Scientific Research Publishing

Journal of Behavioral and Brain Science, 2019, 9, 289-299
http://www.scirp.org/journal/jbbs
ISSN Online: 2160-5874
ISSN Print: 2160-5866

Traumatic Brain Injury in Prisoners: Relation to Risky Decision-Making, Aggression and Criminal Behavior

Niki C. Kuin[1,2*], Erik J. A. Scherder[2], Hanneke Gijsbers[1], Erik D. M. Masthoff[1]

[1]Penitentiary Institution Vught, Vught, The Netherlands
[2]VU University, Department of Clinical Neuropsychology, Amsterdam, The Netherlands
Email: *n.kuin@dji.minjus.nl

How to cite this paper: Kuin, N.C., Scherder, E.J.A., Gijsbers, H. and Masthoff, E.D.M. (2019) Traumatic Brain Injury in Prisoners: Relation to Risky Decision-Making, Aggression and Criminal Behavior. *Journal of Behavioral and Brain Science*, **9**, 289-299.
https://doi.org/10.4236/jbbs.2019.97021

Received: June 14, 2019
Accepted: July 12, 2019
Published: July 15, 2019

Abstract

The objective of this cross-sectional study was to investigate if Traumatic Brain Injury (TBI) is related to decision-making deficits as well as to heightened levels of (reactive) aggression and criminal behavior in a group of Dutch male prisoners. Characteristics of aggression were assessed using three self-report questionnaires as well as systematic staff observations, complemented with data from criminal records. A semi-structured interview was conducted to rate lifetime prevalence of TBI and the Iowa Gambling Task (IGT) was completed to assess risky decision-making. Out of the total of 133 participants, 74 (55.6%) reported having sustained one or more incidents with potential TBI. Statistical comparisons between offenders with and without TBI indicated that the offenders with TBI reported significantly higher levels of (reactive) aggression on two out of three questionnaires than offenders without TBI (p-values ranging from 0.003 to 0.008), but no significant differences were found on staff observations of aggression and on the IGT. The higher conviction rates in offenders with TBI compared to the non-TBI group showed a trend. The confirmed relationship between TBI and higher aggressive tendencies is especially relevant for forensic populations due to the high prevalence rates of TBI in offenders. How this relates to specific cognitive processes remains unclear. The lack of a statistical difference between offenders with and without TBI on the IGT is in contrast with literature in non-offender samples, but seems to be in line with other studies in forensic populations.

Keywords

Aggression, Prisoners, Traumatic Brain Injury, Decision-Making, Iowa Gambling Task

1. Introduction

In the last two decades, brain functioning of criminals has frequently been the subject of neuroscientific investigations [1] [2]. This has led to a build-up of knowledge on specific brain regions and neurocognitive and neurochemical processes involved in violent and antisocial traits that characterize criminal behavior [1] [3] [4] [5] [6]. Interestingly, other investigations focussed on the relationship between (the occurrence of) criminal behavior and traumatic brain injuries (TBI) [7] [8]. It has been found that the prevalence of mild TBI in prison populations is high [9], with average rates of 46.0% to 60.3% [10] [11] and peaks up to 94.7% [12]. These numbers clearly exceed the rates of 10.8% to 31.6%, which are found in the general population [13] [14] [15] [16]. A meta-analysis in juveniles revealed that already during adolescence the odds of having sustained mild TBI is 3.38 times higher for offenders than for their non-delinquent peers [17].

Moreover, it was found that having mild TBI is related to the risk of re-offending [7], and is statistically stronger related to the number of prior convictions in offenders than age, a history of a psychiatric disorder, and low education [8]. In addition, there seems to be a link between having sustained mild TBI and increased levels of violence in a forensic sample [18], just as higher levels of aggression have been associated with (mild) TBI in community populations [19].

