Title: Utility of the Brain Injury Screening Index in Identifying Female Prisoners with a Traumatic Brain Injury and Associated Cognitive Impairment

Abstract

There is a high prevalence of traumatic brain injury (TBI) in prisoners, but screening tools for identifying TBI in female prisoners are not readily available. Using a cross-sectional design, the psychometric properties of the Brain Injury Screening Index (BISI) were investigated in a closed UK female prison. Purposive sampling comprised of 56 females. Assessment included clinical interview; the BISI; self-report measures of mood; and a battery of measures of cognitive functioning. Seven of 10 clinical indicators on the BISI met test-retest reliability criteria. Two of three BISI summary variables demonstrated correlations with questionnaires in the hypothesised directions, however only two BISI variables were associated with cognitive functioning. Findings support further investigation into the validity and reliability of the BISI with a larger sample.

Keywords: head injury; offending; reliability; validity; screen; assessment

Introduction

There is growing evidence that vulnerable and socially disadvantaged groups have higher rates of traumatic brain injury (TBI). These groups include those without homes (McMillan et al., 2015; Oddy, Moir, Fortescue, & Chadwick, 2012), military veterans (French, Lange, & Brickell, 2014; Miller, Ivins, & Schwab, 2013; Terrio et al., 2009) and prisoners (Allely, 2016; Diamond, Harzke, Magaletta, Cummins, & Frankowski, 2007; Durand et al., 2017). Most TBIs are mild (Donnelly et al., 2011). Reports of problematic sequelae following mild TBI (mTBI) range from only 10% (Albicini & McKinlay, 2014) to 42% (Konrad et al., 2011). Research suggests that multiple mTBIs may have a cumulative effect (Collins, Grindel, Lovell, & et al., 1999; Diamond et al., 2007; Iverson, Echemendia, LaMarre, Brooks, & Gaetz, 2012; Miller et al., 2013). While moderate to severe TBIs tend to be self-evident, deficits from mTBIs can be easily overlooked (Donnelly et al., 2011).

Shiroma, Ferguson and Pickelsimer’s (2010) meta-analysis of 20 studies, providing a total of 4,865 offenders, places TBI prevalence in offender populations at 60.25% (95% CI: 48-72%), with a male and female prevalence estimate of 64.41% (95% CI: 53.3 to 75.53%) and 69.98% (95% CI: 50.18-89.79%) respectively. Prevalence rates of multiple TBIs in female offenders have been reported ranging from 35-48% (Ferguson, Pickelsimer, Corrigan, Bogner, & Wald, 2012). Along with a higher prevalence than in the general population, prisoners are at higher risk of neurodisability following TBI, by virtue of reduced cognitive reserve from exposure to factors such substance use and mental health difficulties (Ropacki & Elias, 2003). Longitudinal research from the Swedish population registers found that individuals with TBI have a significantly increased risk of committing a violent crime (Fazel, Lichtenstein, Grann, & Långström, 2011). Fazel et al.’s (2011) study demonstrated convictions occurred subsequent to the TBI and found increased significant risk even when unaffected siblings were used as controls. Even mild TBI in childhood is associated with an array of long-term negative outcomes, including increased risk of arrest, violent offences, and property offences (McKinlay, 2014). Multiple risk factors and adverse life events in this vulnerable population contribute to complex clinical presentations and etiology.

Once in the criminal justice system, individuals with TBI may be more difficult to rehabilitate and discharge, with services ill-equipped to address their needs. Following up a cohort of prisoners 12-30 months post-release, Ray and Richardson (2017) found that the hazard of recidivism increased about 85% for those with a TBI. Hawley and Maden's (2003) study of TBI in medium secure units (MSUs) indicated that 41.60% of service users had a history of TBI, and were significantly more difficult to discharge into the community due to perceived greater risk of violence to others and of self-harm. Research demonstrating increased disciplinary incidents in prisoners with TBI (Merbitz, Jain, Good, & Jain, 1995; Morrell, Merbitz, Jain, & Jain, 1998; Shiroma, Pickelsimer, et al., 2010) suggests that they may also have increased difficulty adapting to prison life due to cognitive and behavioural sequelae such as impulsivity. This has implications for engagement in the legal process, prison management, and post-discharge and release pathways (Jackson & Hardy, 2011). Due to inadequate screening and identification of TBI, services are unable to provide adapted rehabilitation for this population. Under-identification is likely to perpetuate inadequate resources, providing no incentive to fund appropriate interventions.

