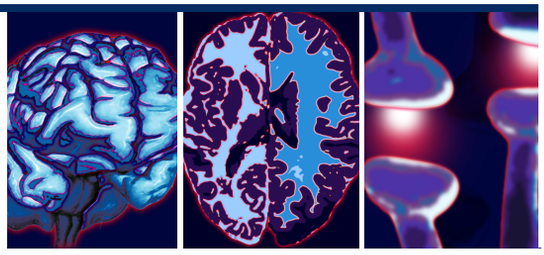
RESEARCH ARTICLE



Depression and traumatic brain injury: symptom profiles of patients treated with cognitive–behavioral therapy or supportive psychotherapy

Emily D'Antonio*[1], Theodore Tsaousides[1], Lisa Spielman[1] & Wayne Gordon[1]

Practice points

- Currently, patients with major depressive disorder following a traumatic brain injury (TBI) are treated as a uniform group, despite the fact that depressed patients' presenting symptoms vary greatly.
- A small number of studies have found evidence that depressed (non-TBI) patients presenting primarily with somatic complaints respond better to antidepressant treatment, while depressed patients presenting primarily with cognitive symptoms (e.g., hopelessness) respond better to cognitive–behavioral therapy (CBT).
- The current study found that in TBI patients diagnosed with major depressive disorder, CBT appeared to reduce mood symptoms (e.g., sadness and loss of interest).
- Supportive psychotherapy (SPT) appeared to reduce symptoms related to behavioral disinhibition (e.g., agitation and irritability).
- A total of 6 months after treatment ended, these differences were maintained, suggesting that the differential treatment effects of CBT and SPT are long lasting.
- Future studies are needed to prospectively examine the differential treatment effects of CBT and SPT, as well as other psychotherapeutic modalities.

SUMMARY **Aims:** This study aimed to examine the differential treatment effects of cognitive–behavioral therapy (CBT) and supportive psychotherapy (SPT) on self-reported symptoms of depression in individuals with traumatic brain injury (TBI) who sought treatment for major depressive disorder (MDD). **Methods:** Participants were individuals with a documented TBI meeting criteria for MDD who, as part of a larger randomized controlled trial comparing treatments for MDD after TBI, received CBT (n = 22) or SPT (n = 22). The average age of participants was 48.8 years (standard deviation = 10.2), 57.1% were female, 57.5% were Caucasian, 20% were Hispanic and 15% were African–American. The main outcome measure was the Beck Depression Inventory-II (BDI-II). **Results:** Mean total BDI-II score for all participants combined at baseline was 25 (standard deviation = 10.0). There were no significant differences in total BDI-II score between treatment groups at either baseline

[1]Brain Injury Research Center, Box 1163, Icahn School of Medicine at Mount Sinai, New York, NY 10029, USA
*Author for correspondence: Tel.: +1 212 241 8119; Fax: +1 212 348 5901; emily.d'antonio@mountsinai.org

Future Medicine part of fsg

or at the end of treatment. Participants treated with CBT reported significant improvements in sadness, loss of interest and loss of interest in sex, while participants treated with SPT reported significant improvements in symptoms of agitation and irritability. **Conclusion:** SPT may better target symptoms of behavioral disinhibition (agitation and irritability), while CBT may better target mood symptoms (sadness) and their behavioral manifestations (loss of interest and loss of interest in sex).

Depression is the most common psychiatric disorder following traumatic brain injury [1–3]. Rates of post-traumatic brain injury (TBI) depression vary greatly, with reports of between 12 and 60% of individuals with TBI reporting clinically significant depressive symptoms [4]. Even after accounting for the likelihood that depression is sometimes incorrectly diagnosed following a TBI, due to the fact that several symptoms (i.e., fatigue and sleep disturbance) are found in both TBI and depression [5], these rates clearly exceed the estimated 6.7% 12-month prevalence rate of depression in the general population [6]. The etiology of post-TBI depression is unknown and is probably related to both neurobiological changes and increased psychosocial stressors that often follow a TBI [7,8]. Regardless of the etiology, it is clear that post-TBI depression has a negative impact on several areas of functioning, including psychosocial functioning and quality of life [9,10].