Both the high prevalence rates of TBI in offenders and its potential relationship to violent tendencies, criminal behavior and re-offending, led us to conclude that TBI is a potential risk factor to consider in prison settings and forensic care in general. However, little is known about how TBI is related to such aggressive and otherwise antisocial behavior. For example, it is important to know which specific neurocognitive difficulties influence the outcome of TBI in offenders on a behavioral level in order to find ways to improve this outcome. Antisocial and aggressive behavior after TBI has often been linked to damage in orbitofrontal and ventromedial regions of the brain [20] [21]. Such brain lesions are associated with problems in neurocognitive functions that are essential for adaptive functioning; the latter is a key aspect in the ability to profit from interventions aimed to prevent recidivism. This includes, for example, deficits in decision-making, and more specific a tendency to take risks and an incapacity to learn from mistakes [21] [22] [23]. These neurocognitive functions are classically assessed with the Iowa Gambling Task [22].

In the present investigation it is examined if offenders with suspected TBI show more decision-making deficits indicating a risky response style than their peers without TBI. A secondary aim was to investigate if there is a relationship between TBI on the one hand and criminal histories and aggression on the other hand. A priori it was hypothesised that, offenders with a lifetime history of TBI would indicate higher levels of (reactive) aggression, higher numbers of prior convictions for (violent) crimes and perform worse on the Iowa Gambling Task compared to offenders without TBI.

This study was part of a larger study on neurocognitive factors associated with aggression in a correctional facility in the Netherlands. TBI was not one of the main topics in that study, but given its clinical relevance, it was decided to share these additional findings in the current brief report.

2. Method

This study was conducted in a prison facility in the Netherlands (Penitentiary Institution Vught) in 2014 and 2015 as part of a larger neuroscientific research. Participants were recruited through posters and letters in different parts of the prison, such as normal prison regimes, specialized wards for repeated offenders and psychiatric care units, thus representing a broad spectrum of the prison population. When interested, they were provided with further written and verbal information about the study and signed informed consent. It was completely voluntarily to take part in the study and no incentives were provided. This study was approved by the Dutch Ministry of Justice and Security with respect to procedural and ethical aspects.

With the use of a semi-structured interview, it was examined if participants had sustained TBI by asking the following questions: "Have you ever sustained a hard blow to your head, leading to a loss of consciousness?" If yes: "how often did this happen?", "what was the cause of the blow to your head?" Furthermore, questions were asked concerning the age of the participant at the time of those incidents, if participants were treated in a hospital for this, how long the loss of consciousness had lasted and if a doctor had ever diagnosed an injury to the brain, and, if so, which type. The answers to those last questions were not included in the statistical analysis, because it appeared that participants found it hard to provide much detail in hindsight, leading to potentially invalid data. The use of a structured interview is regarded as a valid method of assessing lifetime exposure to TBI in prisoners, which has been applied in multiple earlier studies [8] [24] [25].

Hereafter, participants completed a neuropsychological assessment and filled in self-report questionnaires. Decision-making was assessed with a computerised version of the *Iowa Gambling Task* (*IGT*) [22]. In this task, participants are confronted with four packs of cards, and are instructed to select one card at a time with the consequence of winning or losing fictitious money. Advantageous decks give small rewards and small losses, disadvantageous decks give high rewards and high losses. Normal subjects tend to choose randomly at first, but develop a clear preference for safe decks during the final 40 drawings. When such a preference does not become apparent in this stage, this is characteristic of a risky decision-making style [26].

Self-reported aggressive tendencies were assessed with three aggression questionnaires. The 30-item *Impulsive/Premeditated Aggression Scales* (*IPAS*-30) [27] provides a total score and differentiates in two subscales between impulsive and instrumental aggression, just as the 23-item *Reactive-Proactive Aggression*

Questionnaire (*RPQ*) [28]. The shortened 12-item Dutch translation of the *Buss-Perry Aggression Questionnaire (BPAQ-r)* [29] [30] provides a total score and four factor scores: "physical aggression", "verbal aggression", "rage" and "hostility". For each questionnaire applies that higher scores represent more severe characteristics of aggression. The psychometric properties of these three self-report questionnaires are sufficient [31] [32] [33]. In addition, structured observational data on aggressive behavior were gathered during four consecutive weeks. Each week one staff member rated the eleven items of the *Social Dysfunction and Aggression Scale* [34]. Conviction histories were based on criminal records.

For a more detailed description of the procedure and instruments, including their psychometric properties, see Kuin, Masthoff, Munafò, & Penton-Voak [35] and Kuin & Masthoff [36].

