results

Descriptive Results

A subset of the total sample (n = 41) received PCL-R ratings from two independent interviewers. These results indicated that the PCL-R ratings met standard criteria for good reliability (ICCs: PCL-R Total = .96; Factor 1 = .89, Factor 2 = .94; facets 1-4 = .84-.95). For the total sample, PCL-R total score was 18.36 (*SD* = 6.21) and for the TBI +/- groups respectively were, 18.97 (6.70) and 17.86 (6.07). The prevalence of women with a total of 25 or greater was ~16%. One- tailed chi-square analysis indicated that more women with PCL-R total score $\geq$ 25 had a history of TBI (~20%), compared to those below (~12%) the cut-off, $\chi^2(1) = 3.77$, $p < .05$. To conduct additional chi-square analyses, we dichotomized the mental disorder variables to form groups with versus without evidence of mental disorder. Consistent with previous research, there were more women with TBI who displayed evidence of depression (57%) or anxiety (42%), compared to those without a TBI (33%, 21%), respectively, $\chi^2(1) = 17.05$, $p < .001$ and $\chi^2(1) = 12.45$, $p < .001$. However, there were somewhat fewer women with TBI with evidence of a substance use disorder (92%), compared to those without a TBI (98%), $\chi^2(1) = 5.67$, $p < .05$.

Multiple Group Confirmatory Factor Analyses

Model fit for the four-factor model of psychopathy was acceptable and there was no meaningful difference between the constrained (CFI = .90, TLI = .88; RMSEA = .05, SRMR = .09) and unconstrained (CFI = .90, TLI = .87; RMSEA = .05, SRMR = .09) models (ΔCFI = .00). These results provide evidence of strong measurement

invariance. All factor loadings and factor correlations were significant (all *p's* < .01 - .001). MG-CFA provides comparisons of latent PCL-R means. Mplus by default sets one group's latent means to zero (in this case those without TBI) so that comparisons can be made with the other group. The results indicated that those with TBI had significantly higher affective traits (*latent mean* = .29, $p < .05$) and a trend for higher antisocial features (*latent mean* = .15, $p = .11$). The latent means for interpersonal (.02 $p > .05$) and lifestyle traits (.09, $p > .05$) did not differ. Figure 1 displays the standardized parameters for TBI groups (+/-), which highlights strong factor loadings (mean = .64) and moderately strong factor correlations (mean = .54).

Structural Equation Modeling

The SEM had good model fit ($\chi^2(17) = 33.47$, CFI = .95, RMSEA = .04, BIC = 8803). Figure 2 shows the significant standardized structural parameters (see Figure 2 note for average values of *ns* parameters and Supplementary Materials for full Mplus SEM output). Earlier age of TBI (*beta* = -.26, $p < .05$), severity of TBI (*beta* = .29, $p < .01$), and substance use (*beta* = .18, $p < .05$) predicted higher interpersonal-affective (F1) psychopathic features ($R^2 = .15$). Consistent with previous research, younger current age (*beta* = -.28, $p < .05$) and substance use (*beta* = .54, $p < .001$) predicted social deviance (F2) ($R^2 = .42$).[4] Finally, the mood and anxiety composites, respectively, were correlated with number (.21, .20, *p*'s < .001) and severity (.25, .21, *p*'s < .001) of TBIs. Age modestly correlated with the mood composite (.11, $p < .05$).

[4] To be comprehensive, we also tested an SEM whereby the four PCL-R facets loaded onto a single psychopathy factor, which resulted on poor fit ($\chi^2(26) = 88.07$, CFI = .83, RMSEA = .08, BIC = 8834), highlighting the multifarious nature of psychopathic personality.

Discussion

Consistent with large sample modeling research on women and men (Neumann et al., 2015), the current results indicated that the four-factor model of psychopathy was associated with good model fit and showed evidence of measurement invariance across the TBI +/- groups. Thus, assessment of psychopathic traits in justice-involved women reflects the same personality pathology, irrespective of TBI status. Evidence of unbiased assessment of psychopathic features is a critically important finding, given that both TBI and psychopathy are highly prevalent in justice-involved samples. Our results should provide confidence for those doing assessment of psychopathy among justice-involved persons with or without TBI. Also of practical value is our finding that TBI + cases (vs. TBI -) had higher affective psychopathic features and a trend for higher overt antisocial features, thus signaling that such cases may require additional treatment and risk management resources.

Beyond the invariance testing, the SEM results provided a more nuanced picture of how TBI is associated with psychopathic features. Earlier age of TBI and more severe TBI predicted interpersonal-affective (F1) psychopathic features. These results could be due to the use of a sample of women, given they are less likely to show aggression than men (and thus F2 traits) post-TBI (Scott et al., 2015). On the other hand, there are interesting parallels between the neurobiology of TBI and psychopathy. Both are associated with disturbances in frontal-subcortical systems (Kiehl, 2006; McAllister, 2011) as well as white matter connectivity (Dailey et al., 2018; Hoppenbrouwers et al., 2013; Vermeij et al., 2018; Wolf et al., 2015), and therefore central nervous system (CNS) insults resulting from TBI could in theory have some

influence on the development of psychopathic personality. Moreover, that earlier age of TBI was a significant predictor of F1 traits suggests that CNS disruptions at earlier periods of neural maturation may be associated with the development of calloused interpersonal style (see also Anderson et al., 1999). At the same time, psychopathy and the lifestyle associated with this personality pathology could potentially increase the probability of TBI (Elbogen et al., 2015). Furthermore, the neurobiology that is associated with psychopathy could very well pre-date TBI. In this situation, one might confuse the neurobiological 'signature' of psychopathy with a similar pattern produced by TBI and mistakenly assume TBI caused the neuro-sequelae of psychopathy. As such, longitudinal research is needed to help uncover the dynamic nature of psychopathic propensities pre- and post-TBI.

Justice-involved populations of women have a high prevalence of TBI (Shiroma et al., 2012). Studies with justice-involved young and adult women have revealed the leading cause of TBI to be violence related (Brewer-Smyth et al., 2004; Durand et al., 2017; Moore et al., 2014; Schneider et al., 2021). In addition, justice-involved women experience high rates of interpersonal violence, often beginning at a young age (Browne et al., 1999) and intimate partner violence is significantly associated with TBI in women (Valera et al., 2021). Considering that the most common cause of TBI among incarcerated women is violence related, repeated victimization may also help explain why interpersonal-affective traits had a unique association with age and severity of TBI. That is, the interpersonal nature of the violence may be associated with expression of callous and interpersonally manipulative psychopathic propensities, along with the fact that TBI in women is less associated with overt aggression (e.g., F2 traits) compared to

men (Scott et al., 2015). Although research on TBI in women is lagging significantly behind studies with men, it appears that studies with women may help advance understanding of the causes and consequences TBI (Valera et al., 2021). Given that neural connectivity post-TBI may differ between the genders (McGlade et al., 2015), as well as internalizing-externalizing psychopathology (Scott et al., 2015), TBI in women might be specifically associated with F1 traits.

Finally, the results also revealed that TBI was associated with symptoms of anxiety and depression, consistent with other research (Ponsford et al., 2018). However, internalizing psychopathology did not have an association with psychopathic traits. Still, the presence of internalizing psychopathology may have implications for emotion regulation capacity, which can be affected by TBI (Tsaousides et al., 2017). Poor emotion regulation is associated with psychopathic features (Garofalo et al., 2020). Additional research on the links between emotion dysregulation, psychopathy, and TBI will help further explore this area of research.

Limitations

Our study employed a retrospective cross-sectional design, and therefore it is not possible (nor reasonable) to provide causal statements regarding the association between TBI and psychopathy. As we stated, at this point, it is best to adopt a reciprocal effects framework for understanding this association. Self-report of TBIs can be prone to false recall of incidents as well as underestimate of exposure to TBI (McKinlay & Albicini, 2016). Still, research suggests that self-report of TBIs among justice-involved individuals is generally accurate, with one study showing a 70% agreement between hospital records and self-report of TBI (Schofield et al., 2011). Also, research suggests

there is little evidence for an association between response distortion and psychopathy (Watts et al., 2016), which provides some additional confidence for the validity of our results. Yet, the nature of our TBI assessment may not represent the state of the art, and better assessments might reveal different results than ours.

Also, since the location of TBI was not available in the present dataset the relation between TBI location on psychopathic traits will be important to examine in future studies. Finally, mild TBI is associated with a host of psychiatric and neurological outcomes (NASEM, 2022; Perry et al., 2016), and studies show that associations of TBI with personality or other psychopathology is often seen among individuals with mild TBI *without* LOC (McHugo et al., 2017; Perry et al., 2016). Nevertheless, research suggests that TBI *with* LOC status should continue to be examined (Bedard et al., 2020). To this end, it would be wise for investigators to use in-depth assessment not only for psychopathology, but also TBI, such as, the Ohio State University TBI Identification Method (Corrigan & Bogner, 2007).

