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The Relationship Between Traumatic Brain Injuries, Impulsivity, and Crime

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Abstract

The rate of traumatic brain injuries (TBIs) are increasing each year, impacting an estimated 1.4 million Americans. After further investigation, researchers have concluded that 8.5% of the general public sustains at least one TBI, whereas this number ranges from 25% to 87% in criminal populations. In the literature, impulsivity is frequently described as poorly conceived, prematurely expressed, or inappropriate behaviors. Additionally, poor impulse control has been shown to significantly impact the likelihood of criminal activity, increasing the rate of recidivism. The current study examined an archival dataset of 95 incarcerated individuals from a private correctional facility in a large mid-Atlantic state. The dataset was used to measure TBI and impulsivity related to crime. Since the severity of a TBI is important, an analysis examined moderate or severe TBIs to determine if there was a significant relationship to impulsivity and crime. Although the current study did not support every hypothesis, there was a significant and meaningful difference in impulsivity between the groups where a TBI was present, compared to when a TBI was not present. This finding suggests that individuals with moderate or severe TBIs are more likely to display problems associated with impulsivity. As such, the relationships among TBI, impulsivity, and crime clear merit further scientific study, with the ultimate goal of informing clinical practice and criminal justice policy.

Keywords: traumatic brain injury, impulsivity, crime, recidivism

The Relationship Between Traumatic Brain Injuries, Impulsivity, and Crime

In recent years, the topic of traumatic brain injury (TBI) is a growing topic in the field of neuropsychology. According to the Centers of Disease Control and Prevention (CDC; 2015), a TBI is a direct result from a significant bump, blow or jolt to the head or a penetrating head injury that disrupts the normal function of the brain. A TBI resulting from such injuries are typically categorized in severity ranging from mild (a brief change in mental status) to severe (prolonged state of unconsciousness or amnesia; Ray & Richardson, 2017). Higher levels of severity are associated with more significant alteration in brain function which ultimately causes additional harmful neuropsychological consequences (Eme, 2014). When measuring the frequency of TBI, in the United States alone, it is estimated that 1.4 million individuals sustain at least one TBI each year (Shiroma, Ferguson, & Pickelsimer, 2010). With the inclusion of gender, men significantly report higher rates of sustained TBIs compared to women. This statistic is significant when determining the prevalence rate of TBI in the prison population.

One-third of young men in the general population have reported sustaining a TBI by the age of 25. This number is proportionate to the high prevalence rate of reported TBIs in criminal populations since men make up the majority of incarcerated individuals (Farrer & Hedges, 2011). While some studies have found that the rate of TBI in a general population is estimated at 8.5%, when looking at incarcerated populations, this rate significantly increases to an estimated 25% and 87% (Ray & Richardson, 2017). To better understand this discrepancy, researchers have investigated the different cognitive consequences of TBI that may suggest why the percentages in the criminal population are significantly higher when compared to the general population.

Brain and Behavior

There is a fundamental connection between the brain and behavior, and Bechara & Linden (2003) suggests that while individuals can recover from TBIs, as a result, many individual's personality and social behaviors change. Biologically, when certain parts of the brain are damaged (i.e., the frontal lobe, prefrontal cortex, and temporal lobes), this impairs judgment, reasoning, impulse control, and attention (Ray & Richardson, 2017). When there is a loss of frontal lobe inhibition in the subcortical limbic structures, behavioral dysfunction is impacted. As a result, levels of aggression and impulsivity increase, resulting in frequent antisocial and criminal behavior (Greve, Sherwin, Stanford, Mathias, Love, & Ramzinski, 2001). Similarly, the prefrontal cortex can be closely associated with violence and aggression. When this area is injured, researchers have suggested that this significantly increases antisocial behavior, which can lead to frequent incarceration (Ray & Richardson, 2017). Since there is a connection involving violence, aggression, and social behavior with brain injuries (Grafman et al., 1996), it is important to understand these different relationships and how it impacts behavior.