3. Data-Analyses

Data were analysed using IBM SPSS Statistics® software, version 22. The level of significance was set at $\alpha \leq 0.01$ to reduce the risk of a Type-I error due to multiple analyses. The study data were analysed by dividing all participants into two groups: one with a history of suspected TBI and one without. Groups were then compared on measures of decision-making, aggression and criminal histories using either t-tests or non-parametric Mann-Whitney U tests (when the assumptions of normality were not met). Three participants in the TBI group and five in the non-TBI group dropped out of the study after the initial semi-structured interview. Due to outliers, one participant was left-out of the TBI group before conducting statistical analyses.

4. Results

Out of the total of 133 participants, 74 (55.6%) reported having sustained one or more incidents with potential TBI. 59 Participants (44.4%) reported no history of potential TBI. Within the TBI-group 41 participants (55.4%) reported a history with more than one blow to the head with loss of consciousness. **Table 1** displays the most common causes for brain injuries in the TBI-group.

The characteristics of both study groups and their mean scores on all assessed measures of decision-making, aggression and crime history, as well as outcome of the t-tests and Mann-Whitney U-tests are displayed in **Table 2**. During the study, 11 participants dropped out before completing the questionnaires. Therefore, comparative analyses were performed with a reduced number of participants (54 in the TBI group and 70 in the non-TBI group). There was no meaningful difference between those groups in their educational levels or age. Even though, on average, the TBI group had been convicted for four more crimes in their lifetime than the non-TBI group, differences in the distributions of the conviction rates were not statistically significant. On the self-report aggression measures, the TBI group rated significantly more aggressive tendencies than the

Table 1. Causes of potential TBI.

	n	% of Injuries
Fight	24	25.0
Traffic Accident	22	22.9
Fall	17	17.7
(kick) Boxing	13	13.5
Victim Physical Child Abuse	6	6.3
Soccer Accident	4	4.2
Other	10	10.4

Table 2. Group characteristics, mean aggression scores, criminal histories and scores on the IGT of offenders with suspected mild TBI (n = 70) and offenders without suspected TBI (n = 54) and outcome of group comparisons using t-tests or Mann-Whitney U tests.

	TBI Group Mean (*sd*)	Non-TBI Group Mean (*sd*)	*p* ($\alpha = 0.01$)
Age	36.16 (10.81)	36.91 (12.36)	0.72
Level of education[1]	3 (1 - 5)	4 (1-6)	0.90[a]
Lifetime number of convictions	23.33 (22.19)	19.64 (18.46)	0.42[a]
Lifetime convictions for violent crimes	4.23 (3.72)	3.72 (3.46)	0.39[a]
Lifetime convictions for non-violent crimes	19.10 (20.76)	16.00 (17.30)	0.51[a]
IPAS-30 impulsive aggression scale	24.31 (9.97)	24.59 (6.89)	0.85[b]
IPAS-30 instrumental aggression scale	20.21 (7.93)	20.75 (5.92)	0.66[b]
IPAS-30 total score	73.99 (23.18)	74.03 (17.09)	0.99[b]
RPQ proactive aggression scale	6.31 (5.96)	4.72 (4.55)	0.11
RPQ reactive aggression scale	10.78 (5.21)	8.17 (4.65)	0.005*
RPQ total score	17.09 (10.81)	12.87 (8.58)	0.021
BPAQ-r physical aggression scale	8.19 (3.66)	7.11 (3.58)	0.10
BPAQ-r verbal aggression scale	6.20 (2.41)	5.19 (2.26)	0.008[a]*
BPAQ-r rage scale	6.80 (3.24)	5.17 (2.65)	0.003*
BPAQ-r hostility scale	7.32 (3.27)	6.63 (3.21)	0.24
BPAQ-r total score	28.90 (10.18)	24.09 (9.09)	0.007*
Mean SDAS total score from 4 ratings	3.40 (3.33)	3.08 (3.31)	0.47[a]
IGT score block 4	4.24 (9.73)	1.77 (10.88)	0.19
IGT score block 5	1.88 (11.43)	3.40 (10.28)	0.45
IGT NET Total score	10.24 (31.73)	8.68 (35.59)	0.80