Conclusions

The current study found support for unbiased assessment of psychopathic traits among justice- involved women with or without history of TBI. Participants with TBI displayed significantly higher affective psychopathic features compared to those without TBI, and among the TBI+ group, a greater proportion of individuals met criteria for psychopathic personality disorder. Finally, age at first TBI and severity of TBI were significant predictors of interpersonal-affective psychopathic traits.

Acknowledgements

The authors greatly appreciate the women who participated in this study and helped advance the scientific literature on TBI among justice-involved persons. This study was made possible by the following NIH funding, 1R01AA026290-01A1; 5R01MH109329-02; R01NS118075; 1R56DA026505; 1R01MH085010-01A1; 1R01DA020870-01

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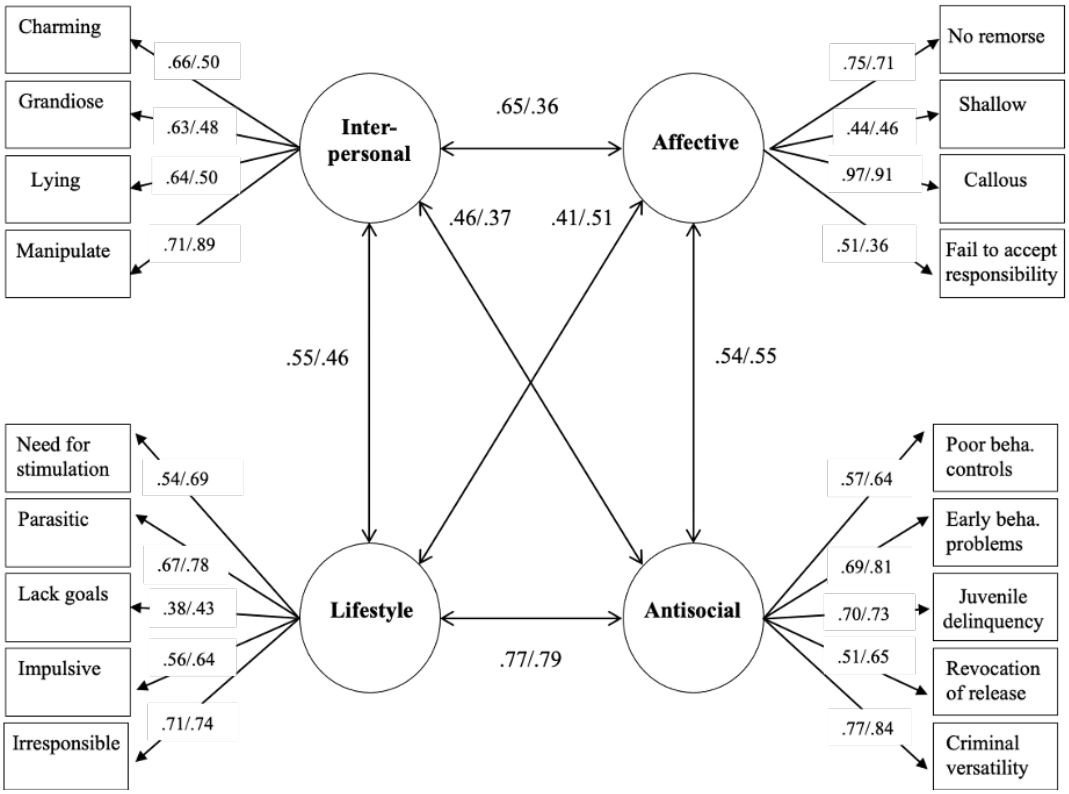
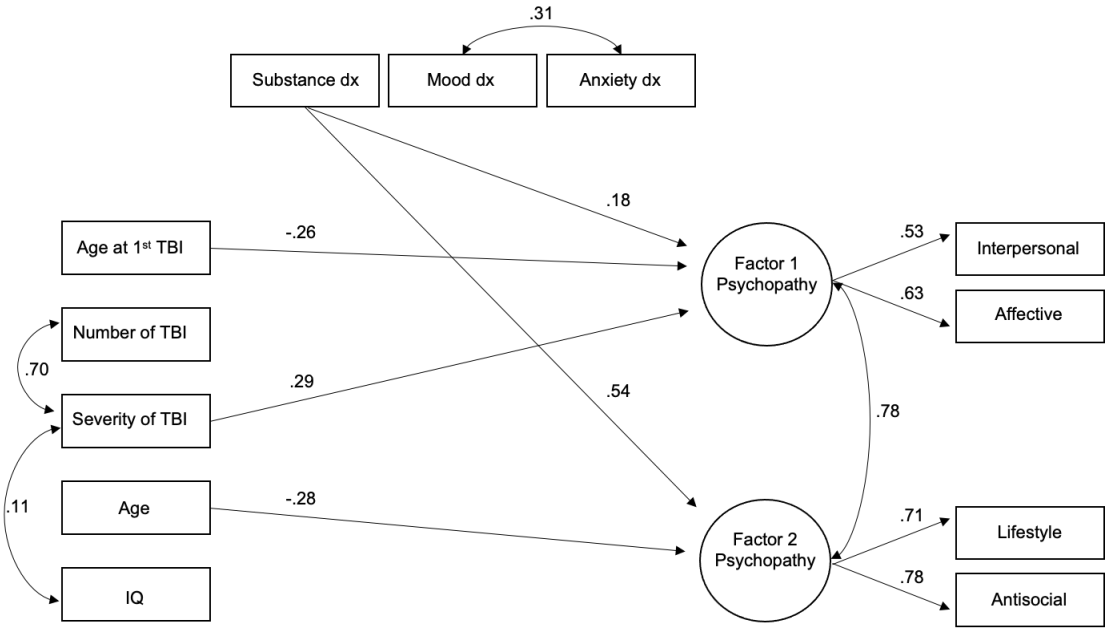
Figure 1. Multiple Group Confirmatory Factor Analysis (MG-CFA) Results for Incarcerated Females Without versus With TBI (TBI- / TBI +)



Note. Parameters for the TBI – group are in front of the slash and for the TBI + behind the slash

Figure 2. Structural Equation Modeling Results (TBI+): Significant parameters



Note. F1 psychopathy = interpersonal-affective traits and F2 psychopathy = behavior lifestyle and overt antisocial/developmental features. SUD = substance use disorders, Mood = mood disorders, Anxiety = anxiety disorders. For the non-significant predictors (not shown), the average SEM structural parameter was -.02, and the non-significant correlations among predictor variables were on average .03.

SUPPLEMENTARY MATERIALS

URSI:_____ EXAMINER: _____ DATE: _____

POST-HEAD INJURY SYMPTOMS QUESTIONNAIRE*

After a head injury or accident some people experience symptoms which can cause worry or nuisance. We would like to know if you suffered from any of the symptoms given below immediately following the head injury/injuries we have just discussed. As many of these symptoms occur normally, we would like you to compare the occurrence of these symptoms before the injury, to those occurring AFTER the injury. **Compared with before the accident(s) did you suffer from any of these symptoms immediately following the accident(s)?**

0 = Not experienced at all; **1** = No more of a problem; **2** = A mild problem; **3** = A moderate problem; **4** = A severe problem

What Happened: _____ **Age**:		
Loss of Consc.?	Y / N	How long ? _____
Loss of Memory?	Y / N	How long before?_____ How long after?
Dazed/disoriented?	Y / N	How long? _____
Using alcohol or other substance at time of injury?	Y / N	What? _____ How much?

					Resolved
Headaches……...	0	1	2	3	4 Y / N
Feelings of Dizziness……..	0	1	2	3	4 Y / N
Nausea and/or Vomiting…….	0	1	2	3	4 Y / N
Noise Sensitivity, easily upset by loud noise…	0	1	2	3	4 Y / N
Sleep Disturbance……...	0	1	2	3	4 Y / N
Fatigue, tiring more easily…..	0	1	2	3	4 Y / N
Being Irritable, easily angered	0	1	2	3	4 Y / N
Feeling Depressed/Tearful…..	0	1	2	3	4 Y / N
Feeling Frustrated/Impatient...	0	1	2	3	4 Y / N
Forgetfulness, poor memory...	0	1	2	3	4 Y / N
Poor Concentration…….	0	1	2	3	4 Y / N
Taking Longer to Think……..	0	1	2	3	4 Y / N
Blurred Vision…….	0	1	2	3	4 Y / N
Light Sensitivity easily upset by bright light...	0	1	2	3	4 Y / N
Double Vision…….	0	1	2	3	4 Y / N
Restlessness…….	0	1	2	3	4 Y / N
*Any other difficulties?_____	0	1	2	3	4 Y / N

* Adapted from the Rivermead Post-Concussion Symptoms Questionnaire; King, N., Crawford, S., Wenden, F., Moss, N., & Wade, D. (1995) J. Neurology 242: 587-592.