Although researchers have investigated the relationship between brain and behavior, one study found that brain injuries were not directly responsible for impulsive aggression; however, the TBI acted as a catalyst that released the already present impulsive aggressive tendencies into action (Greve et al., 2001). Since these issues are directly related to the field of forensic neuropsychology, this arena of research is essential to further investigate the impacts of brain and behavior as it pertains to crime. Therefore, to fully understand this impact of TBI on criminal behavior, research should also focus on the adverse effects closely related to cognitive consequences (e.g., impulsivity, inattention, and aggression).

Impulsivity and TBI

Since there is a lack of research regarding TBI, few researchers have explored the particular relationship between impulsivity and TBI. However, the field of forensic neuropsychology is shedding light on this growing epidemic. Existing research defined impulsivity as an umbrella term that covers widespread actions widely referred to as poorly conceived, prematurely expressed, or inappropriate to the situations, which often results in unwanted consequences (Rochat, Billieux, Gagnon, & Van der Linden, 2018). Prior research on the components of impulsivity suggested it involves: attentional impulsiveness (the ability to focus and maintain cognitive instability), motor impulsiveness (spur of the moment acting and perseverance), and non-planning (the ability to maintain self-control and cognitive complexity; Whiteside & Lynam, 2001). However, current researchers suggest there is a better way to assess and categorize impulsivity. Self-reported impulsivity measures have been created to be a predictive measure when specifically looking at drug use, sexual behavior, antisocial acts, and crime. Higher scores of impulsivity suggested higher risk-taking behaviors, which increased the likelihood of ending up in the criminal justice system (Reynolds, Basso, Miller, Whiteside, & Combs, 2019).

Although there are different ways to measure impulsivity, the Urgency Premeditation Perseverance Sensation Seeking (UPPS) model integrated past theories typically used in research to measure evaluating inhibition. The UPPS identified four distinctive dimensions of impulsivity: (1) Urgency, defined as the tendency to experience intense reactions in negative situations; (2) (Lack of) premeditation, defined as the tendency to disregard potential consequences; (3) (Lack of) perseverance, defined as the ability to remain engaged during tedious or difficult times; and (4) Sensation seeking, defined as the tendency to engage in new or exciting activities (Rochat et al., 2018). However, a shortened version of the UPPS was created as a means to expedite the

assessment process while more accurately assessing impulsivity in sustained TBIs (Rochat, Beni, Annoni, Vuadens, & Linden, 2013). Similarly, a benefit to this shortened version was that the patients and their families had an easier time completing the questionnaire. Unlike other assessments, these questions were a straight forward 4-point Likert scale, assessing both the pre-morbid and the current state (Rochat et al., 2010). Therefore, like the full UPPS, this model still incorporated the four distinct facets of impulsivity, which lead to a better comprehension of related impulsive behaviors after the occurrence of a TBI (Rochat et al., 2010). The shortened version of the UPPS allowed for more accessible assessment, which in turn, made it easier to gather data on individuals with TBIs. Understanding the key components used in the UPPS creates a foundation to further assess impulsivity with various other assessments.

Rochet et al. (2010) concluded that when examining a sample of patients with moderate to severe TBI, there was an increase of impulsivity from the pre-morbid condition. Categories such as urgency, lack of perseverance, and lack of premeditation of the UPPS suggested that TBI is a factor contributing to a change in behavior. However, there was a decrease in the levels of sensation seeking (Rochat et al., 2010). Alternatively, Gordon & Egan (2011) found that low levels of sensation seeking resulted in higher instances of criminal behavior, aggression, and impulsivity. Researchers also suggested that these pathways often lead to unusual expressed antisocial behavior (Gordon & Egan, 2011). Typically, these behaviors resulted in actions that were unlawful, deceitful, aggressive, irresponsible, or manipulative, which lead to the involvement with the criminal justice system (Reynolds et al., 2019). Since there is a limited amount of literature on impulsivity and TBI, further exploring this relationship would increase awareness of these growing issues in the field of forensic neuropsychology.