Many effective behavioral and pharmacological interventions for depression have been identified for individuals without a TBI [11]. Research identifying effective interventions for depression following TBI, however, is very limited. A review by Fann *et al.* identified 27 peer-reviewed studies examining depressive symptoms following TBI [7]; only one of these studies included depression as an inclusion criteria for study entry and could be classified as class I [12], as defined by the American Academy of Neurology (AAN). Therefore, it is difficult to make strong conclusions about which interventions work for individuals with post-TBI depression.

There has been a recent focus in the non-TBI literature on tailoring treatment to patients' individual characteristics rather than diagnosis. This targeted approach to treatment might maximize an individual patient's ability to benefit from treatment. For example, several recent studies have focused on identifying biomarkers that indicate whether a depressed patient is likely to respond to cognitive therapy or antidepressants [13–15]. Siegle and colleagues found that depressed patients with more activity in the subgenual anterior cingulate cortex when viewing negatively valenced words were more likely to respond to cognitive therapy [15]. McGrath and colleagues measured brain glucose metabolism before randomly assigning patients to receive either cognitive–behavioral therapy (CBT) or escitalopram oxalate [14]. Patients responding well to CBT or poorly to escitalopram demonstrated hypometabolism in the right anterior insula, while those responding well to escitalopram or poorly to CBT demonstrated hypermetabolism in the right anterior insula. Neuroimaging treatment selection methods require prospective studies and further refinement before becoming clinically useful. However, this approach may prove to be important in individualizing treatment of major depressive disorder (MDD) and decreasing the negative effects of prescribing an ineffective treatment.

Identifying biomarkers to better individualize treatment of depression is promising, but not yet practical for clinicians treating depressed patients. However, another more practical approach to individualizing treatment of depressive disorder has focused on prescribing a treatment method based on patients' presenting symptoms. MDD is a syndrome identified by a constellation of symptoms and there is a great deal of variety among individuals with regards to the particular set of symptoms experienced [16]. However, there is preliminary evidence from two sources that suggest that certain clusters of symptoms respond better to certain types of interventions and that patients' presenting symptoms can be used to identify a treatment modality that is more likely to be successful.

First, functional imaging studies demonstrate that antidepressants may be more effective in treating patients presenting primarily with somatic complaints (i.e., sleep disturbance and appetite change), while cognitive therapy may be more effective in treating patients presenting primarily with cognitive symptoms (i.e., hopelessness). Depressed patients treated with antidepressants typically show changes in regions associated with subcortical functions, such as sleep and appetite disturbance, alleviating depression with a 'bottom-up'

approach [17,18]. CBT, on the other hand, appears to improve depressive symptoms through a 'top-down' approach, by altering regions associated with attention and memory through changing dysfunctional attitudes and cognitions [19]. Depressed patients presenting with sleep and other vegetative symptoms as their primary complaints, therefore, may experience improvement more rapidly when treated with antidepressants, while patients with cognitive and mood symptoms, such as hopelessness, as their primary complaint may experience more rapid improvement with cognitive therapy.

Second, a small number of studies that have examined patients' self-reported symptom improvements following treatment note improvement in one set of symptoms following antidepressant treatment, and a different set of symptoms following cognitive therapy. Overall, these studies demonstrate that patients treated with psychotherapy reported improvements in mood and cognitive symptoms first, while sleep disturbance improved first in those treated with antidepressants [20,21]. However, Bhar *et al.* found uniform symptom improvement in individuals treated with antidepressants compared with those treated with cognitive therapy [22].

Taken together, these studies provide preliminary evidence that patients may benefit from prescribing a treatment modality tailored to their presenting symptoms. However, all of these studies compared antidepressants with cognitive therapy. No study to date has compared the effects of different types of psychotherapy on symptoms, or explored the idea of prescribing a particular modality of psychotherapy based on the patient's presenting symptoms. Cognitive therapy, for example, may be more efficient and effective for individuals presenting primarily with cognitive symptoms, such as hopelessness, while supportive therapy may be more beneficial for individuals with symptoms related to poor social support, such as withdrawal and loss of pleasure. Considering that as many as 60% of individuals with TBI may experience depressive symptoms [4], it is particularly important to develop efficient and effective treatments for depression in TBI. As a first step in examining this issue in individuals with TBI, we compared two behavioral interventions, CBT and supportive psychotherapy (SPT) for post-TBI depression. Specifically, we examined whether individuals treated with a course of CBT showed improvement on a particular profile of depressive symptoms, while individuals treated with SPT showed improvement in a different group of symptoms. It was hypothesized that:

- Patients treated with CBT will report significantly increased improvements in cognitive and mood symptoms at the end of treatment, as compared with other symptoms of depression;
- Patients treated with supportive therapy will report significantly increased improvements in symptoms related to poor social support (i.e., failure or loss of pleasure) at the end of treatment, as compared with other symptoms of depression;
- Patients in both groups will report lower levels of depression overall (global depression) at the end of treatment.