URSI:_____ EXAMINER: _____ DATE: _____

Compared with before the accident(s) did you suffer from any of these symptoms immediately following the accident?

0 = Not experienced at all; **1** = No more of a problem; **2** = A mild problem; **3** = A moderate problem; **4** = A severe problem

What Happened: _____ **Age**:		
Loss of Consc.? **Loss of Memory?**	Y / N Y / N	How long ? _____ How long before?_____ How long after?
Dazed/disoriented?	Y / N	How long? _____
Using alcohol or other substance at time of injury?	Y / N	What? _____ How much?

					Resolved
Headaches……..	0	1	2	3	4 Y / N
Feelings of Dizziness……..	0	1	2	3	4 Y / N
Nausea and/or Vomiting…….	0	1	2	3	4 Y / N
Noise Sensitivity, easily upset by loud noise…	0	1	2	3	4 Y / N
Sleep Disturbance……...	0	1	2	3	4 Y / N
Fatigue, tiring more easily…..	0	1	2	3	4 Y / N
Being Irritable, easily angered	0	1	2	3	4 Y / N
Feeling Depressed/Tearful…..	0	1	2	3	4 Y / N
Feeling Frustrated/Impatient...	0	1	2	3	4 Y / N
Forgetfulness, poor memory...	0	1	2	3	4 Y / N
Poor Concentration…….	0	1	2	3	4 Y / N
Taking Longer to Think……..	0	1	2	3	4 Y / N
Blurred Vision…….	0	1	2	3	4 Y / N
Light Sensitivity easily upset by bright light...	0	1	2	3	4 Y / N
Double Vision…….	0	1	2	3	4 Y / N
Restlessness…….	0	1	2	3	4 Y / N
*Any other difficulties?_____	0	1	2	3	4 Y / N

Total additional head injuries (additional that are not discussed on this form already) _____
Ages for additional head injuries _____
Any LOC? If so, how long for each _____
Any ongoing symptoms from these head injuries? _____

URSI:_____ EXAMINER: _____ DATE: _____

TBI QUESTIONNAIRE

1. Have you ever been knocked unconscious by a blow to the head? Y / N

2. If yes, how many times? Do NOT include events due to drug or alcohol use. ___

3. Did any of these injuries occur during a sporting event? Y / N
   If yes, how many? _____

4. Did you see a doctor for any of these injuries? Y / N
   If yes, how many? _____

5. Were you hospitalized for any of these injuries? Y / N
   If yes, how many? _____

6. For each time you were knocked unconscious, please answer the following questions in the chart below:
   A. How long were you unconscious?

   B. Did you have any amnesia (did you have difficulty remembering anything that happened before or after the event)?

   C. If yes, how much time before and after you were unconscious did you experience the amnesia?

   D. Did you have any secondary symptoms such as headache, vomiting, double vision, or vertigo?

URSI:_____ EXAMINER: _____ DATE: _____

	HOW LONG?	AMNESIA PRESENT?	IF YES, TIME FRAME (BEFORE AND AFTER)?	SECONDARY SYMPTOMS? (PLEASE LIST)
1) Age:				
2) Age:				
3) Age:				
4) Age:				
5) Age:				
6) Age:				
7) Age:				
8) Age:				
9) Age:				
10) Age:				

DATABASE ENTRY:

1. ∑ Number of LOCs _____
2. ∑ Total time unconscious_____
3. ∑ Total time with amnesia _____
4. ∑ Secondary Symptoms _____
5. ∑ Injuries occurring during a sports event _____
6. ∑ Injuries doctor was seen for _____
7. ∑ Injuries hospitalized for _____

Mplus Output for SEM

STANDARDIZED MODEL RESULTS

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
F1 BY				
INT_M	0.526	0.063	8.300	0.000
AFF_M	0.633	0.068	9.285	0.000
F2 BY				
LIF_M	0.706	0.039	18.281	0.000
ANT_M	0.776	0.037	20.941	0.000
F1 ON				
MOOD_DX2	-0.030	0.081	-0.370	0.711
ANX_DX2	0.027	0.081	0.328	0.743
SUD_DX2	0.178	0.079	2.256	0.024
TOT_NUM	-0.187	0.105	-1.774	0.076
TBI_AGE1	-0.264	0.114	-2.312	0.021
AGEPCLR	0.085	0.082	1.041	0.298
IQ	-0.116	0.078	-1.479	0.139
TBI_WHO	0.290	0.108	2.676	0.007
F2 ON				
MOOD_DX2	-0.063	0.059	-1.057	0.290
ANX_DX2	-0.036	0.059	-0.606	0.544
SUD_DX2	0.553	0.049	11.266	0.000
TOT_NUM	0.097	0.078	1.238	0.216
TBI_AGE1	0.003	0.085	0.029	0.977
AGEPCLR	-0.276	0.055	-4.981	0.000
IQ	-0.073	0.055	-1.316	0.188
TBI_WHO	0.013	0.078	0.162	0.871
F2 WITH				
F1	0.778	0.096	8.073	0.000

MOOD_DX2 WITH				
ANX_DX2	0.307	0.050	6.096	0.000
SUD_DX2	0.037	0.055	0.678	0.498
TOT_NUM	0.214	0.053	4.068	0.000
TBI_AGE1	0.037	0.080	0.461	0.645
AGEPCLR	0.113	0.054	2.087	0.037
IQ	0.076	0.054	1.403	0.161
TBI_WHO	0.246	0.052	4.752	0.000
ANX_DX2 WITH				
SUD_DX2	0.083	0.055	1.517	0.129
TOT_NUM	0.196	0.053	3.691	0.000
TBI_AGE1	0.054	0.077	0.706	0.480
AGEPCLR	0.104	0.054	1.906	0.057
IQ	-0.006	0.055	-0.108	0.914
TBI_WHO	0.210	0.053	3.930	0.000
SUD_DX2 WITH				
TOT_NUM	0.066	0.055	1.204	0.228
TBI_AGE1	-0.002	0.077	-0.031	0.976
AGEPCLR	-0.030	0.054	-0.549	0.583
IQ	-0.069	0.054	-1.274	0.203
TBI_WHO	0.049	0.055	0.903	0.367
TOT_NUM WITH				
TBI_AGE1	-0.078	0.117	-0.663	0.507
AGEPCLR	0.090	0.054	1.674	0.094
IQ	0.056	0.054	1.031	0.302
TBI_WHO	0.707	0.027	25.880	0.000
TBI_AGE1 WITH				
AGEPCLR	0.149	0.079	1.888	0.059
IQ	-0.093	0.081	-1.147	0.251
TBI_WHO	-0.010	0.136	-0.071	0.943
AGEPCLR WITH				
IQ	0.041	0.054	0.767	0.443
TBI_WHO	0.085	0.054	1.571	0.116
IQ WITH				
TBI_WHO	0.108	0.054	2.013	0.044

CHAPTER 3

Traumatic Brain Injury and Psychopathy in Adult Incarcerated Men

Traumatic Brain Injury and Psychopathy in Adult Incarcerated Men

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Declarations of interest: none.

Abstract

Traumatic brain injury (TBI) is often associated with significant personality changes, including reduced empathy, inhibitory capacity, and increased aggression. Psychopathic personality also involves disturbances in empathy, inhibition, and aggression. Furthermore, there is a high prevalence of both psychopathic personality and TBIs in justice-involved populations. However, little research has directly examined the link between TBI and psychopathy. The current study assessed history of TBI along with psychopathic personality via the expert-rated Hare Psychopathy Checklist-Revised (PCL-R) from two diverse independent samples of justice-involved adult males (New Mexico n= 520 and Wisconsin n=529). A structural equation modeling (SEM) approach was used to assess for measurement invariance of the PCL-R items among those with versus without TBI. There was evidence of strong measurement invariance for both samples and individuals with TBI had significantly higher latent psychopathic traits. For the New Mexico sample, PCL-R lifestyle and developmental/antisocial facets differed significantly between TBI groups, while for the Wisconsin sample, all four PCL-R facets differed significantly between TBI groups. The results indicate a link between history of TBI and higher PCL-R scores, and these differences are not due to differences in measurement as a function of TBI status. This study has implications for the use of the PCL-R in adult male inmate populations who suffered a TBI in the past.

