Spring 5-2021

Criterion Validity of the Ohio State University Traumatic Brain Injury Identification Method in a Criminal Justice Sample

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Abstract

The purpose of the current study was to determine the clinical utility of the Ohio State University Traumatic Brain Injury Identification Method (OSU-TBI-ID) in a criminal justice sample, by evaluating the criterion-related validity of this instrument. It was hypothesized that this tool could differentiate between incarcerated individuals with or without a history of Traumatic Brain Injury (TBI) on measures evaluating important TBI-related sequalae. The sample consisted of 95 incarcerated men detained at a private correctional facility in a Mid-Atlantic state. Measures used in this study to evaluate executive functioning difficulties, psychiatric difficulties, substance use problems, institutional misconduct and recidivism were compared between those with and without a history of moderate-to-severe TBI (i.e., the OSU-TBI-ID Worst Score). Results from a series of independent samples *t*-tests and chi-squared tests of independence reveal that the OSU-TBI-ID is effective at tapping into the construct of inhibition in this justice-involved sample. In light of the limitations inherent in the current study design (e.g., generalizability of the archival sample and dichotomous classification of TBI), this finding is quite compelling evidence of the criterion-related validity of the OSU-TBI-ID. Significant relationships were not identified between TBI and other cognitive or behavioral outcomes. Future research should take into account the limitations inherent in this study, and continue to contribute to the area of TBI assessment in criminal justice populations. Development of a reliable and valid method of eliciting a history of TBI in an incarcerated population is essential for improving the treatment and rehabilitation of incarcerated individuals, which will ultimately result in saved resources, successful community reentry, and cultivation of a healthier, safer society.

Keywords: traumatic brain injury, assessment, validity, executive function deficits, criminal justice involvement.

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Traumatic Brain Injury (TBI) has been defined by the Centers for Disease Control and Prevention (CDC) as "a bump, blow or jolt to the head that disrupts the normal function of the brain" (2019). For this injury to be classified as a TBI, it must involve an altered level of consciousness, amnesia, skull fracture, objective neurological or neuropsychological abnormality, or diagnosed intracranial lesion. TBI severity has traditionally been classified on a continuum of mild, moderate, and severe. Coinciding symptom severity can range from mostly benign changes in functioning that are not markedly different to pre-injury levels, to significant and lifelong impairments in cognitive functioning, behavior, and mood (Belanger et al., 2018; Roebuck-Spencer & Sherer, 2018). The dynamics of treatment and recovery from TBI are multifold, and often heavily dependent on factors such as premorbid functioning, TBI severity, and number of head injuries sustained across one's lifetime. Thus, accurate and informative assessment of TBI is the cornerstone upon which rehabilitation plans are built and, consequently, is vital to recovery.

Classification Of TBI

Since TBI severity is a significant prognostic indicator for recovery outcomes, it is vital to be able to clearly distinguish between mild, moderate, and severe TBI. Mild TBI is generally categorized as "an injury to the head as a result of blunt trauma, acceleration or deceleration forces, which results in one or more of the following conditions: observed or self-reported transient confusion, disorientation, or impaired consciousness, dysfunction of memory around the time of the injury, and observed or self-reported loss of consciousness less than 30 minutes" (CDC, 2003). Observed physical abnormalities subsequent to a head injury transitions a mild TBI from an "uncomplicated" to a "complicated" mild TBI. Outcome after an uncomplicated mild TBI is

typically associated with cognitive performance similar to healthy controls, and symptom resolution by three months post injury (Kashluba et al., 2004; Rohling et al., 2011). Similar levels of cognitive and functional outcomes have been demonstrated between complicated mild TBIs and moderate TBIs, characterized by greater severity and pervasiveness of symptomatology (Borgaro, et al., 2003; Kashluba et al., 2008).

Conversely, moderate to severe TBIs are characterized by long-term cognitive, behavioral, and emotional impacts. Individuals sustaining a moderate to severe TBI can exhibit significant deficits across a range of cognitive domains, particularly dysfunction in areas such as executive functioning abilities and memory processes (Carlozzi et al., 2013; Lezak et al., 2012; Vanderploeg et al., 2014). The probability of neurobehavioral impairment increases relative to injury severity, and impaired self-awareness can persist years following a serious injury (Kelley et al., 2014). Moderate to severe TBIs also increase risk for debilitating degenerative illnesses, such as Alzheimer's disease, Parkinson's disease, and other dementias (Bazarian et al., 2009).

The number of TBI related deaths in the US is rising; from approximately 52,000 in 2006, to 56,000 in 2014 (CDC, 2019; Faul, et al., 2010). In less than a decade, the number of TBI-related emergency department visits, hospitalizations, and deaths increased by 53%, from approximately 1.88 million in 2006 to 2.88 million in 2014 (CDC, 2019; Faul et al., 2010). In addition to the human toll of these injuries, TBI diagnosis and treatment has been estimated to cost the US nearly $17 billion each year (CDC, 2003). Taken together, this data makes it clear that TBI is a significant and increasing public health concern.

TBI and Criminal Justice Populations

Understandably, the wide range of social, emotional, cognitive, and behavioral sequalae that can occur following a TBI increase one's risk for manifesting behaviors which deviate from

social and legal norms. TBI most frequently impacts the frontal and anterior tips of the temporal lobes, which are implicated in the regulation of crucial executive functioning abilities, such as attention, memory consolidation, emotion, behavioral planning, and inhibition (Lezak et al., 2012). Within the criminal justice population, those with a history of TBI have demonstrated higher levels of disinhibition and risk-taking behavior, poorer decision-making abilities, more severe issues with substance abuse, and are more likely to demonstrate physical and verbal aggression (Bogner & Corrigan, 2009; Clark et al., 2020; Rochat et al., 2013).