Note. [1]Educational level was based on the classification system of Verhage (1964) [37] in Dutch education with 6 levels of education: 1) not graduated from primary school, 2) only graduated from primary school, 3) vocational education, 4) secondary vocational education, 5) higher vocational education, 6) academic education. Median scores and ranges are displayed instead of means and standard deviations. [a] based on Mann-Whitney U-test instead of t-test, [b] with correction for significant Levene's statistic, * statistically significant at $\alpha \leq 0.01$.

non-TBI group on the RPQ-r reactive aggression scale ($p = 0.005$), as well as the BPAQ-r verbal aggression scale ($p = 0.008$), the BPAQ-r rage scale ($p = 0.003$), and the BPAQ-r total score ($p = 0.007$). No significant differences between the groups were found on the IPAS-30, and other scales of the RPQ and BPAQ-r. In addition, ratings from staff members on aggressive behavior during the past four weeks, were not significantly higher for the TBI group compared to the non-TBI group, and neither were measures of risk taking on the Iowa Gambling Task.

5. Discussion and Conclusion

The study results show that in a Dutch male prison population, rates of TBI are high and comparable to prevalence rates of TBI in prison populations in other countries [8] [9] [10] [11] [17] [38]. Even more, having sustained one or multiple blows to the head was related to heightened self-reported (but not staff-observed) aggressive tendencies on two out of the three questionnaires. Such a connection between TBI and aggression seemed to be the most pronounced for aspects related to reactive aggression (*i.e.* aggression as a result of a perceived provocation or threat), which fits to the problems with executive control and disinhibition of impulses and emotional arousal that people with TBI often experience [19] [21]. Even though offenders with TBI had not committed significantly more crimes than offenders without TBI, there definitely was a trend in the data in this direction. Contrary to our expectations, no group differences could be objectivated in decision-making, which was measured with the IGT. This suggests that TBI is not related to increased risk taking during decision-making in this prison population, which is suggested to be indicative of orbitofrontal or ventromedial brain injuries [20] [23]. This is in contrast with previous findings in non-forensic samples, showing impaired decision-making on the IGT for TBI-patients in comparison to normal controls, independent of TBI-severity or lesion-location [39] [40]. On the other hand, forensic patients without histories of TBI have also shown response patterns comparable to TBI-patients with OFC-lesions in other previous studies [41] [42] [43]. This suggests that there might be a difference between forensic and non-forensic populations in the way that TBI distinctively impacts decision-making, because in non-TBI forensic samples there are signs of decision-making impairments as well.

The prevalence rates of TBI found in the present study are in line with those in previous studies with similar populations in other countries [8] [9] [10] [11] [17] [38] and are therefore likely to present a valid representation of prevalence rates in the general prison population. The prevalence of TBI in the present sample is also comparable with numbers found in non-forensic, psychiatric in-patients, being 38.0% to 68.0% [15] [44]. For example, in a large cohort study, there was a relationship between TBI and a subsequent heightened general risk for suffering from psychiatric disorders and suicidal behavior, independent of sex, age, socio-economic status and alcohol abuse [16]. Suffering from a recent severe psychiatric disorder was an exclusion criterion in the present study, but no statistical correction was performed for lifetime psychiatric disorders. There-

fore, it is uncertain if there was an overlap between psychiatric problems and TBI in the present offender sample. Nevertheless, the high occurrence of TBI in both forensic and psychiatric groups is something that these groups seem to have in common and might be an important factor to consider in clinical forensic as well as psychiatric practice. Increasing insight in the vulnerabilities that these TBI-offenders have, might enable clinicians to reduce problems with aggression in the future, or at least to be better able to identify high-risk groups for criminal recidivism. In order to develop better treatment for these individuals, it is important, however, to gain more insight in which specific neurocognitive dysfunctions may be associated with emotional and behavioral problems, other than the decision-making difficulties that were expected in the present study. Other important domains for future investigations are, for example, inhibitory control, working memory load and problem solving capacities. This knowledge could guide clinicians in deciding how these cognitive problems can be targeted directly in interventions or how they can be compensated for with environmental approaches.