Introduction

Psychopathy is a personality disorder characterized by disturbances in interpersonal, affective, and behavioral functioning (Cleckley, 1976; Hare & Neumann, 2008), manifesting in terms of both overt (e.g., impulsive recklessness, poor behavioral controls) and covert (deceitful manipulation, callousness) dissociality (Hare & Neumann, 2010). The most widely used measure to assess psychopathy in forensic settings is the Hare Psychopathy Checklist-Revised (PCLR; Hare, 1991, 2003; Olver et al., 2020). The PCL-R and its derivatives can be divided into four domains (interpersonal, affective, lifestyle, and antisocial), based on a four-factor model of psychopathy (Hare et al., 2018) that has received strong support across different item sets, assessment approaches, and sample types (Neumann et al., 2015).

Psychopathy is a dimensional construct and in the general population 1% of adults display elevated psychopathic features (Coid et al, 2009; Neumann & Hare, 2008). In male incarcerated adults 15-25% meet PCL-R criteria for psychopathy (Hare, 2003; Kiehl & Hoffmann, 2011). Psychopathy as a construct within the criminal justice system has broad implications for prison sentences, treatment options, and potential risk for recidivism (Anderson & Kiehl, 2014; Beggs & Grace, 2008; Kiehl & Hoffman, 2011; Olver et al., 2020).

Research on psychopathy has rapidly expanded over the past few decades with studies showing that the development of the disorder involves a complex interplay of neurobiological and environmental factors (Dotterer et al., 2021; Walsh & Wu, 2008; Del Giudice, 2018). While considerable research has been conducted on the neurobiology of psychopathy (Seara-Cardoso & Viding, 2015), relatively less attention has been granted

to environmental factors (Eisenbarth et al., 2018), despite the fact that environmental factors likely have reciprocal implications for disturbances in neurobiology and increased risk for expression of psychopathic personality.

One environmental factor that can significantly disrupt underlying neurobiology is traumatic brain injury (TBI) which is defined as "an acquired injury to the brain caused by an external physical force resulting in total or partial disability or impairment" (Kay et al., 1993; United States H.R. 5907). Traumatic brain injury (TBI) is viewed as "complex in texture, massive in scale, full of important research challenges, and largely as unrecognized—or as misunderstood—by the public and most clinicians" (National Academies of Sciences, Engineering, and Medicine [NASEM] 2022, p. xi). The nature of TBI is best understood in terms a bio-psycho-social-ecological framework (NASEM, 2022). For instance, TBI has overall healthcare costs of more than $40 billion (USD) dollars (Miller et al., 2021) in the United States. Even 'mild' TBI poses considerable risk to the individual and the larger society in which they live (Perry et al., 2016). Also, many studies have shown that TBI increases risk for mental disorders and antisocial behavior, but it is also the case that previous mental disorders and antisociality can increase risk of TBI (Elbogen et al., 2015; Koponen et al., 2011). Thus, it is reasonable to adopt a reciprocal effects perspective when discussing the association between TBI and mental disorders.

Personality changes often result from TBI (Barrash et al., 2000; Max et al., 2001; Norup & Mortensen, 2015). A study on children and adolescents reported that 59% with a severe and 5% with a mild/moderate TBI described a change in personality (Max et al., 2001). Specific changes include increased impulsivity (Goswami et al., 2016; Mosti &

Coccaro, 2018; Kerr et al., 2014), aggression (Max et al., 2001; Greve et al., 2001; Mosti & Coccaro, 2018), disinhibition (Max et al., 2001; Osborne-Crowley & McDonald, 2018), violent crime (Fazel et al., 2011), sensation-seeking (Liebel et al., 2020; Veliz et al., 2019) and reduced empathy (Wearne et al., 2020; De Sousa et al., 2011; Wood & Williams, 2008).

The prevalence of TBI is particularly high in incarcerated individuals (Hughes et al., 2015) with rates 5-6 times higher than the prevalence found in the general population (Colantonio et al., 2014; Schneider et al., 2021; Durand et al., 2017; Silver et al., 2001). Individuals who have had a TBI during their childhood are more likely to offend compared to a control group (McKinlay et al., 2014). Furthermore, studies on incarcerated populations have found that individuals with a history of TBI exhibit more impulsive, aggressive and violent behavior as well as greater propensity for self-harm, less self-control, less affective empathy, and are more likely to recidivate sooner after release compared to individuals without a history of TBI (Ray & Richardson, 2017; Schwartz et al., 2017; Vaughn et al., 2014; Williams et al., 2015; Williams et al., 2010; Williams et al., 2018).

Given disturbances in empathy, behavioral regulation, and interpersonal conduct reported among persons with TBI, the potential relevance to psychopathy merits systematic study, though few such studies exist. One study reported elevated psychopathic traits among incarcerated juveniles with a TBI history, compared to those without (Vaughn et al., 2014). Yet, this study did not determine if there was evidence of measurement invariance among those with versus without TBI. A comparison of observed (manifest) variable scores can only be done with confidence when the latent

variable parameters are deemed statistically equivalent across groups (Jackson et al., 2007; Neumann et al., 2021; Olver et al., 2018).

Item-level analyses of psychological inventories are essential to understand how individuals respond to or are rated on items that are empirically tied to theoretical latent constructs (Reise, 1999). For psychopathy scales, item-level latent variable models provide quantitative information on how well items discriminate individuals with different degrees of psychopathic propensity (Hare & Neumann, 2008). In addition to determining that items discriminate equally well among groups of individuals (e.g., TBI+ vs TBI-; males versus females, etc.), it is critical to determine that a given trait score for two different groups represents that same level of the underlying latent trait (e.g., psychopathic personality). Technically, this is the case when the item thresholds (i.e., extremity parameters) are also statistically equivalent across groups. There is good evidence that the PCL-R item discrimination and threshold parameters are generally equivalent across sex (females vs. males; Bolt et al., 2004) and race/ethnicity (Jackson et al., 2007; Olver et al., 2018). However, to date, no study has examined whether and/or how TBI affects the expression and potential risk for elevated psychopathic personality features among adult inmates. To do so, it is important to determine whether the latent PCL-R item parameters differ between groups of individuals with and without a history of TBI. With evidence of parameter equivalence, we can then say that differences in PCL-R trait expression as a function of TBI status are true and meaningful.

Thus, the current study sought to bridge the gap in the literature by investigating the effect TBIs have on PCL-R trait expression in incarcerated populations. Given that TBI has been associated with changes in personality such as increased impulsivity,

aggression, disinhibition, sensation-seeking, and reduced empathy, all of which are also characteristic of psychopathy, we hypothesize that those with a history of TBI will express higher psychopathic traits than those who have never suffered a TBI.

Methods

Participants

The two samples were recruited from correctional facilities in New Mexico and Wisconsin as part of ongoing NIH grants (R01MH070539; R01DA020870; R01DA026505; R01DA026964; R01MH090169; R01MH087525; R01MH114028; from 2007-2020). From 2007-2015 both New Mexico and Wisconsin studies excluded individuals with greater than mild TBI. In 2015, New Mexico allowed all individuals with TBI to participate. Given that inclusion criteria differed between sites in recent years, model analyses were carried out separately for each site.

Participants were compensated with an hourly rate commensurate to standard labor rates at their facilities. All individuals were adult males (age 18 and older) and provided written informed consent. Any inmate with psychosis was excluded from analyses. All procedures were approved and managed by the Ethical and Independent Review Services (E&I) and the University of Wisconsin-Madison. A total of 1049 participants (520 from New Mexico facilities and 529 from Wisconsin facilities) for whom complete data were available were included.

Assessments

Psychopathy was assessed using the Hare Psychopathy Checklist Revised (PCL-R; Hare, 2003). This is an expert-administered rating scale consisting of a semi-structured interview and an extensive file review to provide collateral information for scoring participants on all 20 items. Each item is rated on a three-point scale: 0 = no evidence of a given trait, 1 = some evidence and 2 = pervasive evidence in many domains of an individual's life. A score of 30 or higher is the recommended cutoff for a diagnosis of psychopathy, though it is well recognized that psychopathy is a dimensional construct (Hare & Neumann, 2008). The PCL-R items can be aggregated in terms of specific trait domains: two higher-order domains (Factor 1 & 2) underpinned by four lower-order facets. Factor 1 represents interpersonal (facet 1) and affective (facet 2) traits reflecting grandiosity, manipulativeness versus callousness and lack of empathy. Factor 2 involves lifestyle (facet 3) and antisocial traits (facet 4) including impulsiveness and recklessness versus poor behavioral controls and overt antisocial behavior. All interviews were conducted by staff with extensive training and supervision.

IQ was estimated using the vocabulary and matrix reasoning sub-tests using either the Wechsler Adult Intelligence Scale (WAIS; Wechsler, 1955), the Wechsler Abbreviated Scale of Intelligence (WASI-II; 2011), or the Wechsler Adult Intelligence Scale III (WAIS-III; Wechsler, 1997).