The prevalence of TBI within a justice-involved population appears significantly higher when compared to the general population. TBI prevalence in various correctional settings has been documented to range from 25% to 87% (CDC, 2013). Additional meta-analyses conducted accounting for variations in definitions of head injury, source populations of the studies, differing demographics, and screening methods estimated a narrower prevalence of approximately 48% to 72% (Shiroma et al., 2010). These TBI rates appear significantly higher than the estimated 8.5% prevalence in the general population (Silver et al., 2001). In addition, individuals involved in the criminal justice system are more likely to suffer multiple TBIs throughout their lifetime, and are more likely to develop a substance abuse and/or psychiatric disorder that impacts upon their treatment and rehabilitation trajectory (Schofield et al., 2006; Slaughter et al., 2003).

Further, demographic characteristics such as race and socioeconomic status can impact an individual's likelihood of sustaining a TBI and subsequent recovery trajectories (Arango-Lasprilla & Kreutzer, 2010; Williams et al., 2009). Research has demonstrated the disproportionate representation of individuals from a lower socioeconomic class and minority racial groups within criminal justice populations, which further highlights the vulnerability and need to address TBI-related difficulties within this population (Garland et al., 2008; Weiss & Rosinski, 2016).

Overall, these difficulties can have a significant impact on the functioning of incarcerated individuals, their institutional behavior, and their ability to successfully complete rehabilitation programs (Brown et al., 2018; Matheson et al., 2020). Adjustment to different routines and environments, particularly a restrictive, authoritarian prison setting, is made significantly more difficult due to TBI-related impairments. Those with TBIs generally incur higher rates of in-prison rule infractions, in addition to lower rates of substance abuse treatment completion (Piccolino & Solberg, 2014). Co-occurring substance use may increase cognitive impairments, including decision making deficits, disinhibition and high risk behaviors (Fishbein et al., 2016). Individuals who have suffered a TBI are often less equipped to meet the requirements of community supervision or be successful during probation, which has negative implications for community reentry (Brown et al., 2018), and there is a significant relationship between the presence of a TBI and the likelihood of repeat offending (Ray & Richardson, 2017).

Assessment of TBI

A known history of TBI can inform important lifestyle decisions, and may signal the need for more intensive medical management and treatment decision-making as symptomatology evolves. Importantly, this can improve allocation of resources within criminal justice populations, in order to design more effective rehabilitation programs for individuals with a history of TBI.

The wide range of estimates noted earlier (CDC, 2013; Shiroma et al., 2010) highlights the challenges faced by clinicians and researchers in obtaining an accurate estimate of the prevalence of TBI within the criminal justice system. TBI severity is often measured using methods such as degree of post-traumatic amnesia (PTA), Glasgow Coma Scale (GCS) score, and time to follow commands (Giacino et al., 2002; Nakase-Richardson et al., 2011; Teasdale & Jennett, 1974). However, in addition to conceptual issues with these methods, this information is not always

available to subsequent clinicians due to difficulty obtaining prior medical records (Braine & Cook, 2017; Holdgate et al., 2006). Further, individuals within criminal justice settings are less likely to have sought medical attention subsequent to a head injury, with research indicating that medical attention following TBI is not received by 61% of incarcerated individuals and 30% of individuals with comorbid substance abuse disorders (Bogner & Corrigan, 2009; Setnik & Bazarian, 2007).

Due to these issues in TBI assessment, self-report elicited through structured screening tools is increasingly being recognized as the most accurate and efficient method of estimating lifetime prevalence of TBI (American Congress of Rehabilitation Medicine, 1993; Corrigan & Bogner, 2007b; Dams-O'Connor et al., 2014). At the individual level, reliable and valid screening methods can provide a starting point for a more comprehensive evaluation if necessary, and the connection of an individual to relevant services for rehabilitation where appropriate.

Specifically, a known history of TBI may warrant a more robust neuropsychological evaluation to further inform treatment approaches. Individuals involved in the criminal justice system with a history of TBI might be placed on specialty caseloads, and supervised by individuals trained to manage pertinent TBI-related sequalae, such as mental health and/or substance use disorders. Cognitive and behavioral outcomes of TBI can affect concentration, memory, impulsivity, and overall adaptive functioning, which may be perceived as non-compliance and poor performance, making an individual more likely to incur in-prison rule infractions and ultimately impede their ability to benefit from treatment plans. At a general level, staff working with individuals with a history of TBI might be educated on outcomes of TBI and, subsequently, learn methods for interacting with this cohort of individuals which are characterized by patience and flexibility to account for the range of sequalae experienced, which can impact cognition and

behavior. Treatment responses to individuals with TBI begins with accurate assessment of the presence of TBI history, and the severity of this history on the individual's overall functioning.

The Ohio State University TBI Identification Method

The Ohio State University TBI Identification Method (OSU-TBI-ID) is a structured interview designed for the purpose of detecting a history of exposure to TBI (Corrigan & Bogner, 2007a; Bogner & Corrigan, 2009), developed in line with case definitions and recommendations for TBI surveillance provided by the CDC (2003). It was designed to elicit self- or proxy-reports of TBI occurring over a person's lifetime. Due to the different verbiage used when self-reporting a TBI and the possibility of bias in terminology, individuals are not directly asked if they have experienced a TBI. Rather, their lifetime prevalence of TBI is elicited via a structured interview. The individual is first asked to recall all possible head or neck injuries via a series of questions asked by the examiner; this first step is crucial in obtaining a complete history. Once all injuries are recalled, the next step is to go back and probe further into injury severity. Age, cause, and length of loss of consciousness (or in the absence of complete loss of consciousness, altered consciousness) are queried. Also captured is information pertaining to periods of time involving multiple blows to the head, such as periods of domestic violence or participating in contact sports.