TBI and Crime

Research examining the relationship between TBI and crime is limited, but several researchers have provided evidence of a relationship between TBI with both violent and non-violent criminal behaviors. Similarly, this relationship suggested that people with TBI display higher rates of violence, aggression, and anger when compared to those without (Turkstra, Jones, & Toler, 2003). Therefore, this association between TBI, aggression, and violence demonstrations a lifetime prevalence of TBI in criminal populations, therein demonstrating there this is a significant risk factor leading to high rates of incarceration (Farrer & Hedges, 2011). This link between TBI and crime also reflected the effects of TBI's cognitive consequences and impairments on behavior. After sustaining a TBI, an individual might falsely perceive situations differently compared to those who have never sustained a TBI. Research has suggested that TBI is likely to result in making poor social judgments, drastically overreacting to situations, or lacking the ability to communicate appropriately, hence resulting in conflicts or impulsive actions (Turkstra et al., 2003). Likewise, impairment of these functions is both directly and indirectly responsible for increasing the likelihood that a person with TBI could be exposed to the criminal justice system and recidivism, ultimately hindering their ability for rehabilitation (Bogner & Corrigan, 2009).

Recently researchers have suggested that criminals who sustain a TBI might have repeated experiences with the criminal justice system, and, as a result, understanding how to screen for TBI is essential in helping to deliver appropriate treatment while incarcerated and post-release (Farrer & Hedges, 2011). Williams et al., (2010) suggested incorporating assessments not commonly used to assess certain variables (e.g., impulsivity) could help explore the relationship to crime and behavior from a different perspective. This method could open the

door to new possibilities that would make it probable to enhance rehabilitation and decrease the likelihood of recidivism.

It is abundantly clear that there needs to be more research addressing the relationship between cognitive consequences and crime. However, there has been no literature explicitly addressing the relationship involved with impulsivity, TBI, and crime. By using a different assessment not previously attributed to this model, hopefully the results can further fill the gaps not previously addressed by prior literature.

Current Study

Studies have shown that the rate of TBI in a criminal population is estimated between 25% and 87% (Ray & Richardson, 2017) however, there is a lack of literature in criminal samples that specifically examine the cognitive consequences of TBI (e.g., impulsivity). Since poor impulse control is a common symptom in patients with TBI (Rochat et al., 2010), the current study hypothesized that there will be a positive significant relationship between TBI severity and impulsivity. Ray & Richardson (2017) also found that 53% of their sample was rearrested between 9 and 700 days after being released. This percentage shows the impact TBI has on recidivism/crime rates. For these reasons the current study also hypothesized that there will be a positive significant relationship between severity of TBI and history of arrests. Although there was prior research conducted on TBI and crime, no studies have been conducted that explicitly examined impulsivity and TBI to find a relationship to crime. Therefore, this study explored the relationship between the aforementioned variable and history of interactions with the criminal justice system, and hypothesized that there is a positive significant relationship between impulsivity and history of arrests. Likewise, the current study will further investigate the relationship between TBI, impulsivity, and history of arrest together in a multivariate model.

The main purpose of this study is to shed light on the growing issue related to TBI, impulsivity, and crime, by building upon the prior literature and analyzing the variables in different ways. In particular, this includes the operational definitions and assessments to determine the relationship among TBI, impulsivity, and crime.

Method

Design

The current study incorporated archival data pulled from a larger project that investigated neuropsychological assessments to predict antisocial behavior. The results of that particular study are presented elsewhere (LaDuke, 2016) and do not significantly overlap with the current study's interest. To further investigate the impact of impulsivity and TBI on crime, the current study analyzed the participant's results on assessing TBI, measuring impulsivity, and establishing if there will be a relationship to history of arrests.

Participants

The original sample of the data was collected from a private, community-based correctional facility located in a Mid-Atlantic state between February 2014 and April 2015. A total of 217 individuals were asked to volunteer in the study; however, only 122 individuals were successfully recruited. Of these individuals, 100 successfully consented to participate. Unfortunately, only 95 of the participants followed up with the study and completed both sessions 1 and 2. A demographic questionnaire was administered to address the participants' age, gender identity, cultural identity, spoken languages, and educational level.

The sample included 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%),

including Ethiopian (n = 1, or 1%), Indigenous Indian (n = 1, or 1%), Irish (n = 1, or 1%), Italian (n = 1 or 1%), Jamaican (n =1,or 1%), Mixed (n = 1 or 1%), Puerto Rican (n = 1, or 1%), and Sicilian (n = 1, or 1%). The average age of the participants was 33.71 years old (SD = 10.75). Some participants identified themselves as right-handed (n = 74) whereas others identified themselves as left-handed (n = 10).