The TBI variables were collected by trained researchers via a modified version of the Rivermead Post Concussion Symptoms Questionnaire (King et al., 1995), given continued evidence for its validity (Plass et al., 2019). Specific items pertaining to TBI (i.e., ever had, number, severity of TBI, age(s) of TBI, loss of consciousness, and nature

of post-TBI symptoms) were included so that TBI severity could be operationalized. TBI was defined as an individual reporting at least one TBI of any severity. In other words, a person had experienced a head injury and provided a positive endorsement of at least 2 (= mild problem) or higher (3 = moderate problem; 4 = severe problem). Mild TBI severity scores were coded with respect to World Health Organization (WHO) criteria for mild TBI (mTBI; Holm, et al., 2005). Specifically, "Mild TBI is an acute brain injury resulting from mechanical energy to the head from external physical forces. Operational criteria for clinical identification include: (i) 1 or more of the following: confusion or disorientation, loss of consciousness for thirty minutes or less, post-traumatic amnesia for less than 24 hours, and/or other transient neurological abnormalities such as focal signs, seizure, and intracranial lesion not requiring surgery; […] These manifestations of mTBI must not be due to drugs, alcohol, medications, caused by other injuries or treatment for other injuries (e.g., systemic injuries, facial injuries or intubation), caused by other problems (e.g., psychological trauma, language barrier or coexisting medical conditions) or caused by penetrative cerebral injury" (Holm et al., p.140). Participants whose loss of consciousness exceeded thirty minutes or whose post-traumatic amnesia exceeded 24 hours were classified as moderate/severe TBI.

Statistical Analyses

A structural equation modeling approach was employed to compare PCL-R item parameters (loadings, thresholds) across those with versus without TBI, based on the four-factor PCL-R model of psychopathy (Hare & Neumann, 2008). Specifically, multiple group confirmatory factor analysis (MG-CFA) was used to examine separately

for each sample (New Mexico (NM), Wisconsin (WI)) whether those with TBI history (TBI+) versus without TBI history (TBI-) differed in terms of PCL-R parameters. In this way, we were able to examine the replicability of the four-factor model results among the TBI groups across two independent samples that presented with different racial/ethnic profiles as well as TBI profiles (see Table 1).

A strong measurement invariance approach was used for each sample, whereby MG-CFA was conducted with factor loading and threshold parameters fixed for the TBI groups (+/-). The invariance model was statistically compared to a configural model in which the same four-factor model was tested but without constraining item loadings or thresholds. With evidence of measurement invariance (equality of latent item parameters), we can ensure that comparisons of observed (manifest) variable psychopathy scores are not due to fundamental differences in measurement across the TBI +/- groups (Olver et al., 2018; Walsh et al., 2019). To compare these two models, we did not rely on the traditional chi-square difference test since large sample sizes produce significant x^2 values even when the discrepancies between two models are trivial (West et al., 2012). West and colleagues suggest using guidelines laid out by Cheung and Rensvold (2002) to assess statistical differences in model fit. If the incremental change in the comparative fit index (ΔCFI) between a one model and a (nested) more-constrained model is ≤.01, then the two models do not differ in statistical fit. Note that recent research (Roy et al., 2020) suggests that use of ΔCFI is reasonable with ordinal data when one has good fitting models such as the four-factor PCL-R model of psychopathy (Neumann et al., 2015).

All analyses were conducted using Mplus and robust weighted least squares estimation (WLSMV) (Muthén & Muthén, 1998-2010). Traditional CFI $\geq$ .90 and RMSEA $\leq$ .08 fit cut-offs were used as indicative of acceptable model fit (West et al., 2012). This rationale was used given that model complexity increases the difficulty of achieving conventional levels of model fit (Marsh et al., 2004). We chose to use conventional criteria to avoid falsely rejecting a viable latent variable model.

Finally, after conducting MG-CFA for the respective samples among the TBI+ and TBI- groups, ANOVA and MANOVA analyses were computed to examine how the TBI +/- groups differed on PCL-R total and facet scores. Given that the New Mexico and Wisconsin samples contained large proportions of Latino and African American individuals, respectively, we also included race as a covariate in the analyses (i.e., non-Latino/White vs. non-White). Lastly, age and IQ were added as covariates in these 2-factor (TBI x race/ethnicity) analyses.

Results

Demographics for the variables race and ethnicity are presented in Table 1; demographics for the variables age and IQ are presented in Table 2. Descriptive statistics of PCL-R facet and total scores for the New Mexico and the Wisconsin subsamples are presented in Table 3 and Table 4 respectively.

The MG-CFA results indicated that within each sample (NM TBI +/- and WI TBI+/-), strong measurement invariance was present, i.e., PCL-R item parameters (loadings, thresholds) were equivalent across participants with and without a history of TBI (standardized parameters for New Mexico, see Figure 1, for Wisconsin, see Figure

2). MG-CFA model fit was adequate for both samples (New Mexico: CFI = .90, RMSEA = .05; Wisconsin: CFI = .90, RMSEA = .06) and ΔCFI = 0.0 for both samples.

A 2-way MANOVA (TBI group x race/ethnicity) with age and IQ as covariates indicated no significant interaction effects between history of TBI (+/-) and race/ethnicity, for the New Mexico (white non-Hispanic/Hispanic or non-white) or Wisconsin (white/non-white) sample for the four PCL-R facet scores (Wisconsin: F (4, 494) = .875, $p > .05$; Wilks' Λ = .993, η^2 = .01 New Mexico: F (4, 481) = .626, $p > .05$; Wilks' Λ = .995, η^2 = .01.

Consistent with our expectation, the MANOVA results revealed a significant difference between the TBI +/- groups for both the New Mexico (F(4,481) = 3.601, $p <$ .01; Wilks' Λ = .971, η^2 = .03) and Wisconsin (F(4,494) = 4.235, $p < .01$; Wilks' Λ = .967, η^2 = .03) samples. Having had a TBI was associated with significantly higher PCL-R facet scores. For the New Mexico sample (see Table 3), a main effect of TBI group on PCL-R scores was found for the lifestyle and developmental/antisocial facet (all p's < .01, all η^2's = .02). The Wisconsin sample (see Table 4) showed main effects of TBI group on PCL-R scores on all four facets (all p's < .01 - .001, all η2's ≤ .02). The same pattern of results uncovered for facet scores was also evident when PCL-R total scores were used as dependent variable (New Mexico (F(1,484) = 7.46, $p < .01$, η^2 = .02; Wisconsin (F(1,497) = 14.41, $p < .001$, η^2 = .03; see Tables 3 and 4 for means and SDs).

Consistent with previous research on psychopathy among diverse race/ethnic groups (Olver et al., 2018), the results indicated that non-white (or white Hispanic) individuals, compared to white individuals, tended to have higher PCL-R facet scores (see supplemental text). Finally, IQ was a significant covariate for both the New Mexico

($F(8,962) = 7.826$, $p < .001$; Wilks' $\Lambda = .882$, $\eta^2 = .06$) and Wisconsin ($F(8,988) = 2.292$, $p < .05$; Wilks' $\Lambda = .964$, $\eta^2 = .02$) samples. As found in previous research (Salekin et al., 2004; Vitacco et al., 2005), IQ was positively associated with interpersonal PCL-R facet scores (New Mexico beta = .126, $p < .01$; Wisconsin, beta = .103, $p < .05$). Only in the New Mexico sample was age inversely associated with affective (beta = -.112), lifestyle (beta = -.132), and antisocial (beta = -.251) facet scores (all *p*'s < .05 - .001).

Discussion

This study was designed to comprehensively examine the relationship between psychopathic traits and TBI in men incarcerated in state prisons. Critically, we found similar latent parameters for psychopathic traits across TBI groups (+ vs. -). These results highlight that PCL-R item ratings discriminate equally well among those with and those without a history of TBI and that a given PCL-R score reflects the same (latent) level of psychopathic propensity irrespective of TBI status. Therefore, investigators can be confident that psychopathic personality is assessed in an unbiased fashion across TBI groups for male adult incarcerated individuals. This work is consistent with other large sample studies that have compared the nature of PCL-R scores and their correlates across diverse samples (Olver et al., 2018).

Since PCL-R measurement invariance was established for both WI and NM samples, this indicates that the observed differences in psychopathy scores were not due to methodological measurement error (bias) across TBI groups but instead reflect differences in psychopathic trait features between groups. We found that psychopathy scores were significantly higher in adult male inmates who had experienced a TBI compared to those

who did not experience a TBI. These results held true for both NM and WI samples of offenders. These findings are congruent with a previous report (Vaughn et al., 2014) showing that incarcerated juveniles with a history of TBI scored higher on the PCL:YV compared to those who had not had a TBI.