The OSU-TBI-ID has been shown to be useful in eliciting a lifetime history of TBI in a number of populations and settings. It has demonstrated effectiveness in eliciting adult recall of childhood TBIs in an otherwise healthy sample, wherein most of the cohort accurately reported whether or not they had experienced a medically attended TBI with loss of consciousness (McKinlay et al., 2017). It has also been used in identification of TBI in veteran samples (Schwab et al., 2017) and individuals with serious mental illness and chronic homelessness (Gargaro et al., 2016) to determine the extent of TBI-related consequences on their functioning in these special

populations. The OSU-TBI-ID has been included in the Traumatic Brain Injury Model Systems (TBIMS) program, a central resource for clinicians with the purpose of advancing rigor and efficiency in scientific efforts to assess the experience of individuals with TBI longitudinally (TBIMS, 2019), and has also been included as part of the National Institute of Neurological Disorders and Stroke (NINDS) TBI Common Data Elements (NINDS, 2012).

The OSU-TBI-ID has also been used to collect information on the prevalence of TBI within a sample of male inmates admitted to a state prison in the US (Ray et al., 2014). Results indicated that 35.7% (n = 297) of the sample reported experiencing a history of TBI during their lifetime, when TBI history included "any TBI" (i.e., probable, mild, moderate, and severe). The OSU-TBI-ID has been used in a study to investigate the impact of TBI history on recidivism in a sample of 151 male inmates, wherein those who screened positive for TBI had a history of "possible, mild, moderate, or severe TBI" (35.8%, n = 54; Ray & Richardson, 2017). Another study administered the OSU-TBI-ID to 636 male and female inmates in a South Carolina prison to elicit a lifetime history of TBI for these individuals (Ferguson et al., 2012). In this sample, 68% reported a lifetime history of TBI overall, including 65% of the men and 72% of the women in the sample. Of note, individuals in this study were classified as having sustained a TBI if after the injury they experienced any length of time involving "altered consciousness."

In terms of psychometrics, this tool has demonstrated strong inter-rater reliability and criterion-related validity within substance abuse samples. Specifically, age at injury and persisting symptoms contributed independently to the prediction of common cognitive and behavioral consequences of TBI, and periods of repeated injury as measured by this instrument may be a useful predictor of consequences of TBI on measures of cognitive performance, affective status, and interpersonal functioning (Corrigan & Bogner, 2007a; Corrigan et al., 2012). Within a criminal

justice sample, preliminary research indicates that the OSU-TBI-ID has demonstrated evidence of satisfactory test-retest reliability and criterion-related validity within an incarcerated sample of both men and women (*n* = 210; Bogner & Corrigan, 2009). In this study, TBI was identified in 78% of the sample, and age at injury, number of TBIs with loss of consciousness, and persisting symptoms also contributed independently to the prediction of common cognitive and behavioral consequences of TBI.

Overall, the OSU-TBI-ID is a valuable tool for a number of reasons. It has a relatively short administration time, provides straightforward operationalizations of the outcome measures, and contains indices which have been shown to be effective at capturing lifetime exposure to TBI. Importantly, it can capture TBIs which have not received medical attention, which is vital in assessment of TBI history in a criminal justice population (Setnik & Bazarian, 2007). Taken together, the OSU-TBI-ID presents as one of the most practical ways forward in effectively capturing an accurate estimate of lifetime exposure to TBI in a justice-involved population.

However, despite the fact that this tool has been used to collect information on lifetime history of TBI in criminal justice settings, there is still a lack of research outside of the single initial study investigating the psychometrics of this instrument within this population of individuals (Bogner and Corrigan, 2009). There is a need for further investigation of the psychometrics of this tool within this specific population, as validity must be continuously evaluated within different samples and contexts across time. Additionally, there have been alterations made to the tool over the years (e.g., the inclusion of repeated head impacts and removal of anoxic injuries). They have also added additional guidelines to provide more standardized data collection methods (Bogner et al., 2017; NINDS, 2012; TBIMS, 2019).

Current Study

The current study attempts to address this gap in the literature and advance TBI assessment in criminal justice samples. More research is needed on the psychometrics of self-report measures of TBI within criminal justice populations specifically, as this has been postulated as the most efficient and effective way forward in collecting a lifetime history of TBI in this population. The OSU-TBI-ID in particular has demonstrated promise for use with incarcerated individuals. Therefore, the current study aims to further assess the criterion-related validity of the current version of the OSU-TBI-ID in a different sample of incarcerated individuals, with the ultimate goal of contributing to the psychometric literature of self-report measures (generally) and the OSU-TBI-ID (specifically) within criminal justice populations. Specifically, based on the prior literature, it was hypothesized that TBI would be significantly related to common negative consequences of TBI, including executive functioning difficulties, psychiatric difficulties, and substance use problems. Additionally, it was hypothesized that TBI would be significantly related to both institutional misconduct and recidivism.

Method

The current study incorporated archival data from a prior study exploring the ability of neuropsychological assessment to inform violence risk assessment. The results of that study are presented elsewhere (LaDuke, 2016; LaDuke et al., 2017), and do not significantly overlap with the current study in terms of focus or content. The current study uses a cross-sectional design to investigate whether the OSU-TBI-ID demonstrates evidence of criterion-related validity in a criminal justice sample, in that it will be significantly related to measures assessing pertinent consequences of TBI including executive functioning difficulties, psychiatric difficulties, substance abuse problems, institutional misconduct, and recidivism.

Participants

The original study involved recruitment of participants from a private correctional facility in a Mid-Atlantic state between February 2014 and April 2015. Individuals were randomly selected and invited to participate in the study. The inclusion criterion was being a resident of the Albert "Bo" Robinson Assessment and Treatment Center, a private correctional facility providing services for individuals transferred from federal correctional facilities. To be eligible for transfer to this facility, individuals must have no history of adult arson or sexual offenses, be 24 months or less from their parole eligibility date, and be on minimum-security status. Residents of the facility have a variety of current charges, including drug-related offenses, property crimes, and violent crimes. However, specific information about each participant's instant offense or the exact length of their current incarceration was not available for this sample.