Many studies use a self-report methodology to measure TBI prevalence rates (Allely, 2016). While there is no readily available 'gold standard', as many do not seek medical assistance at the time of injury (Allely, 2016), it is important that instruments used to screen for TBI have satisfactory psychometric properties. There are currently three published screening tools, which have a growing evidence base for use with prisoners (Allely, 2016), the Brain Injury Screening Index (BISI; Pitman, Haddlesey, Ramos, Oddy, and Fortescue, 2015), the Traumatic Brain Injury Questionnaire (TBIQ; Diamond et al., 2007) and the Ohio State University TBI Identification Method (OSU TBI-ID; Bogner & Corrigan, 2009). It is difficult to compare these tools as they have differing goals and different aspects of their psychometric properties have been reported. In a sample of male prisoners in the UK, the BISI has demonstrated poor to moderate inter-rater reliability when used by staff with little or no training in its use, and moderate to good test-retest reliability (Ramos, Liddement, Addicott, Fortescue, & Oddy, submitted). Sensitivity ranged from moderate to good, with poor to moderate specificity across three administrations. The BISI has also demonstrated convergence with both self-report questionnaires of behavioural disorder and neuropsychological measures in UK male prisoners (Pitman et al., 2015), and has been used with a homeless population (McMillan et al., 2015; Oddy et al., 2012). The validity and reliability of the TBIQ has been explored with a mixed group of male and female prisoners in the USA (Diamond et al., 2007). It has been found to have moderate test-retest reliability, good internal consistency and excellent criterion validity. The validity and reliability of the OSU TBI-ID has been explored in males and females with a history of substance use (Corrigan & Bogner, 2007), as well as a prison population (Bogner & Corrigan, 2009). Moderate test-retest reliability was found and indices derived from the screening tool predicted common cognitive and behavioural consequences of TBI. However, indices on the OSU TBI-ID, which required an estimate of mTBIs, relating to episodes such as intimate partner violence, were found to be unreliable (Bogner & Corrigan, 2009). The OSU TBI-ID may be inappropriate for female prison populations because one of the pathways to TBI among women prisoners is thought to be intimate partner violence victimisation (Kwako et al., 2011). To date, the BISI is the only screening tool to have its properties explored within a UK population, and due to its increasing use with vulnerable populations, this research sought to examine its utility within a female prison in the UK.

Developing a valid TBI screen will enable researchers to determine the prevalence of TBI in a range of groups, including UK female offenders, which is currently unknown. The causes of TBI in women prisoners are known to be different from those in male prisoners (Brewer-Smyth, Burgess, & Shults, 2004; Durand et al., 2017; Woolhouse, McKinlay, & Grace, 2017) so the reliability and validity of a self-report screen for brain injury may differ in male and female populations. The present study aims to explore the test-retest reliability and criterion validity of the BISI as a tool for screening for a history of TBI in female prisoners.

It is hypothesised that the BISI will have good test-retest reliability, measured using Kappa coefficients for all binary variables and examined using intra-class correlation coefficients (ICC) for all continuous variables. In terms of criterion validity, we hypothesise the indices of Indicator of TBI, TBI Severity Index, and Total BISI Score will be positively correlated with scores obtained on the self-report measures of mood and neurodisability; and negatively correlated with neuropsychological measures of cognitive functioning.

Method

Ethics

This study was granted favourable ethical opinion by the National Offender Management Service National Research Committee of the Her Majesty's Prison Service for England and Wales (NOMS application number 2013-266) and the Ethics Committee at a UK university.

Participants

The study was conducted at a UK closed women's prison, with an operational capacity of 282. Participants were recruited from new prison receptions. Prisoners from 18 to 80 years of age, in line with test instrument norms, were included. Exclusion criteria were acute symptoms of physical or mental illness, a confirmed diagnosis of dyslexia, problems with literacy, inadequate English fluency, or having acquired a TBI in the last six months, as the validity of all measures has not been established in these subgroups. Participants with a learning disability (LD) were included, unless any question of capacity to consent was raised. Of 116 prisoners who were approached, 20 were ineligible (Figure 1). Of the remaining 96, 56 (56.3%) completed the assessment, with 26 (46.42%) self-reporting a “blow to the head”, coded as an Indicator of TBI. All participants who reported a blow to the head were included in the TBI group. It is important to note that a history of a blow to the head would not mean that the clinical criteria for a TBI have been met, rather that they have screened positively for being at-risk of TBI.