Thirteen (14%) participants identified themselves as having a diagnosis of a mental illness. These included: 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), and a current tic disorder (n = 1, or 1 %).

The inclusion criterion of the initial data was a resident of the facility, and they had to be preparing for re-entering into the community following their incarceration. The exclusion criterion was being a woman; placement in the facility following a violation of parole; having a diagnosis of a major psychotic or mood disorder; vision disability/blindness; deafness; extreme impairment; and lack of ability to comprehend spoken or written English.

Procedure

Individuals at the correctional facility were randomly selected and invited to participate in the original study that collected the data (LaDuke, 2016). There was no compensation and all interested individuals were volunteers. These individuals received a brief screen to ensure admissibility for the study. Individuals who consented were verbally administered a demographic questionnaire and completed a screening measure for reading level (WRAT4 Word Reading subtest) to ensure that they meet the eligibility criteria. Participants who met the inclusion criteria were then administered a battery of neuropsychological and clinical measures.

Graduate-level research assistants with significant training and experience related to the measures administered the battery with a high level of competency and completed data collection for the study. A team of board-certified forensic psychologists and neuropsychologists were responsible for the training and supervision. The quality assurance was completed by the original study on all scores during the data entry. Neuropsychological and clinical measures were administered in a randomized order to ensure participant motivation, reactivity, and withdrawal were balanced throughout the measures. Participant performance validity was also measured through behavioral observations.

For the use of the current study, four graduate students and one undergraduate student from John Jay College of Criminal Justice converted all original raw data into an electronic database. To account for internal consistency, data was double coded and later compared.[1]

Measures

Participants were originally administered a battery of demographic, neuropsychological, and clinical measures (LaDuke, 2016). The current study focuses on the following measures.

Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID)

The OSU TBI-ID is a measure that screens for the history and severity of TBI (Corrigan & Bogner, 2007). Incidences include TBI with loss of consciousness, age of first TBI, worst impact, and mild repeated injuries. The OSU TBI-ID exhibits a good inter-rater and test re-test reliability. Prior research also demonstrated that the OSU TBI-ID has good predictive validity with measuring cognitive performances, as well as good reliability and predictive validity of misconduct within incarcerated samples (Bogner & Corrigan, 2009).

[1] Prior to final dataset being developed, it couldn't be finished due to the COVID-19 outbreak. The current dataset was not final, but steps were taken to excluded inconsistencies between the variables.

To test the different hypotheses, TBI history and severity was measured in two ways. When running correlations, TBI worst injury was scored on a continuous scale from 1 to 5 (1 = no TBI, 2 = mild TBI without loss of consciousness, 3 = mild TBI with loss of consciousness, 4 = moderate TBI, and 5 = severe TBI). Research also suggests that when looking at the symptoms and impairment related to TBIs, moderate-to-severe TBIs are more likely to result in lifelong impairment and decreased functioning, while no-to-mild TBIs can return back to normal fairly quickly (McGarity et al., 2019). For this reason, the worst TBI was also operationalized as a dichotomous variable: whether a participant had sustained a moderate or severe TBI compared to if they had not (0 = no and 1 = yes). Both of these conceptualizations of TBI history and severity have been validated in prior research with general populations (Corrigan & Bogner, 2007) and justice-involved individuals (Bogner & Corrigan, 2009).

Color-Word Interference Test *(CWIT)*

The CWIT is a measure of processing speed and impulsivity included in the Delis-Kaplan Executive Functioning System (DKEFS; Delis, Kaplan, & Kramer, 2001). Specifically, the CWIT measures color naming (condition 1), color-word reading (condition 2), inhibition response (condition 3), and the ability to switch between rules (condition 4). Age-stratified standard scores are derived from the total completion time and the total resulting errors from the different conditions. For the purpose of this study, standard scores from condition 3 were used to measure the participant's impulsivity, and lower scores suggested higher impairment. Standardized scores were used to measure impulsivity because a standardization already exists and there are concerns regarding using raw scores since there is no representation involving prison populations.