Exclusion criteria included being a woman (due to variations in violence risk factors for this population and the restricted number of women residents at Bo Robinson); placement at the correctional facility from a county jail or due to a parole violation (to ensure all study participants have already been sentenced and came directly from correctional institutions rather than from the community); a history of a major psychotic or mood disorder diagnosis (due to variations in violence risk factors for this population); blindness, deafness, or upper extremity impairment (to ensure performance on the study measures was not affected by sensory, perceptual, or motor disability); and lack of proficiency in comprehending English, as defined by less than a 5^{th} grade reading level (to ensure completion of informed consent and the various study measures).

A total of 217 individuals were invited to participate, and 122 individuals were successfully recruited. Of these 122 individuals, 100 consented to participate, and ultimately 95 participants were included in the study. A demographic questionnaire was administered to collect information

on participant's age, gender identity, cultural identity, spoken languages, and educational level. Participants who satisfied inclusion and exclusion criteria were administered a battery of neuropsychological and other clinical measures across two sessions.

Participants could identify themselves as multiple races or ethnicities. Participants identified themselves as Black or African American (*n* = 53, or 56%); White or Caucasian (*n* = 26, or 27%); Hispanic, Latino, or Spanish (*n* = 18, or 19%); American Indian or Native Alaskan (*n* = 7, or 7%); Asian or Asian American (*n* = 1, or 1%); and Other (*n* = 7, or 7%). The average age of participants was 33.71 years old (*SD* = 10.75). The entire study sample identified as men (*n* = 95, 100%). Based on these demographics, the current study sample appeared to differ somewhat from relevant correctional populations during the same general time period in terms of cultural identity (i.e., 37% Black, 32% White; 22% Hispanic, and 9% Other; Bureau of Justice Statistics [BJS], 2015), age (i.e., *M* = 37.8, *SE* = 0.6; BJS, 2016), and gender identity (i.e., 7% female; BJS, 2015).

Participants identified as either right (*n* = 74, or 78%) or left handed (*n* = 10, or 11%). Handedness was not identified for some participants (*n* = 11, or 12%). Thirteen participants (14%) identified themselves as having a diagnosis of a mental illness, including ADHD (*n* = 1, or 1%), a history of ADHD (*n* = 1, or 1%), a history of anxiety (*n* = 4, or 4%), a history of bipolar disorder (*n* = 3, or 3%), a history of depression (*n* = 3, or 3%), a history of PTSD (*n* = 2, or 2%), a history of schizophrenia (substance use related; *n* = 1, or 1%), and a current tic disorder (*n* = 1, or 1%).

Procedure

Individuals at the correctional facility were randomly selected for invitation to participate in the current study using a random numbers table. Those who elected to participate received a brief eligibility screening for the study. There was no compensation, and participation was completely voluntary. Individuals who consented were verbally administered a demographic

questionnaire and completed a screening measure for reading level. Participants who satisfied inclusion and exclusion criteria were administered a battery of neuropsychological and other clinical measures across two sessions. The data collection was completed by graduate-level research assistants, overseen by board-certified forensic psychologists and neuropsychologists. Measures were administered in a randomized order to ensure confounds related to participant motivation, reactivity, and withdrawal were balanced across measures. Embedded performance validity measures were included, and no participants were removed due to invalid performance.

Between 2019 and 2020, four additional research assistants coded all original data into an electronic database for further analyses. All data was double-coded to support internal consistency. The data included in this database will be used in all further analyses.

Measures

Participants were originally administered a battery of demographic, neuropsychological and clinical measures (LaDuke, 2016). In order to test the hypotheses of the current study, neuropsychological tests were selected that measured *TBI outcome*, *executive functioning difficulties*, and *psychiatric difficulties*. The total score from a substance abuse screening measure was selected to measure *substance use problems*. Two variables were selected which measured *institutional misconduct* and *recidivism*. These tests, related constructs, and relevant psychometrics are discussed below. Of note, the archival dataset from which these measures were selected did not include item-level responses, precluding calculation of study-specific psychometrics such as internal consistency.

TBI Outcome

Ohio State University Traumatic Brain Injury Identification Method (OSU-TBI-ID). The OSU-TBI-ID is a brief screen of history and severity of TBI. This measure collects

information on the incidence of TBI with loss of consciousness, age of first TBI, severity of worst incident of TBI, and mild repeated injuries. The OSU-TBI-ID has demonstrated promising psychometrics within criminal justice samples and with individuals with co-morbid substance abuse disorders; specifically, it has demonstrated evidence of predictive validity with measures of cognitive performance, affective status, and interpersonal functioning (Corrigan & Bogner, 2007a); evidence of satisfactory reliability and validity within substance abuse populations (Corrigan et al., 2012); and evidence of satisfactory test-retest reliability and predictive validity within incarcerated samples (Bogner & Corrigan, 2009). For the current study, *TBI outcome* was specifically measured by the OSU-TBI-ID Worst Score, which is dichotomized as "yes" or "no" depending on whether the individual sustained one or more moderate to severe TBIs throughout their lifetime (i.e., any TBI with 30 minutes or more loss of consciousness).

Executive functioning difficulties

Color-Word Interference Test (CWIT). The CWIT is a paper-and-pencil test that is part of the Delis-Kaplan Executive Function System (D-KEFS; Delis et al., 2001a). The CWIT is a modification of the traditional Stroop Test. The CWIT measures color naming (Condition 1), color-word reading (Condition 2), inhibition of a rote response in favor of a novel behavior (Condition 3), and the ability to switch between competing rules in a timed condition (Condition 4). Scores are derived from the total time taken to complete each condition, in addition to the total number of errors made. The CWIT has demonstrated evidence of satisfactory test-retest reliability and convergent validity across age groups (Delis et al., 2001b). For the current study, the CWIT Condition 3 inhibition raw score and Condition 4 color inhibition/switching raw score were used as measures of executive function**.**

Behavioral Assessment of the Dysexecutive Syndrome (BADS). The BADS (Wilson et al.,1996) is a neuropsychological test designed to measure organization, planning, and complex problem solving. Individuals with deficits in executive functioning are conceptualized to have greater difficulties when carrying out these behaviors. The BADS includes a self-report measure of executive dysfunction, called the Dysexecutive Questionnaire (or DEX). Each item on the DEX is scored on a five-point Likert scale ranging from "Never" to "Very often," and all items are summed to produce a DEX score. This tool has demonstrated evidence of satisfactory reliability and validity in the assessment of behavioral symptoms of dysexecutive functioning in mixed community, psychiatric, and neurological samples (Shaw et al., 2015). For the current study, BADS DEX raw scores were used as a self-report measure of executive functioning.