Methods

Participants

Participants were drawn from a sample recruited for a larger study that compared the efficacy of SPT and CBT in treating depression in individuals with a TBI. The study was approved by the Institutional Review Board of the Icahn School of Medicine at Mount Sinai (NY, USA) and the conduct of the investigation conformed to the protocol and ethical principles governing research with human beings. Inclusion criteria for the larger study were as follows: 18 years or older; a history of TBI with documented loss of consciousness or other medical evidence of a TBI (i.e., pathology on neuroimaging); at least 12 months postinjury; met diagnostic criteria for a major depressive episode using DSM-IV criteria; and able to comprehend or answer verbal or written questionnaires. Participants were included only if they were not currently receiving psychological treatment and were willing to abstain from seeking psychotherapy during the course of participation. Individuals using prescribed mood medications were not excluded if their dosage had been stable for at least 6 months. Individuals with a history of psychotic disorder, current substance abuse, pre-existing neurological disorder other than TBI or mental retardation were excluded from participation.

In total, 44 of the participants from the larger study who completed a BDI-II, both at baseline and the end of treatment, were included in the analyses. Average participant age was 48.8 years (standard deviation [SD] = 10.2) and the majority of participants were female (57.1%). In total, 57% were Caucasian, 20% were Hispanic and

15% were African–American. A total of 27% reported a high school education or less, 36.4% reported some college education or a college degree and 22.7% reported education beyond a college degree. Participants reported an average of 7.69 years since their index injury, with a range of 1–48 years. For injury severity, 9% reported an injury of mild severity, 9.3% reported an injury of moderate severity and 14% reported an injury falling into the severe category. There were no significant differences found between treatment groups with regards to time since injury ($t(42) = -1.27$; not significant) or injury severity ($\chi^2(2,n = 44) = 0.39$; not significant).

Measures & procedures

The BDI-II is a 21-item self-report instrument that assesses the severity of depression. Each item is rated on a four-point scale and the possible score ranges from 0 to 63. Validity and reliability of the BDI-II has been established for the general population [23]. Vanheule *et al.* examined ten factor structure models of the BDI-II [24] and found the model by Buckley *et al.* [25] to have the best fit. This model is comprised of cognitive, somatic and affective factors [25]. It should be noted that diagnosing major depression in individuals with TBI is complex owing to the fact that several symptoms of TBI overlap with symptoms of depression. For example, both are associated with fatigue [26], social withdrawal [27] and sleep disturbance [28]. No study to date has examined the reliability and validity of the BDI-II in a TBI sample; however, the original BDI has been shown to be reliable ($\alpha = 0.92$) in a TBI group [29].

Treatment group assignment was randomized. Participants completed the BDI-II prior to beginning treatment, at the completion of the 16-session treatment, and at a follow-up appointment 6 months after treatment ended. Participants in both groups received 16 sessions of individual treatment. The initial session lasted 90 min, with the remaining sessions lasting 50 min. Treatment duration was 3 months, with twice-weekly sessions for the first month and weekly sessions for months 2 and 3. The treatment was administered by doctoral level psychologists trained in a manualized treatment protocol for SPT or CBT. Treatment fidelity was assessed in two ways: therapists attended a weekly supervisory meeting, in which treatment session checklists were reviewed, to ensure that specified tasks were accomplished in each session; and all sessions were recorded and protocol adherence was rated by two independent evaluators who rated three randomly selected session tapes using the Collaborative Study Psychotherapy Rating Scale [30].

The CBT intervention focused on cognitive distortions described by Beck [31], and was modified to address cognitive deficits associated with TBI. The modifications were based on Hibbard and colleagues' CBT for the treatment of individuals with stroke and TBI [32]. For example, compensatory strategies to address memory problems and executive dysfunction were utilized (e.g., tape recording sessions, and using a diary to track thoughts and feelings). Therapists used cognitive restructuring techniques to challenge and reshape automatic thoughts into rational self-statements. Other CBT techniques, such as increasing social outreach and relaxation, were also utilized. The SPT intervention provided participants with an empathetic environment to discuss issues related to their depression. Therapy was focused on providing psychosocial education about depressive symptoms and promoting the participants' ability to talk about their experience of TBI and depression, without introducing any specific elements of CBT.