Several reasons can be postulated as to why higher psychopathy scores were found in individuals who have suffered a TBI compared to inmates without TBI. One reason is that TBIs can affect neurocognitive functioning, personality and behavioral traits (Keenan et al., 2007; Max et al., 2015). Namely, TBI leads to higher impulsivity, less behavioral self-control, more violent behavior, and reduced empathy – all factors relevant to the construct of psychopathy (Fazel et al., 2011; Ray & Richardson, 2017; Schwartz et al., 2017; Vaughn et al., 2014; Williams et al., 2015; Wood & Williams, 2008). Another reason for the PCL-R group differences by TBI may be that individuals with high PCL-R scores are simply at greater risk of experiencing a TBI due to their high-risk temperament. It would be quite valuable to examine the developmental trajectories of at-risk youth to help disentangle these potential pathways.

One might also expect to find an effect of the specific location of past TBIs on PCL-R scores, as different regions of the brain have been linked to psychopathic traits in multiple neurobiological studies (Kiehl, 2006; Weber et al., 2008). For example, atypical anatomical integrity and functional response in the amygdala, which plays a key role in the rapid, automatic and non-conscious processing of salient stimuli, and the ventromedial prefrontal cortex, a key node of cortical and subcortical networks that subserve cognitive functions such as decision-making processes, valuation, and moral reasoning, have been implicated in psychopathic traits (Blair, 2007; Hare et al., 2009;

Koenigs, 2012; Raine, 2008; Strayhorn 2002). Damage to the prefrontal cortex has been shown to cause behavioral changes affecting people's empathy, remorselessness, and impulsivity, which may be relevant to understanding the link between history of TBI and higher psychopathy scores (Granacher & Fozdar, 2007; Koenigs, 2012). However, how specific location and severity of TBI affect the occurrence of psychopathic traits has not been studied to date. Hence, using brain imaging technology to investigate how location and severity of TBI affect individual's psychopathy scores will be helpful in understanding these conditions in more detail. Moreover, future work should consider examining age of TBI on psychopathic traits. Are there critical windows in development that moderate these traits?

For the Wisconsin sample, but not the New Mexico sample, TBI was associated with elevated Facet 1 (interpersonal) and Facet 2 (affective) traits. These differences between sites may be due to differences in sampling procedures and population differences. In both states individuals who volunteered for research, but reported severe TBI, were initially excluded from NIH studies (circa 2007-2015). In New Mexico (around 2015) individuals with all levels of TBI were allowed to participate. Thus, the New Mexico sample included moderate to severe TBI, whereas the Wisconsin site was limited to mild TBI. Further, Wisconsin showed higher average PCL-R scores (mean of 23) compared to New Mexico (mean of 20). Wisconsin also had higher Facet 1 and Facet 2 scores than New Mexico. Thus, there may be population differences between states. Future studies are needed to confirm and extend these findings.

The present study examined very large samples from two state correctional populations. However, the sample was limited in that it did not include large numbers of

participants with moderate to severe traumatic brain injury. The present sample also excluded participates who had psychotic disorders. Future studies should examine whether these results generalize to other populations.

In summary, in the two large, demographically diverse prison populations included in the present study, male inmates with TBI have elevated psychopathy scores relative to inmates without TBI. Gaining a better understanding of the relationship between psychopathy and TBI in incarcerated individuals will provide us with an ameliorated framework that can ideally be used in the criminal justice system to improve predictions of recidivism as well as treatment and rehabilitation options.

Acknowledgments

This work was supported by NIH grants R01MH070539 (recipient: Kent A. Kiehl); R01DA020870 (recipient: Kent A. Kiehl); R01DA026505 (recipient: Kent A. Kiehl); R01DA026964 (recipient: Kent A. Kiehl); R01MH090169 (recipient: David S. Kosson, Kent A. Kiehl subcontract PI); R01MH087525 (recipient: Jean Decety); R01MH114028 (recipient: Carla L. Harenski); from 2007-2020.

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Table 1: Descriptive statistics for demographic variables of adult incarcerated males (N = 1049)

	New Mexico (N = 520)		**Wisconsin** (N = 529)	
	N	*%*	*N*	*%*
Race				
White	413	79.4	290	54.8
Black or African/American	54	10.4	201	38.0
Asian	3	0.6	2	0.4
American Indian/Alaska Native	41	7.9	9	1.7
Native Hawaiian or other Pacific Islander	0	0	3	0.6
More than one	7	1.3	3	0.6
Unknown/not reported	2	0.4	21	3.9
Ethnicity				
Hispanic or Latino	273	52.5	22	4.2
Not Hispanic or Latino	247	47.5	499	94.3
Unknown/not reported	0	0	8	1.5
TBI Severity				
No TBI	253	48.7	356	67.3
All reported TBI are mild	188	36.2	141	26.7
At least one reported TBI is moderate/severe	60	11.5	8	1.5
Severity could not be determined	19	3.6	24	4.5

Table 2: Descriptive statistics of continuous demographic variables age and IQ

	New Mexico						
	Min	*Max*	*Mean*	*SD*	*95% C.I.*	*Median*	*IQR*
Age	18	60	34.3	8.8	33.5-35.0	34	13
IQ	66	137	97.1	13.6	95.9-98.3	97	17
	Wisconsin						
	Min	*Max*	*Mean*	*SD*	*95% C.I.*	*Median*	*IQR*
Age	18	62	32.2	7.7	31.6-32.9	31	11
IQ	71	134	97.6	13.4	96.4-98.7	97	17

Table 3: Descriptive statistics for the New Mexico sample; PCL-R mean item facet scores and PCL-R mean total scores for no TBI (-), TBI (+), and total (M±SD).

	Interpersonal	Affective	Lifestyle	Antisocial	Total
No TBI (n = 253)	.53 ± .50	.94 ± .54	1.09 ± .45	1.38 ± .46	19.96 ± 6.74
TBI (n = 267)	.54 ± .49	.94 ± .49	1.18 ± .43*	1.50 ± .44*	21.21 ± 6.74*
Total (n = 520)	.54 ± .50	.94 ± .52	1.14 ± .44	1.44 ± .45	20.60 ± 6.76

*TBI+ group greater than TBI- group at p< .05.

Table 4: Descriptive statistics for the Wisconsin sample; PCL-R facet and PCL-R total scores for no TBI (-), TBI (+), and total (M±SD).

	Interpersonal	Affective	Lifestyle	Antisocial	Total
No TBI (n = 356)	.74 ± .50	1.44 ± .44	1.31 ± .43	1.10 ± .57	22.49 ± 7.25
TBI (n = 173)	.85 ± .56*	1.54 ± .42*	1.43 ± .38*	1.22 ± .58*	24.56 ± 7.34*
Total (n = 529)	.78 ± .52	1.47 ± .43	1.35 ± .42	1.14 ± .57	23.16 ± 7.34

*TBI+ group greater than TBI- group at p< .05.

Figure 1*:* New Mexico – Multiple group confirmatory factor analysis results;

Strong invariance: No TBI (N = 253); TBI (N = 267)