Even though the findings in the present study can be relevant for clinical practice regardless of the specific direction of the relationship between TBI and aggression, it is important to keep in mind that a relationship between TBI and criminality does not automatically imply that TBI causes the criminal or aggressive behavior in this group. Another explanation for this relationship could be that antisocial personality traits increase both the risk for criminal behavior and the risk for TBI, for example, because antisocial traits are related to sensation seeking behavior and drug abuse, leading to increased risk for accidents and falls, or because individuals with antisocial traits become relatively easily involved in fights with potential risk of being injured. Only longitudinal studies could verify this.

Some other critical remarks are in place as well concerning this study's limitations. First of all, there was no random sampling method in the selection of offenders for this study: they could sign in on their own initiative and be only recruited in a single prison location. Reduction of the risk of a selection bias could be guaranteed by screening all new incoming prisoners, for example, or choosing participants in multiple settings. Unfortunately, it was not possible to do so in the present study, due to the fact that this was part of a larger project, but this is something to take in consideration for future studies. Furthermore, having sustained TBI was assessed with a semi-structured interview that was based on the main questions in other instruments that have been validated for this purpose [24] [25], but not the entire instrument was applied. Especially since we experienced that offenders in the present study often had difficulties providing details on their injuries, it is important to use a method that has been validated for this purpose to optimise the chances of gaining valid data [38]. There are specific tools that have been recommended for this purpose [38] [45], which is certainly important for future studies. These are, for example, the Traumatic Brain Injury Questionnaire (TBIQ) [46], the Brain Injury Screening Index (BISI) [47] and the Ohio State Univer-

sity (OSU-TBI-ID) TBI Identification method [24]. Important to remark in this regard is, however, that most studies in offender populations that applied these tools, revealed similar prevalence rates of TBI as the present study or even higher [8] [24] [38] [47] [48] [49] [50]. This makes it unlikely that there was an overestimation of TBI prevalence in the present study.

In spite of the mentioned study limitations, our results certainly fuel the discussion on the importance of adequately recognising and treating offenders with potential TBI.

Acknowledgments

No funding was provided for this study. We would like to express our gratitude to all participants in the study. The test-assistants, who were involved in the data-collection, M. Kramer, S. Setorg, M. Rutten, P. Fasel, L. Selhorst, A. van der Schoot, A. van Lieshout, P. Rijkers, J. Oomkens, J. van der Most and S. van Hees, are all gratefully acknowledged.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Raine, A. and Yang, Y. (2006) Neural Foundations to Moral Reasoning and Antisocial Behavior. *Social Cognitive and Affective Neuroscience*, **1**, 203-213.

[2] Raine, A. (2013) The Anatomy of Violence: The Biological Roots of Crime. Vintage, New York.

[3] Book, A.S., Starzyk, K.B. and Quinsey, V.L. (2001) The Relationship between Testosterone and Aggression: A Meta-Analysis. *Aggression and Violent Behavior*, **6**, 579-599.

[4] Marsh, A.A. and Blair, R.J.R. (2008) Deficits in Facial Affect Recognition among Antisocial Populations: A Meta-Analysis. *Neuroscience and Biobehavioral Reviews*, **32**, 454-465. https://doi.org/10.1016/j.neubiorev.2007.08.003

[5] Ogilvie, J.M., Stewart, A.L., Chan, R.C.K. and Shum, D.H.K. (2011) Neuropsychological Measures of Executive Function and Antisocial Behavior: A Meta-Analysis. *Criminology*, **49**, 1063-1107. https://doi.org/10.1111/j.1745-9125.2011.00252.x

[6] van Goozen, S.H.M. and Fairchild, G. (2006) Neuroendocrine and Neurotransmitter Correlates in Children with Antisocial Behavior. *Hormones and Behavior*, **50**, 647-654. https://doi.org/10.1016/j.yhbeh.2006.06.021

[7] Williams, W.H., *et al.* (2010) Traumatic Brain Injury in a Prison Population: Prevalence and Risk for Re-Offending. *Brain Injury*, **24**, 1184-1188. https://doi.org/10.3109/02699052.2010.495697

[8] Ray, B., Sapp, D. and Kincaid, A. (2014) Traumatic Brain Injury among Indiana State Prisoners. *Journal of Forensic Sciences*, **59**, 1248-1253. https://doi.org/10.1111/1556-4029.12466