Results

Twenty-two participants received SPT and 22 received CBT. There were no significant differences between treatment groups regarding age ($t(41) = 0.34$; not significant), education ($\chi^2(5,n = 42) = 2.58$; not significant) or ethnicity ($\chi^2(3,n = 42) = 1.83$; not significant).

Paired t-tests with a false discovery rate correction were conducted to determine which individual symptoms of depression improved over the course of treatment and whether the symptoms that improved differed between treatment groups. The Benjamini–Hochberg procedure was used to account for multiple comparisons [33]. Participants in the CBT group reported significant improvement in sadness ($t(21) = 2.9$; $p < 0.05$; $r^2 = 0.29$), loss of interest ($t(21) = 2.9$; $p < 0.05$; $r^2 = 0.28$) and loss of interest in sex ($t(21) = 2.3$; $p < 0.05$; $r^2 = 0.20$), while participants in the SPT group reported significant improvement in agitation ($t(21) = 2.7$; $p < 0.05$; $r^2 = 0.25$) and irritability ($t(21) = 4.2$; $p < 0.01$; $r^2 = 0.45$) **(Table 1)**. Paired t-tests were also conducted to determine whether participants in either group improved on the cognitive, somatic or affective factors **(Table 2)** [25]. Participants in

Table 1. Beck Depression Inventory-II symptom means and standard deviations pre- and post-intervention.

BDI-II symptom	Preintervention mean (SD)	Postintervention mean (SD)	Difference
CBT group			
Sadness	1.27 (0.70)	0.77 (0.81)	t(22) = 2.93; p < 0.01
Pessimism	1.32 (0.95)	1.23 (0.23)	t(22) = 0.35; NS
Past failure	1.50 (1.00)	1.05 (1.01)	t(22) = 1.74; NS
Loss of pleasure	1.68 (0.80)	1.27 (0.70)	t(22) = 1.57; NS
Guilty feeling	1.23 (0.92)	0.95 (0.95)	t(22) = 1.00; NS
Punishment	0.95 (1.23)	0.64 (1.14)	t(22) = 1.00; NS
Self-dislike	1.50 (0.90)	1.09 (0.95)	t(22) = 1.44; NS
Self-critical	1.41 (1.01)	0.91 (1.10)	t(22) = 1.86; NS
Suicidal	0.68 (0.78)	0.59 (0.79)	t(22) = 0.49; NS
Crying	1.18 (0.83)	1.05 (1.04)	t(22) = 0.55; NS
Agitation	0.82 (0.85)	1.00 (1.15)	t(22) = -0.70; NS
Loss of interest	1.64 (1.09)	0.86 (1.16)	t(21) = 2.94; p < 0.01
Indecisiveness	1.14 (1.08)	1.00 (1.02)	t(22) = 0.46; NS
Worthlessness	1.36 (1.04)	0.91 (1.10)	t(22) = 1.56; NS
Loss of energy	1.41 (0.73)	1.18 (1.00)	t(22) = 0.96; NS
Sleeping patterns	1.68 (0.99)	1.55 (1.05)	t(22) = 0.50; NS
Irritability	1.18 (0.97)	0.77 (0.97)	t(22) = 2.11; NS
Appetite	0.95 (0.89)	1.00 (1.02)	t(22) = -0.24; NS
Concentration	1.45 (0.80)	1.41 (0.90)	t(22) = 0.19; NS
Fatigue	1.41 (1.00)	1.09 (0.91)	t(22) = 1.58; NS
Loss of interest in sex	1.52 (1.12)	0.95 (1.20)	t(21) = 2.34; p < 0.05
SPT group			
Sadness	1.18 (0.66)	0.82 (0.73)	t(22) = 2.01; NS
Pessimism	1.36 (1.05)	1.00 (1.02)	t(22) = 2.01; NS
Past failure	1.23 (1.11)	0.95 (0.99)	t(22) = 1.24; NS
Loss of pleasure	1.48 (0.75)	1.48 (1.03)	t(22) = 0.00; NS
Guilty feeling	0.77 (0.68)	0.68 (0.72)	t(22) = 0.57; NS
Punishment	1.00 (1.20)	0.59 (1.05)	t(22) = 1.37; NS
Self-dislike	1.32 (0.89)	1.14 (0.90)	t(22) = 0.78; NS
Self-critical	1.05 (0.89)	1.00 (0.87)	t(22) = 0.20; NS
Suicidal	0.30 (0.47)	0.32 (0.57)	t(22) = 0.00; NS
Crying	0.82 (0.85)	0.86 (0.89)	t(22) = -0.21; NS
Agitation	1.05 (0.79)	0.59 (0.67)	t(22) = 2.66; p < 0.05
Loss of interest	1.23 (1.02)	1.05 (0.95)	t(22) = 0.94; NS
Indecisiveness	1.27 (0.88)	1.23 (1.02)	t(22) = 0.22; NS
Worthlessness	0.86 (0.91)	0.91 (1.02)	t(22) = -0.025; NS
Loss of energy	1.09 (0.68)	1.32 (0.84)	t(22) = -1.31; NS
Sleeping patterns	1.39 (0.86)	1.24 (1.04)	t(22) = 0.65; NS
Irritability	1.59 (0.79)	0.082 (0.73)	t(22) = 4.17; p < 0.01
Appetite	1.05 (1.05)	1.00 (1.02)	t(22) = 0.21; NS
Concentration	1.55 (0.91)	1.45 (0.85)	t(22) = 0.46; NS
Fatigue	1.50 (0.86)	1.32 (0.99)	t(22) = 0.94; NS
Loss of interest in sex	1.30 (0.98)	1.15 (1.13)	t(22) = 0.77; NS