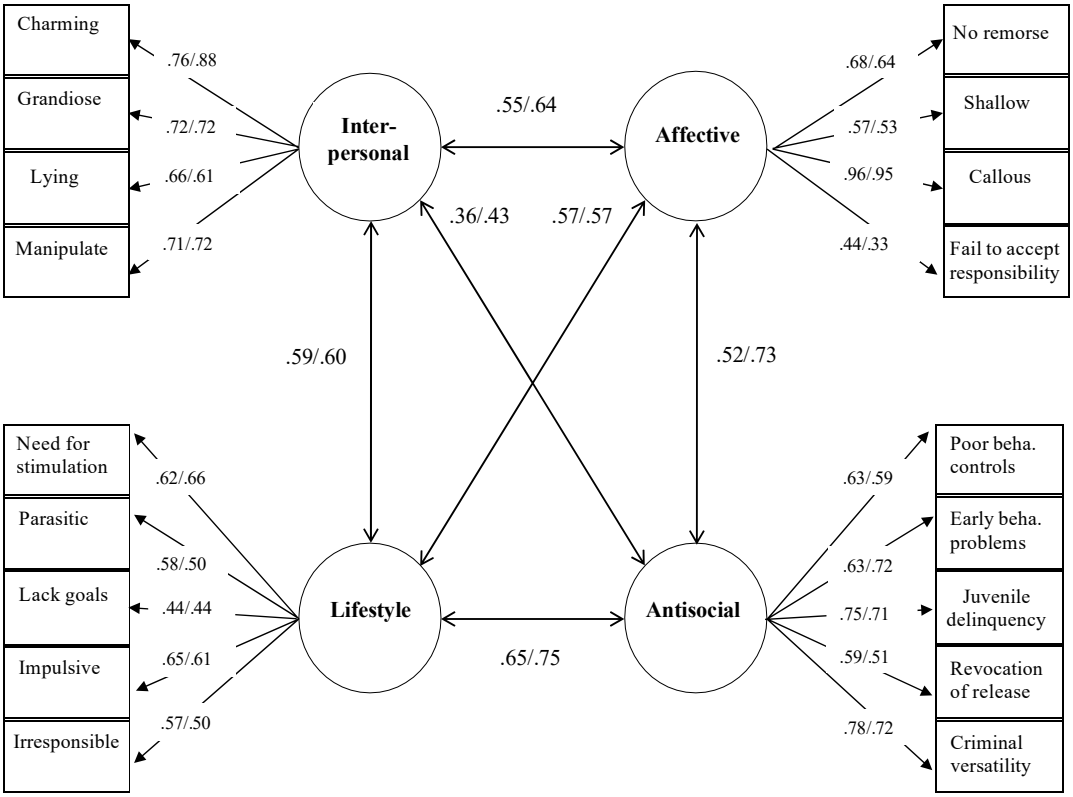
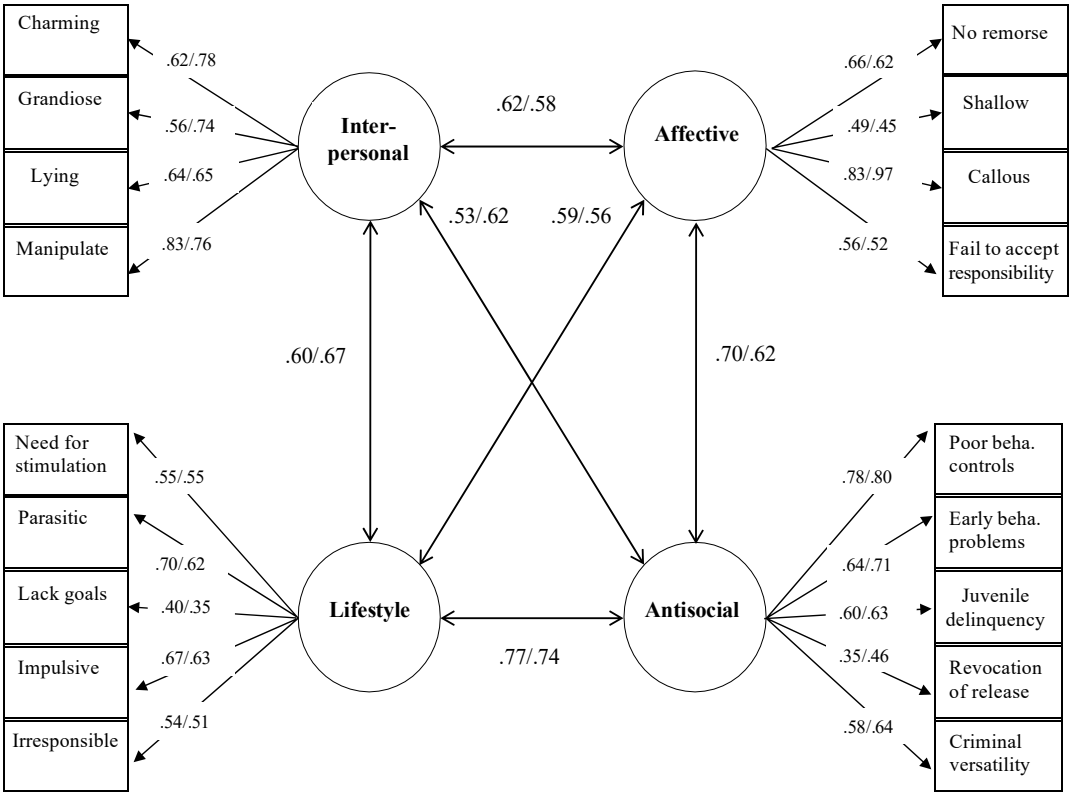


Figure 2*:* Wisconsin – Multiple group confirmatory factor analysis results;

Strong invariance: No TBI (N = 356); TBI (N = 173)



CHAPTER 4

General Discussion

General Discussion

The general discussion will summarize the dissertation's results by addressing similarities and differences in methodology, results, and interpretation of both studies. The impact of the findings will be laid out in the context of the individual, in terms of mental and public health, and into a unified framework within the criminal justice system. Finally, limitations and strengths of both studies will be addressed with current and continued challenges that need to be overcome and with suggestions for future research directions. Recommendations will be discussed on how to implement the findings of this dissertation into guiding current and future education, prevention and policymaking with regards to TBI and psychopathy within criminal justice-involved populations.

This research is the first to examine whether and how TBIs are related to the occurrence of psychopathy as well as testing for measurement invariance between groups of TBI+ and TBI- to assure the assessed latent construct of psychopathy is the same between the groups. Results showed evidence for strong measurement invariance in both studies for men and women, allowing to compare the groups TBI+ and TBI- without further data alignment or assessment tool change (Cieciuch et al., 2019).

In women, those with a PCL-R score above 25 (as the cutoff to determine psychopathic tendencies) were significantly more likely to have had a history of TBI compared to those below this cutoff. In accordance with previous research, depression and anxiety were significantly more likely to occur in women in the TBI+ compared to the TBI- group. However, against expectations, those with a history of TBI were less likely to have a substance use disorder compared to those without history of TBI (92% vs. 98%, $p < .05$). Given the large number of women with a substance use disorder in our

sample this result likely does not carry clinical significance. The MG-CFA showed acceptable model fit for the 4-factor model with the TBI+ group showing significantly higher affective traits and a trend for higher antisocial traits (p = .11) compared to the TBI- group. Structural equation modeling revealed that earlier age of TBI, severity of TBI, and substance use predicted higher Factor 1 traits and that younger current age and substance use disorder predicted higher Factor 2 traits.

In men, MANOVA results showed that the TBI+ group had significantly higher PCL-R total scores in both the WI and NM sample. For WI, all four facets showed higher PCL-R scores for the TBI+ group and for NM, the PCL-R lifestyle and developmental/antisocial facet in were significantly higher in the TBI+ group.

In summary, our studies are the first ones to show that both incarcerated adult men and women with a history of TBI show elevated PCL-R scores compared to those without a history of TBI. The only studies that have previously examined the relationship between TBI history and psychopathy were performed with juvenile populations (Olson & Vaughn, 2021; Vaughn et al., 2014). Our research is the first to look at adult individuals.

Psychopathy can develop and be diagnosed early on in an individual's life and TBI can occur at any point in life, but occurrence rates are age-dependent. In a sample of 1627 patients, Blaya and colleagues (2022) report the highest occurrence rates for males at age 21-30 (30%) and age 31-40 (24.2%). For women, the highest rates of TBI are recorded for the age cohorts 11-20 (19.8%), 1-10 (17%), and 41-50 years (17.5%). These numbers make it clear that studying adults is crucial in understanding the relationship between TBI and psychopathy.

Women's incarceration rates have steadily increased and reached an all-time high (Heimer et al., 2022). Hence, studying women in the criminal justice system has become increasingly important. However, there is still a lack of understanding regarding how psychopathy manifests in women. Here, we examined a women-only sample to determine whether TBI and psychopathy co-occur. This is the first study establishing a link between psychopathy and traumatic brain injury in adult women.

A discussion on the relationship between TBI and psychopathy would be incomplete without discussing possible treatment avenues. For the effective treatment of TBI, it is crucial to understand its sequelae. Consequences of TBI affect a wide range of the domains in an individual's life, possibly leading to neurological impairment, cognitive impairment, changes in behavior and personality, such as motor function impairment, post-traumatic epilepsy, memory impairment, language problems, impaired social skills, poor anger management, decreased disinhibition, increased impulsivity, anxiety, depression, post-traumatic stress disorder, and difficulties in maintaining interpersonal relationships (Khan et al., 2003).

In terms of TBI treatment and rehabilitation, a variety of options can be considered, including acute medical rehabilitation, community-integrated rehabilitation, and adapted lifestyle sustaining services such as acute behavior management (Chung & Khan, 2014; Galgano et al., 2017; Khan et al., 2003). Dependent on the specific type and location of brain damage, various types of psychotherapy for co-occurring psychological disorders exist such as group anger management (Walker et al., 2010) or post-traumatic stress disorder interventions (PTSD; Bryant et al., 2022) and behavioral interventions (Ylvisaker et al., 2007). Treatment for traumatic brain injuries aims to reduce or

potentially reverse some of the damage caused in the brain. Traditional approaches address immediate needs such as physical, and speech therapy. Stem cell therapy shows promising results in rodent models as well as preclinical trials with potential for future application in humans (Pischiutta et al., 2021). Different stem cell therapies have had positive neurodegenerative outcomes that result in sensorimotor and cognitive improvements, and anatomical changes (Pischiutta et al., 2021, for review see Zibara et al., 2019).