Porteus Maze Task (PMT). The PMT is a paper-and-pencil measure consisting of mazes of increasing difficulty (Porteus, 1965). The PMT produces a Test Age (TA) score based on the highest level of difficulty completed by participants, and a Qualitative (Q) score based on errors such as crossing lines, lifting the pencil off the paper, and changing directions. For the current study, the PMT Q Score was used to measure executive functioning.

Trail Making Test (TMT). The TMT (Reitan, 1955, 1958) is a paper-and-pencil test, and measures executive functioning abilities such as attention, impulsivity, working memory, set shifting, and cognitive flexibility. The TMT is one of the most widely used neuropsychological measures of executive functioning (Rabin et al., 2016). Participants must connect a series of scrambled numbered circles in ascending order in a timed condition (Trails A), and then to alternate between numbered and lettered circles in ascending order in a timed condition (Trails B). TMT Trial A raw score and TMT Trial B raw score were used in the current study as measures of executive functioning.

Symbol Digit Modalities Test (SDMT). The SDMT (Smith, 1991) is a measure which is sensitive to general cognitive impairment. This is a timed test requiring participants to match written numbers to paired abstract symbols, and has demonstrated strong convergent validity with other tests of general cognitive abilities (Strauss et al., 2006). The SDMT Written raw score was used in the current study as a measure of executive functioning.

Ruff 2 & 7 Selective Attention Test (Ruff 2 & 7). The Ruff 2 & 7 (Ruff et al., 2002) is a paper-and-pencil task of sustained and selective visual attention. Individuals view an array of numeric (Controlled Search) and alphanumeric strings (Automatic Detection), and cross out certain targets (i.e., 2 and 7). Scores include both speed and accuracy in both of these areas. The Ruff 2 & 7 has demonstrated evidence of satisfactory internal reliability, test-retest reliability, and convergent validity with other measures of sustained and selective attention (Ruff et al., 2002). The Ruff 2 & 7 Controlled Search Accuracy raw score, which includes the number of errors made plus speed of completion, was used in the current study as a measure of executive function.

Psychiatric Difficulties

Beck Depression Inventory (BDI-II). The BDI-II is a brief self-report measure collecting information on symptoms of depression in adult populations, based on DSM-IV diagnostic criteria (Beck et al., 1996). Individuals indicate the incidence and severity of typical symptoms of depression, based on 21 items scored via a four-point Likert scale of symptom severity. Total BDI-II scores range from 0 to 63, and are interpreted as representing minimal depression (0-13), mild depression (14-19), moderate depression (20-28), and severe depression (29-63) (Beck et al., 1996). This is a widely used tool and has demonstrated evidence of satisfactory reliability and validity in multiple samples (Wang & Gorenstein, 2013). For the current study, the total score on the BDI-II was used to measure *psychiatric difficulties*.

Substance Use Problems

Simple Screening Instrument for Substance Abuse (SSI-SA). The SSI-SA is a brief measure screening for multiple substance abuse disorders (Boothroyd et al., 2015). The instrument is comprised of five primary content domains, including substance consumption (frequency, length, and amount), preoccupation with and loss of control of substance use (both brief and extended periods), adverse consequences related to substance use, problem recognition (reflecting level of insight into adverse consequences), and physiological indices of tolerance and withdrawal. This tool has demonstrated evidence of satisfactory internal consistency and validity (Boothroyd et al., 2015). For the current study, the SSI-SA total score was used to measure the variable *substance use problems.*

Institutional Misconduct

The institutional outcome measure as part of the dataset used in this study collected outcome data related to various types of institutional misconduct; specifically, institutional violence and program failure. Additionally, participant's number of institutional merits, institutional demerits, program violations and behavioral contracts accrued since their entry into the facility were collected. For the current study, the number of institutional demerits accrued by the participant during their time in the facility was used as a measure of *institutional misconduct.*

Recidivism

Recidivism was operationalized as any new charge incurred by participants within approximately 1-2 years of their release, in the original state of data collection or any bordering states (i.e., three states total). Exact dates of release from the correctional facility were not included in the archival database used in this study, precluding calculation of time at risk for recidivism in the community. In general, time at risk for the sample is estimated to be approximately 12-25

months. Additionally, information on the exact nature and severity of offenses were also not available for the current analyses. For this study, *recidivism* was therefore measured as a dichotomous variable categorized as "yes" (i.e., accrued any new charges as defined above) and "no" (i.e., no new charges as defined above).

Statistical Analysis Plan

Independent samples *t*-tests were run between the TBI outcome measure and each of the continuous variables outlined above, including measures of executive function, depression, substance abuse, and institutional misconduct. Effect sizes of each association were analyzed, in order to determine the magnitude of the relationship between TBI outcome and each variable. A chi-square test of independence evaluated whether there is a statistically significant association between TBI outcome and the dichotomous variable for recidivism.

Results

Preliminary analyses

Descriptive statistics were analyzed for all relevant variables. Descriptive statistics for demographic items have been previously presented (see Sample section). Descriptive statistics for all categorical variables are presented in Table 1, and descriptive statistics for recidivism are presented in Table 2. Within this sample, 21% (n = 20) were identified as having a history of a moderate to severe TBI. The average length of time between the last TBI sustained and data collection was 8.3 years (SD = 6.3, *range* = 1-23 years).