BDI-II: Beck Depression Inventory-II; CBT: Cognitive–behavioral therapy; NS: Not significant; SD: Standard deviation; SPT: Supportive psychotherapy.

Table 2. Beck Depression Inventory-II factor score means and standard deviations pre- and post-intervention.

Factor	Pre-intervention mean (SD)	Post-intervention mean (SD)	Difference
CBT group			
Cognitive	11.23 (5.15)	8.14 (7.51)	t(21) = 2.00; NS
Affective	5.64 (2.40)	4.19 (3.70)	t(21) = 1.86; NS
Somatic	10.67 (4.46)	8.90 (5.87)	t(21) = 1.60; NS
SPT group			
Cognitive	9.09 (5.62)	7.41 (5.99)	t(21) = 1.37; NS
Affective	4.76 (2.34)	4.57 (3.23)	t(21) = 0.36; NS
Somatic	10.26 (3.66)	8.42 (5.17)	t(21) = 2.13, $p < 0.05$

CBT: Cognitive–behavioral therapy; NS: Not significant; SD: Standard deviation; SPT: Supportive psychotherapy.

the SPT group improved significantly on the somatic factor ($t(21) = 2.1$; $p < 0.05$; $r^2 = 0.17$). Improvement on the cognitive factor approached significance in the CBT group ($t(21) = 2.07$; $p = 0.058$). No other significant improvements were found regarding factor scores.

Regarding the third hypothesis, participants in both treatment groups reported similar levels of depression (total BDI-II score) both at baseline ($t(42) = 0.98$; not significant) and the end of treatment ($t(42) = 0.09$; not significant). There were no significant differences between treatment groups on any individual BDI-II symptom at baseline. Mean BDI-II score at baseline for both groups combined was 25.9 (SD = 10.1), indicating a moderate level of depression. Participants were significantly less depressed at the end of treatment ($t(43) = 2.5$; $p < 0.05$), with a total BDI-II score for both groups combined of 21.1 (SD = 13.7). Participants in the CBT group had a decrease in total BDI-II score from 27.36 (SD = 9.72) at baseline to 21.27 (SD = 15.69) at the end of treatment. Participants in the SPT group had a decrease in total BDI-II score from 24.41 (SD = 10.20) at baseline to 20.90 (SD = 12.02) at end of treatment.