Treatment for psychopathy, on the other hand, continues to show mixed results in terms of treatment outcomes. Multiple studies have shown that psychotherapy for inmates does not result in reduced recidivism. Treatment of people high on psychopathic traits with cognitive-behavioral therapy (CBT) show limited success and at times even adverse effects as measured by treatment engagement, treatment completion, and recidivism rates (De Brito et al., 2021; Klein Haneveld et al., 2018; O'Brien & Daffern, 2017).

It is especially relevant to treat psychopathy and TBI together – because not only do they frequently co-occur, but there are likely bi-directional reinforcement effects of TBI on psychopathy and vice versa.

Strengths and Limitations

The presented studies have a few noteworthy strengths. First, both studies include large sample sizes which allowed for more specific analyses with regards to different variables such as mental disorders and substance use.

These studies are the first to test for measurement invariance. Measurement invariance was assessed at the item level as the parameters were restricted to each item. Good model fit supports that measurement invariance in our datasets is present,

meaning that we can say with good certainty that the latent construct of psychopathy can be assessed in a similar fashion for individuals with and without history of TBI.

Results of our studies should be interpreted with caution due to some limitations that are worth mentioning. One of these pertains to the different questionnaires used to acquire history of TBI. The internal TBI questionnaire used between 2007 and 2009 and the Rivermead Questionnaire used after 2009 were different in several critical ways. The internal TBI questionnaire was not tested for reliability nor validity. One of the reasons that the internal TBI questionnaire was later replaced with the Rivermead Post Concussion Questionnaire is that the internal TBI questionnaire only recorded TBIs that resulted in loss of consciousness, whereas the Rivermead Questionnaire asks about all types of head injury, including those that did not result in loss of consciousness. Using two different questionnaires, only one of which accounts for loss of consciousness, does not address the entirety of TBI, which is a major constraint. However, it needs to be noted that only a small subset of participants (n=20) was administered the internal questionnaire.

Different types of bias can occur when conducting scientific research, some of which relate to challenges using self-report data. In the present studies, TBI history was recorded using solely retrospective self-report data. This can potentially pose a problem, especially when significant misrepresentation of reported data skews the results in a systematic way. It could be argued that self-report is prone to misrepresentation of the occurrence and severity of TBI. One study on incarcerated individuals showed only 70% agreement between self-reports of TBI and the individual's hospital medical records (Schofield et al., 2011). This phenomenon is open to interpretation, but compared to, for

instance, interrater reliability, 70% would not meet the acceptable standard of rigor in most instances. On the other hand, obtaining self-report data is still the most accessible, fast, and inexpensive method at hand. Low reliability of self-reports could be addressed by taking into account individuals' medical records.

For the women's dataset, PCL-R scores were double-rated for only 8.3% of the sample (41 out of 341). Interrater reliability as calculated through intra-class correlations (ICC) was .96 for the PCL-R total score and between .84 and .95 for the facet scores which is considered good. Different measures were taken to assure interrater reliability: through regular interrater reliability calculations (ICC), thorough initial training for PCL-R assessments, and a refresher training (a group of raters scores the same participant, and scores are later compared).

Lastly, through our studies we were not able to say what the cause and effect is in the observed relationship between psychopathy and TBI - whether TBI causes psychopathic tendencies or psychopathic tendencies result in TBIs. It seems likely to hypothesize that both might be interrelated in that having higher psychopathic tendencies would increase the likelihood of suffering a TBI and having suffered a TBI to increase the likelihood of developing psychopathic tendencies.

There is significant overlap between affected brain regions between psychopathic individuals and those with a history of TBI (Bryant et al., 2022; Weber et al., 2008). For both, structural abnormalities have been found in the prefrontal cortex, the amygdala, and the hippocampus (Anderson & Kiehl, 2014; Koenigs, 2012; McAllister, 2011). Due to the variety of brain locations that are affected when one suffers a TBI as well as the multifaceted nature of origins of psychopathic behaviors it would be premature to assume

that TBI will result in a higher propensity of showing symptoms of psychopathy. Expanded future research is needed to elucidate this matter further.

Future Research Directions

Some of the above-mentioned challenges were overcome in that adults were used as participants in these studies – not only juveniles as in previous research. Working with a women-only sample and testing for measurement invariance to assure the same latent construct of psychopathy is measured between individuals with and without history of TBI has not been done before in relation to TBI and psychopathy. However, there are still some challenges that will be discussed here in more detail with the hope of them being considered in future research.

Despite the apparent similarities between symptoms of psychopathy and sequelae of TBI, these studies are amongst the first ones to specifically examine the relationship between TBI and psychopathy. Future research on this topic could include medical data on the history of TBI such as hospital or medical records. This would expand measure inclusiveness for severe TBI where treatment is sought, but still cannot address the difficulty in measuring TBI that are not medically treated. One way to circumvent this would be to conduct a longitudinal study that allows for recollection of events over the course of a longer period of time. However, this method has its own pitfalls, with missing data points and patients potentially dropping out over the course of the study.

It has been established that psychopathy differs cross-culturally (Cooke, 1998) meaning that despite the relatively mixed racial and ethnic backgrounds in our sample it would be beneficial to conduct research that goes beyond samples from correctional facilities in the United States to be able to generalize the findings to a broader spectrum

of people.

Participants in this study were all 18 years and older. As previously mentioned, it is crucial to study adults when aiming to understand the relationship between psychopathy and TBI. Having said that, most physiological and developmental processes occur during teenage years. TBI during these critical times of development might have an especially relevant effect on the developing brain and potentially the likelihood of developing psychopathy (Del Giudice et al., 2011). Hence, it is beneficial to continue to study juveniles, and particularly through longitudinal studies, to identify the direction of cause and effect between psychopathy and TBI.

Further, both of our studies used incarcerated individuals. Despite the increased prevalence of psychopathy as well as TBI occurrence of individuals in correctional facilities there is also a non-negligible amount of psychopathic individuals that are not incarcerated who would be of interest to study. This also would allow for a more general picture of how TBIs affect psychopathy and vice versa.

Implications and Recommendations for Prevention, Education, and Policymaking

The Center for Disease Control and Prevention has invested in programs to reduce the occurrence of diseases and disorders such as obesity, diabetes, tobacco use, and cancer (Bunnell et al., 2012; Reidy et al., 2015). Similarly, acting on the biological and environmental levels during the critical developmental periods of an individual's lifetime during which psychopathic traits first to emerge (Del Giudice et al., 2011) could result in more targeted and individualized prevention and treatment plans.

A better understanding of the specific developmental stages during which traits of

psychopathy first occur will help to identify individuals at risk of developing psychopathy earlier and therefore aid in developing specific intervention plans.

Likewise, knowledge about how the neural damage resulting from TBI affects the different factors and facets of psychopathy, we would potentially be able to create individualized prevention, intervention, and treatment plans. Allocating more resources towards education and prevention of TBI (e.g., wearing helmets on motorcycles, reducing driving while intoxicated, prevention of violence) will continue to have a positive impact on the reduction of TBI occurrence.

As previously discussed, a strong link exists between psychopathy and violence, aggression, and recidivism and it should therefore be made a priority to continue research to determine what treatment options are best suited to reduce the symptoms of psychopathy, especially in incarcerated populations.

Hopefully, the results of this dissertation show the need to further study psychopathy in relation to TBI and to continue to conduct research on different prevention and treatment options to decrease the negative outcomes that are associated with TBI, psychopathy, and the combination of both. Ultimately, those in charge of policy-making as well as clinical and criminal-justice involved personnel are the ones who will need to adjust and improve diagnoses, interventions, and treatment plans for individuals at risk for psychopathy. Not only the individual will benefit from these discussed changes but society as a whole.

Conclusion

The presented research sheds light on the relationship between history of TBI and psychopathic tendencies in adult incarcerated men and women. Understanding these complex phenomena and how they interact with one another can help guide decision-making processes on prevention, rehabilitation, and treatment options.

Future research will benefit from applying an intersectional approach to gain insight into the details of how TBI and psychopathy interact with one another, and longitudinal studies will potentially help to identify the causal link between TBI history and psychopathy.

Finally, gaining a better understanding of psychopathy and TBI history in incarcerated individuals will provide us with an ameliorated framework for use in the criminal justice system to improve predictions of recidivism as well as treatment and rehabilitation options for individuals with history of TBI that are at elevated risk of showing psychopathic tendencies.

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