Table 1

Descriptive Statistics for Continuous Variables

Measure	*n*	*Mean*	*SD*	*Min*	*Max*	*Skewness (SE)*	*Kurtosis (SE)*	*Normality*
CWIT Condition 3	87	54.89	15.95	10	116	1.42(0.26)	4.62(0.51)	<.001
CWIT Condition 4	88	66.82	16.09	10	114	0.13(0.26)	1.48(0.51)	0.62
Ruff 2 & 7	88	94.65	4.87	69.61	100	-2.05(0.26)	6.98(0.51)	<.001
PMT Q Score	91	3.73	2.95	0	13	0.91(0.25)	0.42(0.50)	<.001
SDMT Written Raw Score	91	-0.69	0.93	27	69	-0.17(0.25)	0.22(0.50)	.008
TMT Trial A Raw Score	91	28.85	9.95	13	62	1.07(0.25)	1.22(0.50)	.017
TMT Trial B Raw Score	89	82.3	40.59	37	280	2.61(0.26)	8.88(0.51)	<.001
SSI-SA Total Score	86	1.60	1.93	0	10	1.76(0.26)	4.10(0.51)	<.001
Institutional Demerits	75	4.12	5.30	0	23	1.89(0.28)	3.18(0.55)	<.001
BDI-II Total Score	91	10.29	6.70	0	34	0.93(0.25)	1.40(0.50)	.002
BADS DEX Raw Score	90	15.63	9.07	0	41	0.43(0.25)	-.337(0.50)	.299

Note. CWIT = Color-Word Interference Test, PMT = Porteus Maze Task, Ruff 2&7 = Ruff 2&7 Controlled Search accuracy Test, SDMT = Symbol Digit Modalities Test, SSI-SA = Simple Screening Instrument for Substance Abuse, BDI-II = Beck Depression Inventory – II, BADS DEX = Behavioral Assessment of the Dysexecutive Syndrome, TMT = Trail Making Test.

Table 2

Descriptive Statistics for Recidivism

Recidivism Outcome	*TBI*	*No TBI*	*Total*
Yes	4	11	15
No	16	59	75
Total	15	70	90

Note. TBI = Traumatic brain injury.

Review of boxplots and histograms indicate that there were no outliers present for the variables CWIT Condition 4 and the PMT Q. All other variables had one to three outliers, with the exception of the TMT Trial B which had four outliers, and institutional demerits which had five outliers. In addition, as the data was double-coded, it is highly unlikely that any outliers are the product of measurement or other types of errors, and are more likely a reflection of the characteristics of the actual population. In order to maintain this likely reflection of the population, and to avoid extraneous manipulation of data, outliers were not removed from the dataset.

Additionally, scores on the BADS DEX and the CWIT Condition 4 were normally distributed, as assessed by Shapiro-Wilk's test ($p < 0.05$). The CWIT Condition 3, Ruff 2 & 7 Controlled Search Accuracy, PMT Q, SDMT, TMT Trial A, TMT Trial B, SSI-SA, institutional demerits, and BDI-II were not normally distributed, as assessed by Shapiro-Wilk's test ($p > .05$). Upon further analysis of the spread of the data (visually observing the nature of the skewed data via histograms and boxplots), and taking into account the nature of the population and constructs themselves, it was deemed appropriate to continue with the data analysis, concurrently acknowledging the violation of the assumption of normality in the interpretation of the data output. Most executive function measures depicted a moderate positive skew, indicating that most individuals scored on the lower end of the measure, with the exception of a few participants who received higher scores. Given the nature of the sample, it is not unexpected for the normality of the distribution to differ from what is considered a "normal" distribution. Ultimately, although the assumptions inherent in parametric tests were not met for certain variables in this study, no transformations were conducted in order to avoid deviating too far from the original constructs of interest.

Hypothesis testing

Although 95 individuals participated in the study, four cases were excluded due to missing data. Therefore, the current analyses include data from 91 individuals; 21% (n = 20) of individuals who have sustained at least one moderate to severe TBI, and 75% (n = 71) who have never experienced a moderate to severe TBI, as captured by the OSU-TBI-ID.

Homogeneity of variance was observed for CWIT Condition 3 Inhibition Raw Score (p = .30), CWIT Condition 4 Color Inhibition/Switching Raw Score (p = .80), BADS DEX Raw Score (p = .30), PMT Q Score (p = .80), Ruff 2 & 7 Controlled Search Accuracy Raw Score (p = .90), SDMT Written Raw Score (p = .20), TMT Trial A Raw Score (p = .40), TMT Trial B Raw Score (p = .90), SSI-SA Total Score (p = .80), and BDI-II Total Score (p = .70) However, for number of institutional demerits, the assumption of homogeneity of variances was violated (p = .0).

Table 3 depicts results from exploratory analyses for all continuous variables. Results of independent sample t-tests revealed a difference in mean scores on measures of inhibition (CWIT Condition 3 and CWIT Condition 4), in that individuals with a moderate to severe TBI had a higher completion time on these measures than individuals without TBI. Effect sizes for these measures revealed strong association. No other significant differences were observed for other measures, although the SDMT and institutional demerits measures demonstrated a small effect size with regards to strength of association. Additionally, no significant difference was observed between TBI and recidivism, and a strong association was not identified (Fisher's Exact Test; p = .74, φ = 0.048).