Insert Figure 1 here

Materials

Data were gathered using a semi-structured interview, clinical questionnaires, and neuropsychological measures. The interview was designed to ascertain history of TBI, offending, mental health, and social history. The BISI is an 11 item TBI screening questionnaire designed by the Disabilities Trust (http://www.thedtgroup.org/foundation/about-the-foundation/brain-injury-screening-index). The BISI provides categorical screening data. Attempts have been made to quantify results using two different indices. The TBI Severity Index is calculated by multiplying the highest rate of unconsciousness, rated on a 0-3 Likert scale, by the number of TBIs (Pitman et al., 2015). The Total BISI Score provides an indicator of clinical need, based on indicators of TBI frequency and severity, with a range of 0-25. For both indices, it is expected that higher scores indicate more severe injuries.

To explore criterion validity, a battery of self-report measures assessed current mental health and perceived cognitive functioning. This included the Beck Depression Inventory II (BDI-II; Beck, Steer, & Brown, 1996), the Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988), the Impact of Events Scale-Revised (IES-R; Weiss & Marmar, 1997), The Neurobehavioral Functioning Inventory (NFI; Kreutzer, Seel, & Marwitz, 1999), and the Dysexecutive Questionnaire (DEX; Wilson, Evans, Emslie, Alderman, & Burgess, 1998). A clinician administered battery of cognitive measures was utilised, comprising of the Test of Premorbid Function (TOPF; Wechsler, 2009), the Wechsler Abbreviated Scale of Intelligence (WASI-II; Wechsler & Zhou, 2011), The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS; Randolph, 1998), the Behavioural Assessment of the Dysexecutive Syndrome (BADS; Wilson, Alderman, Burgess, Emslie, & Evans,1996), and the Test of Memory Malingering (TOMM; Tombaugh, 1996).

Procedure

All new receptions during the period of data collection were invited to participate. Participants were provided with information about the study and asked to provide written consent.

Assessment took place over two sessions on different days, ideally a week apart. Days between Part One and Part Two of the assessment ranged from three to 42 (M = 11.55, SD = 9.07), with both parts taking approximately two hours. During Part One, participants completed the BISI, the clinical interview, the BDI-II, BAI, IES-R, and commenced the neuropsychological battery with the TOMM, TOPF, and RBANS. The tests in Part Two were administered in the following order: the WASI-II, the BADS, the DEX, and the NFI. The BISI was also re-administered during Part Two to allow test-retest reliability to be investigated. Participants chose the Part One endpoint to manage fatigue. Most participants stopped after the RBANS. Participants could request a feedback session at the end of the assessment.

Analysis

Analyses were done using IBM SPSS version 20 (IBM, 2011). Data preparation included checking responses, calculating total scores, and assessing normality of distribution. If *z* scores were significantly higher than zero ($z > 1.96$, $p < .05$) then data were considered to be abnormally distributed (Field, 2013), in which case non-parametric equivalents of tests were used where appropriate.

A significance level of $p \leq .0004$ was applied to analyses based on a Bonferroni correction for multiple comparisons. Retest reliability was assessed for the continuous variables across the two time points with intraclass correlation coefficients (ICCs) using a two-way fixed effect model for agreement (Rankin & Stokes, 1998). For the nominal variables, Cohen's kappa (Cohen, 1960) assessed retest reliability. Variables on the BISI were tested for convergence with measures using correlation coefficients.

Results

Participants ranged from 21 to 64 years of age (*M* = 38.66, *SD* = 11.47). Estimated Premorbid IQ based on the TOPF ranged from 72 to 110 (*M* = 92.59, *SD* = 8.15), while obtained IQ on the WASI-II ranged from 67 to 126 (*M* = 94.65, *SD* = 13.48). Most participants identified themselves as White British (73.20%). Number of years spent in education ranged from two to 20 (*M* = 11.83, *SD* = 3.15).