Criminal Justice Involvement

Participant's history of juvenile arrests and dispositions, adult arrests and convictions, juvenile placements, and various other misconducts was coded from their official criminal justice records housed within their institution. To better understand crime, the participant's juvenile and adult arrest history were combined for an overall raw score to measure their involved with the criminal justice system.

Statistical Analysis Approach

For the current study, there were three different approaches used to test the hypotheses. Correlations were used to quantify the degree to which the different variables were related. Through a correlation analysis, the current study was able to examine the correlation coefficients that described how much one variable changed in accordance with the other. This analysis was determined to be effective when looking at the relationships between TBI worst injury, impulsivity, and overall history of arrests.

The current study used an independent samples t-test to further investigate difference in individuals, by comparing two independent groups. Likewise, an analysis of covariance (ANCOVA) was chosen to analyze covariance by testing the main interaction effects of impulsivity by overall history of arrests, with TBI worst injury.

For the purpose of this study, all hypotheses were interpreted based on a significance level of $p < 0.05$. No corrections were made to correct for the inflated risk for a type 1 error due to the exploratory nature of these analyses.

Results

Hypothesis 1: There will be a significant positive correlation between TBI severity and impulsivity. A Pearson's correlation was used to measure the relationship between the

severity of TBI severity (n = 88, M = 2.6, SD = 1.23) and impulsivity (n = 88, M = 10.09, SD = 5.42). Results using a one-tailed test showed no significant association between the two variables, r = -.157, n = 85, p = .076, r^2 = .02 (small effect). Consequently, these results suggest that there was no significant correlation between the TBI severity and impulsivity in this sample.

Hypothesis 2: There will be a significant positive correlation between TBI severity and overall history of arrests. A Pearson's correlation was used to determine the relationship between the TBI severity (n = 88, M = 2.6, SD = 1.23) and the overall history of arrests (n = 79, M = 16.06, SD = 12.78). Results using a one-tailed test showed no significant association between the two variables, r = .117, n = 76, p = .157, r^2 = .01 (small effect). These results suggest that there was no significant correlation between TBI severity and the overall history of arrests in this sample.

Hypothesis 3: There will be a significant positive correlation between impulsivity and overall history of arrests. A Pearson's correlation was used to determine the relationship between impulsivity and overall history of arrests. The results indicated that there was no positive significant correlation at the 0.05 level between the variables (r = .186, n = 78, p = .052, r^2 = .03 (small effect). This suggests that there was no significant relationship between impulsivity and overall history of arrests in this sample.

Hypothesis 4: There will be a relationship between impulsivity and history or arrests, adjusting for TBI severity. Since there were no significant findings after running the correlation between impulsivity and history of arrests, running a partial correlation between impulsivity and history of arrests while adjusting for TBI severity was not justified.

Hypothesis 5: There will be a significant difference in impulsivity between a group with no/dazed/mild TBI and a group with moderate/severe TBI. An independent samples t-

test compared impulsivity between participants with a history of no/dazed/mild TBI (n = 64, M = 10.65, SD = 5.82) and moderate/severe TBI (n = 18, M = 8.11, SD = 3.69). Since the Levene's Test was not significant (F = .109, p = .742), equal variances were assumed. There was a significant and meaningful difference in impulsivity between groups, $t(78) = 1.744$, $p = 0.042$, d = .52 (medium effect). This provides support for the hypothesized relationship between TBI and impulsivity.

Hypothesis 6: There will be a significant difference in overall history of arrests between a group with no/dazed/mild TBI and a group with moderate/severe TBI. An independent samples t-test compared overall history of arrests between participants with a history no/dazed/mild TBI with moderate/severe TBI. The Levene's Test was not significant (F = .499, p = .482), equal variances were assumed. No statistically significant difference in overall history of arrests was found between groups, $t(69) = .782$, $p = .218$, although the effect size (d = .22) suggest a small practical significance between these variables.

Hypothesis 7: There is a significant effect of impulsivity on overall history of arrests when controlling for TBI severity. Despite the significant findings above, given the lack of significance between impulsivity and overall history of arrests, it was determined that there were not sufficient significant results to justify further analysis.