Table 3

Significance tests for categorical variables

Measure	TBI		No TBI		Significance test		Effect size	
	n	*M (SD)*	*n*	*M (SD)*	*t*	*df*	*p*	*d*
CWIT Condition 3	18	62.22 (17.65)	69	52.97 (15.03)	-2.243	85	0.03	0.56
CWIT Condition 4	19	74.16 (14.35)	69	64.80 (16.05)	-2.3	86	0.02	0.61
BADS DEX	19	15 (9.07)	71	15.80 (9.13)	0.341	88	0.734	0.09
PMT	20	3.85 (2.74)	71	3.7 (3.03)	-0.213	89	0.832	0.06
Ruff 2 & 7	19	94.40 (4.17)	69	94.72 (5.09)	0.265	86	0.792	0.07
SDMT	20	45.45 (6.77)	71	47.24 (8.51)	0.865	89	0.389	0.24
TMT Trial A	20	29.35 (9.22)	71	28.70 (10.21)	-0.255	89	0.799	0.07
TMT Trial B	19	85.37 (33.12)	70	81.49 (42.57)	-0.368	87	0.714	0.10
SSI-SA	20	1.45 (1.82)	66	1.65 (1.97)	0.407	84	0.685	0.11
Institutional Demerits	20	5.15 (7.07)	55	3.75 (4.52)	-1.014	73	0.314	0.24
BDI-II	20	11.3 (6.06)	70	10.14 (6.82)	-0.685	88	0.495	0.18

Note. CWIT = Color-Word Interference Test, PMT = Porteus Maze Task, Ruff 2&7 = Ruff 2&7 Controlled Search accuracy Test, SDMT = Symbol Digit Modalities Test, SSI-SA = Simple Screening Instrument for Substance Abuse, BDI-II = Beck Depression Inventory – II, BADS DEX = Behavioral Assessment of the Dysexecutive Syndrome, TMT = Trail Making Test.

Discussion

The current study evaluated the criterion-related validity of the OSU-TBI-ID, and aimed to contribute to and update the current literature on the psychometric properties of this self-report measure among a criminal justice sample. It was hypothesized that TBI would relate to executive functioning difficulties, substance use problems, psychiatric difficulties, institutional misconduct, and recidivism. Results indicated a strong relationship between TBI and disinhibition (i.e., CWIT Conditions 3 and 4). This result is in line with previous literature demonstrating executive functioning deficits subsequent to a TBI, which may be especially relevant with regards to disinhibition in justice-involved individuals (Clark et al., 2012; Rochat et al., 2013). Notably, both the SDMT and the number of institutional demerits demonstrated small effect sizes in relation to TBI, which could be evidence of potentially meaningful associations between TBI and both general cognitive impairment and institutional misconduct in this sample.

Unfortunately, statistically significant relationships with regards to TBI and other measures of executive function (i.e., PMT, SDMT, TMT, Ruff 2 & 7 and the BADS DEX) were not identified in the current study. Statistical associations between TBI and measures of substance abuse (SSI-SA) and psychiatric difficulties (BDI-II) were also absent in this study. The lack of statistically significant relationships between TBI and these common outcomes of TBI was unexpected. Research has demonstrated a higher probability that an individual within the criminal justice system who has sustained a TBI may be more prone to development of substance use disorders and psychiatric difficulties, which in turn may impact upon their ability to successfully adhere to and complete treatment programs (Piccolino & Solberg, 2014; Slaughter et al., 2003). Furthermore, institutional misconduct and recidivism were not found to be significantly related to TBI. This was also an unexpected finding, and contradicts prior research which demonstrates an

association between a history of TBI and the likelihood of increased institutional misconduct and recidivism (Clark et al., 2020; Ray & Richardson, 2017).

There are however several limitations inherent in this study design which could potentially explain these unexpected findings. Firstly, this study involved a small sample size; 95 individuals consented to participate in the original study, which is relatively smaller than that of other studies which utilized the OSU-TBI-ID within a criminal justice sample (i.e., Bogner & Corrigan, 2009, n = 210; Ferguson et al., 2012, n = 636; Ray et al., 2014, n = 831). There are also characteristics of the sample which could impact upon the ability to generalize to the broader criminal justice population. This study was conducted at a single site, which was a private, minimum security prison, housing inmates transferred from federal correctional facilities. Criminal histories of the participants excluded arson and sexual offenses. The current study sample demographics also differed somewhat from general criminal justice population demographics around the time which the study was conducted with regards to age and cultural identity, and this study only included males. Future research may improve upon the current study by including larger, more demographically diverse samples, from multiple sites which closely approximate the criminal justice population at the local, state, and federal level, in addition to inclusivity regarding pre-trial, post-conviction, probation and parole populations.

Additionally, the prevalence of TBI in this sample was relatively low (21%) compared to that of other samples investigating TBI in criminal justice populations (i.e., 25-87% [CDC, 2013] and 48-72% [Shiroma et al., 2010]). The prevalence of TBI observed in the current sample may be explained by the study design; psychiatric and physiological exclusion criteria, in conjunction with how TBI was operationalized in the current study, may be driving this relatively low rate. Individuals were screened positive for a TBI in this study only if this injury resulted in loss of

consciousness greater than 30 minutes (a moderate to severe TBI), which is a more stringent definition of TBI in line with the OSU-TBI-ID manual. However, this definition sacrifices inclusion of milder forms of TBI wherein there is altered consciousness, or loss of consciousness less than 30 minutes.

Relatedly, the disparity in definitions of TBI across studies, screening methods, differing sample demographics and categorization criteria of injury severity has likely contributed significantly to the wide range estimated for the prevalence of TBI in criminal justice populations. Specifically, prior research administering the OSU-TBI-ID in incarcerated populations has estimated TBI prevalence to be 78% (Bogner & Corrigan, 2009), 68% (Ferguson et al., 2012), 35.7% (Ray et al., 2014), and 35.8% (Ray & Richardson, 2017). Two studies categorized TBI history as inclusive of "possible, mild, moderate and severe TBI," in samples of male participants (Ray et al., 2014; Ray & Richardson, 2017). Bogner and Corrigan (2009) included both male and female prisoners, and TBI history included altered consciousness, loss of consciousness below 30 minutes, and loss of consciousness greater than 30 minutes. Ferguson et al. (2012) used the criteria of "altered consciousness" in ascribing a diagnosis of TBI, and included a sample of both males and females who were pending imminent release, just granted parole release, and long-term inmates who were sentenced to life or death. Therefore, the variation in TBI prevalence across studies may be explained by the disparity in categorization of TBI, different sample characteristics, and variable assessment techniques.