[9] Farrer, T.J. and Hedges, D.W. (2011) Prevalence of Traumatic Brain Injury in Incarcerated Groups Compared to the General Population: A Meta-Analysis. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, **35**, 390-394.

https://doi.org/10.1016/j.pnpbp.2011.01.007

[10] Shiroma, E.J., Ferguson, P.L. and Pickelsimer, E.E. (2010) Prevalence of Traumatic Brain Injury in an Offender Population: A Meta-Analysis. *Journal of Correctional Health Care*, **16**, 147-159. https://doi.org/10.1177/1078345809356538

[11] Durand, E., Chevignard, M., Ruet, A., Dereixe, A., Jourdan, C. and Pradat-Diehl, P. (2017) History of Traumatic Brain Injury in Prison Populations: A Systematic Review. *Annals of Physical and Rehabilitation Medicine*, **60**, 95-101. https://doi.org/10.1016/j.rehab.2017.02.003

[12] Woolhouse, R., McKinlay, A. and Grace, R.C. (2018) Women in Prison with Traumatic Brain Injury: Prevalence, Mechanism, and Impact on Mental Health. *International Journal of Offender Therapy and Comparative Criminology*, **62**, 3135-3150. https://doi.org/10.1177/0306624X17726519

[13] McKinlay, A., *et al.* (2008) Prevalence of Traumatic Brain Injury among Children, Adolescents and Young Adults: Prospective Evidence from a Birth Cohort. *Brain Injury*, **22**, 175-181. https://doi.org/10.1080/02699050801888824

[14] Kisser, J., Waldstein, S.R., Evans, M.K. and Zonderman, A.B. (2017) Lifetime Prevalence of Traumatic Brain Injury in a Demographically Diverse Community Sample. *Brain Injury*, **31**, 620-623. https://doi.org/10.1080/02699052.2017.1283057

[15] McGuire, L.M., Burright, R.G., Williams, R. and Donovick, P.J. (1998) Prevalence of Traumatic Brain Injury in Psychiatric and Non-Psychiatric Subjects. *Brain Injury*, **12**, 207-214. https://doi.org/10.1080/026990598122683

[16] Silver, J.M., Kramer, R., Greenwald, S. and Weissman, M. (2001) The Association between Head Injuries and Psychiatric Disorders: Findings from the New Haven NIMH Epidemiologic Catchment Area Study. *Brain Injury*, **15**, 935-945. https://doi.org/10.1080/02699050110065295

[17] Farrer, T.J., Frost, R.B. and Hedges, D.W. (2013) Prevalence of Traumatic Brain Injury in Juvenile Offenders: A Meta-Analysis. *Child Neuropsychology*, **19**, 225-234. https://doi.org/10.1080/09297049.2011.647901

[18] Huw Williams, W., Cordan, G., Mewse, A.J., Tonks, J. and Burgess, C.N.W. (2010) Self-Reported Traumatic Brain Injury in Male Young Offenders: A Risk Factor for Re-Offending, Poor Mental Health and Violence? *Neuropsychological Rehabilitation*, **20**, 801-812. https://doi.org/10.1080/09602011.2010.519613

[19] Buckley, L., Kaye, S.-A., Stork, R.P., Heinze, J.E. and Eckner, J.T. (2017) Traumatic Brain Injury and Aggression: A Systematic Review and Future Directions Using Community Samples. *Aggression and Violent Behavior*, **37**, 26-34. https://doi.org/10.1016/j.avb.2017.08.004

[20] Jonker, F., Jonker, C., Scheltens, P. and Scherder, E.J. (2014) The Role of the Orbitofrontal Cortex in Behavior and Cognition. *Brain Injury*, **28**, 526.