Those who experienced a “blow to the head” (n = 26) reported a mean of 2.83 injuries (*SD* = 1.71). Age at first TBI ranged from 2 to 46 years-old (*M* = 17.57, *SD* = 10.17), while age of the most serious TBI ranged from 5 to 46 (*M* = 22.21, *SD* = 8.89). Table 1 outlines the reported causes of the TBIs.

Insert Table 1 here

Time since first TBI ranged from three to 50 years (*M* = 23.22, *SD* = 16.73), and time since most recent TBI from six months to 33 years (*M* = 8.55, *SD* = 7.72). Of participants who experienced a TBI, 83% reported at least one episode of loss of consciousness (LOC), with 40.50% of TBIs involving LOC. Most severe LOC reported in the clinical interview was over six hours for 24.13% of participants, between ten minutes and six hours for 17.24%, under ten minutes for 41.37%, with just dizziness reported by the remaining 17.24%. In 43.01% of cases of TBI, participants did not seek or come to the attention of medical or professional assistance (Table 1).

The TBI Severity Index ranged from one to 15 (*M* = 4.81, *SD* = 4.43). The BISI Total Score ranged from zero to 22 (*M* = 4.79, *SD* = 5.17).

Test-Retest Reliability

For test-retest reliability, five of the seven continuous variables demonstrated adequate reliability, with all ICC confidence intervals over .50 (Table 2; Koo & Li, 2016). The most reliable variables were Total Number of TBIs, the BISI Total Score, and the Age at first TBI, which had large positive coefficients.

Insert Table 2 here

For the binary variables, Indicator of TBI and Other Acquired Brain Injury (ABI) reached statistical significance (Table 3) with substantial to excellent retest reliability (Landis & Koch, 1977).

Insert Table 3 here

Criterion Validity

No significant difference was found between those with and without a reported TBI on premorbid IQ, age, educational background, TOMM score, and alcohol use (Table 4).

Two participants scored under the cut-off of 45 on the TOMM, one of whom reported a TBI. Clinical observation and the effort index derived from the RBANS (Silverberg, Wertheimer, & Fichtenberg, 2007) suggested true effort was exerted during testing, and therefore these participants were not excluded from analyses.

Insert Table 4 here

Key summary variables on the BISI were tested for convergence with neuropsychological measures of cognitive functioning and standardised self-report questionnaires of mood and neurodisability (Table 5). The TBI Severity Index was not correlated with the self-report mood questionnaires nor with the neuropsychological measures.

The BISI Total Score correlated only the with NFI Motor subscale. The BISI Total Score did not correlate with any of the neuropsychological measures of cognitive functioning.

Similarly to the BISI Total Score, only the NFI Motor subscale was associated with reported history of TBI on the BISI. There were no correlations with the neuropsychological measures of cognitive functioning.

Insert Table 5 here

Discussion

In the TBI group 83% of participants who experienced a TBI reported at least one episode of LOC, similar to the 80.6% reported in Pitman et al.'s (2015) male sample. Colantonio et al. (2014), whose TBI screening method had a similar genesis (Hwang et al., 2008) as the BISI, reported that 84.2% of females and 73.4% of males experienced one or more episodes of LOC. Across both Pitman et al. (2015) and this study, the TBI Severity Index demonstrated similar means (*M*=5.39 *SD*=4.25 in the male sample; *M*=4.81 *SD*=4.43 in the female sample), suggesting that the frequency and severity of traumatic brain injuries sustained is comparable across males and females. The female sample had a similar age at first TBI (17.57 years in this sample vs. 17.71 years), echoing Durand et al.'s (2017) study which found no significant gender differences in age at first TBI. Other studies have found that females have a slightly older age of onset (Colantonio et al., 2014; Fishbein, Dariotis, Ferguson, & Pickelsimer, 2014). Comparison with Pitman et al.'s (2015) male sample suggests that females may be less likely to seek help at the time of injury (43.01% in this sample vs. 31.00%) thus indicating gender specific behavioural patterns in TBI (O' Sullivan, Glorney, Sterr, Oddy, & Da Silva Ramos, 2015). Kaba et al. (2014) found similar prevalence of TBI across gender, but females scored higher on severity and frequency scales of common cognitive and physical symptoms after a head injury, as well as accessing significantly more mental health services subsequently. Women may be less likely to access health services at the time of injury, but seek help to cope with the complex sequelae experienced at a later point. The most frequently reported causes of TBI were domestic violence, road traffic accidents, and fights, which is consistent with Durand et al. (2017) and Brewer-Smyth et al.'s (2004) findings of violence related incidents being the leading cause of TBIs amongst women.