Research has demonstrated the potentially worsening effects of TBI longitudinally (Finnanger et al., 2013; Kashluba et al., 2004). Within this sample, the average time since last injury was 8.3 years. Another avenue for future research could be to investigate the latency of TBI symptom manifestation and how these symptoms may affect the validity of this measure within

this population, wherein the injury itself may impede accurate data collection due to the plethora of cognitive difficulties which occur subsequent to a TBI.

Unfortunately, offense type and severity and their potential relationship with TBI outcomes could not be determined in the current study. The variable for recidivism was collapsed into a dichotomous "yes" or "no" variable, reflecting if the individual has repeat offended or not. More specified information pertaining to the nature and severity of repeat offenses were not available for analysis, which may be important to further investigate the impact TBI and subsequent sequalae has on offense type and severity (Matheson et al., 2020; Ray et al., 2014). Further, recidivism data was also limited by the lack of specific time at risk in the archival dataset; although the period of 1-2 years seen in the current study spans relatively common outcome periods used in recidivism research, not knowing the exact time at risk in the community for each participant limits an understanding of how comparable the current results are to other recidivism research more directly. Future research should aim to include specification of offense types in analyses to investigate the impact of TBI on types and rates of recidivism.

The current study used a dichotomous definition of TBI. Statistically, this method was selected as it was more straightforward, and was proposed as a preliminary analysis from which more sophisticated statistical analyses can be conducted. Prior research conducted more intricate statistical analysis when investigating the criterion-related validity of the OSU-TBI-ID, and evaluated which specific indices of this instrument are most predictive of common TBI related sequalae (Bogner & Corrigan, 2009). Future research would benefit from taking this same approach, as identification of specific summary indices (e.g., age at first TBI, number of TBIs sustained, and symptoms persisting) which are most predictive of negative TBI-related sequalae could be beneficial for specific treatment and rehabilitation planning, as they may inform symptom

manifestation and signal the need for more specialized treatment approaches. More intricate statistical analyses, such as regression modeling, would be beneficial in investigation of specific summary indices of the OSU-TBI-ID and their ability to predict common cognitive and behavioral outcomes of TBI.

Construct validity of the OSU-TBI-ID method was also assumed for the current study, wherein it was assumed that the instrument itself is accurately measuring the construct of TBI. Research has demonstrated the promising psychometric properties of the OSU-TBI-ID in substance abuse and offender populations, in that this instrument has effectively elicited a history of TBI in these samples in a reliable and valid way (Bogner & Corrigan, 2009; Corrigan et al., 2012). For the sake of parsimony, and to focus on criterion validity evidence, construct validity specifically was not evaluated within the current study. Future research should evaluate both the construct and criterion validity of this instrument within a criminal justice population, in order to add to the literature surrounding psychometrics and self-report measures.

There are also some issues inherent in this tool with regards to TBI assessment, concurrent with the general problem of lack of standardization in classification of TBI. For example, this tool does not capture information related to PTA, nor does it differentiate between complicated versus non-complicated TBI, both of which have important implications for prognostication and, ultimately, treatment planning (Finnanger et al., 2013; Kashluba, et al., 2008). Prior research indicates that the OSU-TBI-ID should be used in conjunction with other measures of cognitive impairment to increase diagnostic accuracy (Glover et al., 2018).

Self-report measures are considered best practice in capturing an individual's lifetime history of TBI within a criminal justice population, as there may be no documented evidence of TBI history given the fact that most individuals in this population may not seek medical attention

subsequent to a head injury (Setnik & Bazarian, 2007). The OSU-TBI-ID has many advantages for assessing TBI in a criminal justice population, given the short administration time, unambiguous language and definitions, and ability of the tool to elicit recall for TBIs which have not received medical attention. The OSU-TBI-ID has been used to collect a lifetime history of TBI within criminal justice samples, despite the lack of robust research investigating the psychometric properties of this instrument within a criminal justice population. The current study aimed to address this gap, by investigating the criterion-related validity of the instrument within a specific criminal justice sample. Future research should continue to contribute to the investigation of reliability and validity of this tool within a range of criminal justice samples and settings, and employ more intricate statistical designs and analyses.

In order to begin to develop a component of the criminal justice system which can better serve individuals who have suffered a TBI, a method of identifying a lifetime history of TBI is the obvious first step. This can be used at entry points to the criminal justice system, such as incarceration, probation, or re-incarceration, in order to continually assess the diverse and continually evolving needs of individuals who have sustained a TBI. A known history of TBI can inform correctional staff's management of individuals with TBI. Prison protocols might involve robust education on the manifestation of TBI symptoms for correctional staff, and individuals with a known history of TBI should be placed within specialty caseloads, involving supervision by individuals who are trained in management of co-occurring disorders such as substance abuse or psychiatric disorders, who can also craft appropriate treatment programs. Programs tailored to individuals with TBI can be characterized by patience and flexibility, to ensure the deficits in adaptive functioning exhibited by inmates with a history of TBI are being understood and accounted for. More structured assistance and informed methods of interaction which take into

account each individual's unique symptom manifestation can help ensure an individual with TBI is benefitting from treatment programs as much as possible.

Conclusion

Ultimately, this study aimed to contribute to the literature surrounding identification of TBI in criminal justice populations, by investigating the validity of a promising TBI identification tool within a sample of incarcerated men. The prevalence of TBI in criminal justice populations is significantly higher than that of the general population; despite this, research thus far has been sparse in identifying reliable and valid tools for use within incarcerated samples, thus impeding progress in crucial program modifications and improvements. The field should attempt to move towards a more standardized and psychometrically sound way of investigating the prevalence of TBI in prison populations in order to collate a more accurate estimate of the prevalence of TBI. This can inform rehabilitation and treatment, and allow for more efficient resource allocation and informed treatment protocols for individuals with a lifetime history of TBI. Ultimately, the goal is to advance towards successful community reentry, lowering the likelihood of recidivism and future contact with the criminal justice system for more inmates, and cultivation of a healthier, safer society.

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