[21] Wood, R.L. and Worthington, A. (2017) Neurobehavioral Abnormalities Associated with Executive Dysfunction after Traumatic Brain Injury. *Frontiers in Behavioral Neuroscience*, **11**, 195. https://doi.org/10.3389/fnbeh.2017.00195

[22] Bechara, A., Damasio, A.R., Damasio, H. and Anderson, S.W. (1994) Insensitivity to Future Consequences Following Damage to Human Prefrontal Cortex. *Cognition*, **50**, 7-15. https://doi.org/10.1016/0010-0277(94)90018-3

[23] Bechara, A., Tranel, D. and Damasio, H. (2000) Characterization of the Decision-Making Deficit of Patients with Ventromedial Prefrontal Cortex Lesions. *Brain*: *A Journal of Neurology*, **123**, 2189-2202. https://doi.org/10.1093/brain/123.11.2189

[24] Bogner, J. and Corrigan, J.D. (2009) Reliability and Predictive Validity of the Ohio State University TBI Identification Method with Prisoners. *The Journal of Head Trauma Rehabilitation*, **24**, 279-291. https://doi.org/10.1097/HTR.0b013e3181a66356

[25] Corrigan, J.D. and Bogner, J. (2007) Initial Reliability and Validity of the Ohio State University TBI Identification Method. *The Journal of Head Trauma Rehabilitation*, **22**, 318-329. https://doi.org/10.1097/01.HTR.0000300227.67748.77

[26] Buelow, M.T. and Suhr, J.A. (2009) Construct Validity of the Iowa Gambling Task. *Neuropsychology Review*, **19**, 102-114. https://doi.org/10.1007/s11065-009-9083-4

[27] Stanford, M.S., *et al.* (2003) Characterizing Aggressive Behavior. *Assessment*, **10**, 183-190. https://doi.org/10.1177/1073191103010002009

[28] Raine, A., *et al.* (2006) The Reactive-Proactive Aggression Questionnaire: Differential Correlates of Reactive and Proactive Aggression in Adolescent Boys. *Aggressive Behavior*, **32**, 159-171. https://doi.org/10.1002/ab.20115

[29] Buss, A.H. and Perry, M. (1992) The Aggression Questionnaire. *Journal of Personality and Social Psychology*, **63**, 452-459. https://doi.org/10.1037/0022-3514.63.3.452

[30] Meesters, C., Muris, P., Bosma, H., Schouten, E. and Beuving, S. (1996) Psychometric Evaluation of the Dutch Version of the Aggression Questionnaire. *Behaviour Research and Therapy*, **34**, 839-843. https://doi.org/10.1016/0005-7967(96)00065-4

[31] Kuyck, W.G.E., de Beurs, E., Barendregt, M. and van den Brink, W. (2013) Psychometric Evaluation of the Dutch Version of the Impulsive/Premeditated Aggression Scale (IPAS) in Male and Female Prisoners. *The International Journal of Forensic Mental Health*, **12**, 172-179. https://doi.org/10.1080/14999013.2013.819396

[32] Cima, M., Raine, A., Meesters, C. and Popma, A. (2013) Validation of the Dutch Reactive Proactive Questionnaire (RPQ): Differential Correlates of Reactive and Proactive Aggression from Childhood to Adulthood. *Aggressive Behavior*, **39**, 99-113. https://doi.org/10.1002/ab.21458

[33] Hornsveld, R.H.J., Murris, P. and Kraaimaat, F.W. (2009) Drie zelfrapportage vragenlijsten voor de forensische psychiatrie. De Bondt grafimedia communicatie, Barendrecht.

[34] Wistedt, B., Rasmussen, A., Pedersen, L., Malm, U., Träskman-Bendz, L., Wakelin, J. and Bech, P. (1990) The Development of an Observer-Scale for Measuring Social Dysfunction and Aggression. *Pharmacopsychiatry*, **23**, 249-252. https://doi.org/10.1055/s-2007-1014514

[35] Kuin, N.C., Masthoff, E.D.M., Munafò, M.R. and Penton-Voak, I.S. (2017) Perceiving the Evil Eye: Investigating Hostile Interpretation of Ambiguous Facial Emotional Expression in Violent and Non-Violent Offenders. *PLoS ONE*, **12**, e0187080. https://doi.org/10.1371/journal.pone.0187080

[36] Kuin, N.C. and Masthoff, E.D.M. (2016) Investigating the Relationship between Psychopathic Personality Traits and Decision-making Deficits in a Prison Population. *Journal of Forensic Psychology*, **1**, 1-7. https://doi.org/10.4172/2475-319X.1000104

[37] Verhage, F. (1964) Intelligentie en leeftijd. Onderzoek bij Nederlanders van twaalf tot zevenenzeventig jaar. Van Gorcum, Assen, Netherlands.