Results support the test-retest reliability of the BISI, seven of the 10 variables meeting minimum criteria for adequate test-retest reliability (Koo & Li, 2016; Landis & Koch, 1977). Results extend Ramos et al.'s (submitted) findings of the BISI's good test-retest reliability in a male population to a female population. Comparing with the OSU TBI-ID and TBIQ across variables designed to capture the same data with prison populations, the BISI demonstrated the highest reliability across three of the four variables (Table 6), although the OSU TBI-ID has been the most widely researched screen (Allely, 2016; Bogner et al., 2017; O'Rourke, Linden, Lohan, & Bates-Gaston, 2016). Differences may be attributable to sample differences: the OSU TBI-ID and TBIQ being used in American populations; length of retest period, with the TBIQ reporting approximately two to four weeks between testing sessions, the OSU TBI-ID reporting one to two weeks, while this study had a mean of 11.55 days; or differences in question phrasing. Phrasing may be an issue for the BISI's longest LOC item, which asks participants to state length of LOC rather than providing categories as in the OSU TBI-ID, with poor recall leading to high variability in responses, which is likely to be a factor for those with a TBI history. Exploring the reliability of the OSU TBI-ID, Bogner and Corrigan (2009) also found that items requiring estimation of LOC in particular had lower reliability.

Insert Table 6 here

Results suggest that further investigation of the criterion validity of the BISI is required. None of the BISI's summary variables demonstrated statistically significant consistent correlations with the neuropsychological battery scores. However, the majority of the TBIs reported were mild, and do not often lead to permanent cognitive deficits in the general population. This is the only TBI screening tool in an offender population that has had criterion validity investigated against a battery of neuropsychological tests, and emphasises the need to explore convergence with psychometric assessments.

The BISI Total Score and TBI Indicator variables demonstrated correlations in the expected direction across the self-report measures of neurodisability, however only the NFI Motor subscale was associated with both summary variables. Comparing the scores of those with and without a self-identified TBI history, the self-report questionnaires demonstrated the stronger relationships as opposed to the cognitive measures. This mirrors results found in the male study (Pitman et al., 2015), with the largest effect sizes being found in self-report measures. Durand et al.(2017) found that perceived health was notably worse in women with a TBI than men, hypothesising that women are particularly at risk of accumulating multiple health problems post-TBI. The convergence with self-report measures of neurodisability and mood rather than the objective cognitive assessments, highlights the complex relationship.

Chamelian and Feinstein (2006) found that when mood is controlled for in TBI, subjective cognitive difficulties no longer predict most objective cognitive difficulties, with psychological factors influencing objective recovery. This may be particularly relevant for TBI rehabilitation considering females report higher levels of somatic depression in particular (Silverstein, 2002). While this may be an artefact of the gender response bias hypothesis (Sigmon et al., 2005), which posits that gender differences in depression prevalence rates may reflect a tendency for men to underreport depressive symptoms, examining means across self-report measures of mood and cognitive functioning between this study and Pitman et al.'s (2015) study, the female group did not consistently report greater pathology than the male sample across measures. For example, scores on the BDI-II and NFI Depression subscale are higher than the male sample in the non-TBI group but similar in the TBI group. This convergence also demonstrates the difficult negotiation between sensitivity and specificity when screening for TBI. TBI symptoms and risk factors overlap significantly with psychiatric constructs. Albicini and McKinlay (2014) highlight the absence of a gold standard in TBI assessment, emphasising the complex nature and specialist skills required to diagnose TBI. It is recommended that future TBI research includes neuropsychological cognitive assessments to refine screens and reduce the false positives, which can lead to inefficient use of clinical resources, overburdening services and ultimately compromising their sustainability.