Discussion

The current study aimed to provide insight into the relationships among TBI, impulsivity, and crime. Since prior research has suggested that people in the criminal justice system have higher rates of TBI compared to the general public (Turkstra et al., 2003), a model was created connecting TBI, impulsivity, and crime. Building from the literature, the current study investigated these relationships by running correlations between each set of variables (i.e., TBI

and impulsivity, TBI and arrests, and impulsivity and arrests). Despite the strong theoretical assumptions, the results of the current study did not line up with prior research; however, it is evident that results might be different if tested in a different manner. Perhaps when examining these relationship, analyzing TBI differently (age at first TBI, number of TBIs, or repeated TBIs) would change the results.

Relatedly, the second approach taken by the current study suggests that there is a deeper connection between TBI, impulsivity, and arrests; unfortunately, the current study's approach did not fully depict this relationship properly. However, similar to previous literature, we were able to determine that people who have sustained a moderate or severe TBI are more likely to have problems related to impulsivity. Since this degree of severity has a greater impact on the brain when compared to no TBI or lower severity TBIs, it makes sense that individuals with moderate or severe TBIs are more likely to display problems with impulsiveness (Rochat et al., 2010). Though there were significant results between impulsivity and TBI, why wasn't there any significance between TBI and overall arrests?

When looking at how the current study quantified TBI related to arrests, maybe the wrong approach was taken. Since research suggests that there is a significant relationship between TBI and crime, maybe to successfully find significance, crime needed to be operationalized differently. For instance, frequent interactions with the criminal justice system is important to look at when considering TBI and impulsivity, but maybe the current study should have focused on the total number of convictions since the literature suggests a high number of incarcerated individuals have reported significantly high rates of TBIs. Overall, although there was strong theoretical evidence that would have supported all, if not most of the current study's hypotheses, there are a few reasons/limitations for why we did not find significance.

Limitations & Implications for Future Research

When considering the sample size, a large sample size should hypothetically lead to more accurate and representative results. Therefore, one limitation of the current study could be the limited number of participants that were recruited for the initial dataset. A second limitation could be the actual sample. Although the sample did consist of individuals in a correctional facility, it can be seen as a biased sample. The participants were held in a two-year, minimum security facility, and half of the total number of individuals approached declined to participate.

A third limitation of this study can include the particular assessment that was used and the specific population. The Color Word Interference Test was used to measure impulsivity, which was then converted into a standardized score. Although this assessment has been used in prior research to measure impulsivity, the population that the standardized score was normed on does not accurately reflect the prison population (LaDuke, DeMatteo, Heilbrun, Gallo, & Swirsky-Sacchetti, 2017). Because of this limitation, the scores were not normed on a sample similar to our participants, therefore this lowered the strength of the scores.

While this study's results only supported one of the hypotheses, there is strong evidence from the literature to support an important relationship between TBI, impulsivity, and crime. As previously mentioned, since researchers have suggested that impulsivity is a prominent cognitive consequence of TBI and a large percentage of people in the prison population have sustained a TBI, future researchers need to explore these relationships further. In particular, when moving forward, researchers need to consider involving a larger sample size to produce more accurate results. Also, since the current study used an assessment that could not accurately represent the prison population, it is important that future researchers should consider utilizing an assessment that targets a diverse population similar to the demographic of the criminal justice system.

Conclusion

In conclusion, the current study investigated the relationships of TBI, impulsivity, and crime in an incarcerated sample. All but one of the hypotheses did not offer any statistical significance. However, a relationship was determined between impulsivity and the severity of TBI. Regardless of the findings found by this research, the purpose of this study was to shed light on the growing issue of TBI in the criminal population in the hopes that future researchers will acknowledge there needs to be more research conducted on the relationship between TBI, impulsivity, and crime. With sufficient research on this topic, the research could be implemented to aid in policy-making and other social services. Through this process, parole officers or other officials could acknowledge that screening for high levels of impulsivity could explain why an individual is behaving a certain way. Likewise, within policy-making, resources can be allocated to screen for both TBI and impulsivity to develop case management to aid in assimilating these individuals back into society. Additional research could potentially support similar hypotheses and suggest that by taking measure to help people who have sustained a TBI, this could help lower their criminal justice involvement.

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