[38] Allely, C.S. (2016) Prevalence and Assessment of Traumatic Brain Injury in Prison Inmates: A Systematic PRISMA Review. *Brain Injury*, **30**, 1161-1180. https://doi.org/10.1080/02699052.2016.1191674

[39] Cotrena, C., Damiani Branco, L., Zimmermann, N., Oliveira Cardoso, C., Grassi-Oliveira, R. and Paz Fonseca, R. (2014) Impaired Decision-Making after Traumatic Brain Injury: The Iowa Gambling Task. *Brain Injury*, **28**, 1070-1075. https://doi.org/10.3109/02699052.2014.896943

[40] Sigurdardottir, S., Tone, J., Nada, A., Cecilie, R. and Schanke, A.-K. (2010) Olfactory Dysfunction, Gambling Task Performance and Intracranial Lesions after Traumatic Brain Injury. *Neuropsychology*, **24**, 504-513. https://doi.org/10.1037/a0018934

[41] Kuin, N., Masthoff, E., Kramer, M. and Scherder, E. (2015) The Role of Risky Decision-Making in Aggression: A Systematic Review. *Aggression and Violent Behavior*, **25**, 159-172. https://doi.org/10.1016/j.avb.2015.07.018

[42] Best, M., Williams, J.M. and Coccaro, E.F. (2002) Evidence for a Dysfunctional Prefrontal Circuit in Patients with an Impulsive Aggressive Disorder. *Proceedings of the National Academy of Sciences of the United States of America*, **99**, 8448-8453. https://doi.org/10.1073/pnas.112604099

[43] Jollant, F., *et al.* (2005) Impaired Decision-making in Suicide Attempters. *The American Journal of Psychiatry*, **162**, 304-310. https://doi.org/10.1176/appi.ajp.162.2.304

[44] Burg, J.S., McGuire, L.M., Burright, R.G. and Donovick, P.J. (1996) Prevalence of Traumatic Brain Injury in an Inpatient Psychiatric Population. *Journal of Clinical Psychology in Medical Settings*, **3**, 243-251. https://doi.org/10.1007/BF01993910

[45] O'Rourke, C., Linden, M.A., Lohan, M. and Bates-Gaston, J. (2016) Traumatic Brain Injury and Co-Occurring Problems in Prison Populations: A Systematic Review. *Brain Injury*, **30**, 839-854. https://doi.org/10.3109/02699052.2016.1146967

[46] Diamond, P.M., Harzke, A., Magaletta, P., Cummins, A. and Frankowski, R. (2007) Screening for Traumatic Brain Injury in an Offender Sample: A First Look at the Reliability and Validity of the Traumatic Brain Injury Questionnaire. *The Journal of Head Trauma Rehabilitation*, **22**, 330-338. https://doi.org/10.1097/01.HTR.0000300228.05867.5c

[47] Pitman, I., Haddlesey, C., Ramos, S.D.S., Oddy, M. and Fortescue, D. (2015) The Association between Neuropsychological Performance and Self-Reported Traumatic Brain Injury in a Sample of Adult Male Prisoners in the UK. *Neuropsychological Rehabilitation*, **25**, 763-779. https://doi.org/10.1080/09602011.2014.973887

[48] Ferguson, P.L., Pickelsimer, E., Corrigan, J., Bogner, J. and Wald, M. (2012) Prevalence of Traumatic Brain Injury among Prisoners in South Carolina. *The Journal of Head Trauma Rehabilitation*, **27**, E11-E20. https://doi.org/10.1097/HTR.0b013e31824e5f47

[49] Kaba, F., Diamond, P., Haque, A., MacDonald, R. and Venters, H. (2014) Traumatic Brain Injury among Newly Admitted Adolescents in the New York City Jail System. *Journal of Adolescent Health*, **54**, 615-617. https://doi.org/10.1016/j.jadohealth.2013.12.013

[50] Piccolino, A.L. and Solberg, K.B. (2014) The Impact of Traumatic Brain Injury on Prison Health Services and Offender Management. *Journal of Correctional Health Care*, **20**, 203-212. https://doi.org/10.1177/1078345814530871