Contrary to the hypotheses, the TBI Severity Index demonstrated no association with the self-report measures, and the cognitive tests. It is possible that the TBI Severity Index is an invalid clinical indicator in this population due to gender differences in TBI presentation, such as difficulties in recalling periods of LOC. Albicini and McKinlay (2014) emphasise the problem with validity that relying on self-report LOC causes for diagnosis, for example, individuals confusing post-traumatic amnesia (PTA) with LOC, which are subjectively experienced as the same (i.e. a gap in memory). Without reliable corroborating reports, using LOC as an indicator is likely to be misleading. Considering most women in this study did not seek medical help, corroborating reports are unlikely to exist. Longest LOC could be rephrased to capture LOC range, however due to poor validity of self-report LOC, particularly in mild TBI, LOC range may not contribute sufficient clinical value to a screen, and may be best removed.

Reliance on self-report is an ongoing issue in screening for TBI, with responses demanding understanding of the question, retrieval of relevant information, forming a judgement based on integration of retrieved information, and mapping the judgement to potential responses (Tourangeau, Rips, & Rasinski, 2000). Brief scales and surveys are at risk of detecting all but the most recent or severe TBIs (Corrigan, Selassie, & Orman, 2010). McKinlay, Horwood and Fergusson's (2016) cohort study found only 50% of hospitalised TBIs were recalled. Equally, reliance on medical records can risk under-identification of TBI, with reports of up to 43% of individuals with a TBI not seeking medical attention (Setnik & Bazarian, 2007), as well as risk of errors and insufficient recording (Horwitz & Yu, 1984). Schofield, Butler, Hollis and D'Este (2011) found that prisoners' self-report of TBI is generally accurate when compared with hospital record, but lower education and a lifetime history of more than seven TBIs was associated with less agreement. This suggests that screening for TBI may require a combination of self-report and review of medical records.

While the BISI was designed to be administered with minimal training, in this study the BISI was administered by trainee clinical psychologists with experience working with TBI. Therefore the findings may not be representative of administration in general practice, such as by prison officers or others where staff workloads are high and training in working with TBI is rare. Administration by a clinician with experience in TBI would likely increase the sensitivity and specificity of the BISI as they may be more skilled at picking up on mild

TBI. Ramos et al. (submitted) identified the importance of staff training to improve inter-rater reliability in the BISI.

The small sample size proves to be a limitation of this study. The response rate of 56.3% was also lower than that of the male study, which had 66% of eligible participants complete the full neuropsychological battery (Pitman, Haddlesey, Ramos, Oddy, & Fortescue, 2014). This difference may be attributable to variation in study design which was informed by constraints of the prison regime. It is important to note that acquiring larger samples of females is prison proves challenging with women only making up a small proportion of the prison population.

There are a number of limitations for establishing test-retest reliability. Although every effort was made to ensure a retest interval of seven days, due to the practicalities of conducting research in a prison, this was not always possible. There was a wide interval range, however 87.5% of participants had an interval of seven days or longer. It could also be argued that knowledge of the BISI results could bias scoring at the second time point, or scoring of the neuropsychological battery; however adherence to assessment instructions minimised this risk. The TOMM was only administered on the first testing session, therefore it is possible that participants with reduced effort in the second testing session could have been missed.

Conclusions

This study of adult female prisoners in the UK provides support for further investigation and refinement of a short TBI screening tool. Seven out of 10 clinical indicators demonstrated adequate test-retest reliability. For criterion validity, two of the three summary variables were associated in the hypothesised directions with a range of measures of mood and neurodisability, indicating the value of further research with a larger sample. These findings have implications for the future refinement of the BISI, which will allow it to address under-identification of TBI in female prisoners.

This study is the first of its kind to explore reliability and validity of the BISI screening tool for female offenders, beginning to extend evidence of its utility from male offenders (Pitman et al., 2015). The development of a reliable and valid screening tool for women with TBI will enable researchers to address the dearth of studies into TBI in female offenders (O' Sullivan et al., 2015), highlighted in the UK by the Repairing Shattered Lives report (Williams, 2012). Adoption of a screening tool by female prisons can inform funding for services, by ensuring the most efficient use of resources. Identifying this vulnerable population can help apportion funding into training of prison staff in working with female offenders with TBI, inform offender rehabilitation plans, promote the population’s engagement with the criminal justice system, and identify who would benefit from specialist assessment and rehabilitation services. Differences in presentation of TBI between men and women, such as help seeking behaviours, emphasise the possibility of gender specific behavioural pathways in TBI, which require much further research.

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