At a 6-month follow-up, improvements in symptom reports were maintained; total BDI-II score was not significantly different from end-of-treatment for the CBT group ($t(15) = 0.56$; not significant) or the SPT group ($t(12) = 0.11$; not significant). The total BDI-II score for both groups combined at the 6-month follow-up was 18.96 (SD = 13.02); for the CBT group, the total score was 18.80 (SD = 15.21) and for the SPT group, the total score was 19.15 (SD = 10.31). Participants in the CBT group continued to show improvement in sadness ($t(15) = 3.50$; $p < 0.01$; $r^2 = 0.37$), loss of interest ($t(15) = 3.05$; $p < 0.01$, $r^2 = 0.31$) and loss of interest in sex ($t(15) = 2.82$; $p < 0.05$; $r^2 = 0.27$), as compared with their baseline ratings. Participants in the SPT group continued to show improvement in agitation ($t(12) = 2.94$; $p < 0.05$; $r^2 = 0.29$) and irritability ($t(12) = 2.74$; $p < 0.05$; $r^2 = 0.26$), as compared with their baseline ratings. In addition, participants in the SPT group continued to show improvements on the somatic factor ($t(12) = 3.08$; $p < 0.05$; $r^2 = 0.44$). While the CBT group showed no significant improvement on any factor score at the end of treatment, significant improvement was reported on the cognitive factor ($t(13) = 3.53$; $p < 0.05$; $r^2 = 0.48$) and the somatic factor ($t(15) = 2.81$; $p < 0.05$; $r^2 = 0.34$) at 6 months post-treatment, as compared with baseline.

Discussion

The results of this study support the notion that different psychological treatment modalities differentially impact individual symptoms of depression. In a group of individuals with post-TBI depression, those treated with SPT and those treated with CBT demonstrated significant improvements on different sets of symptoms. Specifically, SPT targeted symptoms related to behavioral disinhibition (agitation and irritability), while CBT targeted mood symptoms (sadness) and their behavioral manifestations (loss of interest and loss of interest in sex). This supported our hypothesis regarding CBT targeting mood symptoms, but did not support our hypothesis regarding SPT targeting symptoms related to social support, such as failure and loss of pleasure.

Our results were consistent with the non-TBI literature comparing the impact of cognitive therapy versus medication on individual symptoms of depression. These studies examined the time course of symptom improvement, and

found that vegetative symptoms improve first in patients treated with antidepressant medication, while mood and cognitive symptoms improve first in patients treated with psychotherapy [20,21]. The present study is the first to examine these issues in a TBI sample and confirms the finding in non-TBI samples that different methods of treatment impact individual symptoms differently. Furthermore, the present study expands this finding by demonstrating that this concept also applies to different modalities of psychotherapy. Not only do patients treated with antidepressant medication experience a different pattern of symptom relief compared with those treated with psychotherapy, but patients treated with cognitive therapy experience a different pattern of symptom relief compared with those treated with SPT. Additionally, the present study demonstrates that the differential effects of CBT and SPT continue after treatment has ended. Individuals treated with CBT maintained their treatment gains in mood symptoms and their behavioral manifestations 6 months after the end of treatment, while individuals treated with SPT continued to show significant improvement in symptoms related to behavioral disinhibition. Limited literature has suggested that the differential effects of treatment may only apply to the earlier stages of treatment, and that by the end of treatment, different treatment modalities have a similar impact on individual symptoms of depression [22]. Our study demonstrates that not only do different psychotherapeutic modalities have a differential impact at the end of treatment, but that this difference also is present 6 months post-treatment. This underscores the long-term importance of prescribing a particular treatment modality based on symptom presentation.

There are several limitations to this study that should be addressed by future research. The first is the small sample size and low statistical power, which limits generalizations that can be made from these findings. Second, generalizations that can be made from this study are restricted by the fact that the participants were all at least 12 months postinjury, limiting conclusions with regards to individuals in the acute stage after TBI. Similarly, these results may only apply to depression in the context of brain injury. As noted, there is significant overlap between the symptoms of depression and brain injury [5], and it is difficult to determine whether this overlap had an impact on the results. Third, individual symptoms were not assessed throughout the course of treatment in the present study, but only prior to beginning treatment and at the end of treatment. Future studies would benefit from assessing the longitudinal course of symptom change throughout treatment to determine if individual symptom improvements occur at different rates in different treatment modalities. Future research should include a broader range of symptoms in examining the relationship between symptom profiles and treatment modality. Finally, conclusions drawn from these data are limited due to the fact that these were *post hoc* analyses. Future studies designed prospectively to compare individual symptom differences after treatment with CBT and SPT would allow for stronger conclusions regarding treatment practices.

Although preliminary, these findings are clinically significant in suggesting that different methods of psychotherapy may treat depression through different mechanisms. Future studies should prospectively examine whether post-TBI depression can be treated more effectively by prescribing treatment based on the clinical presentation of individual patients. This represents a paradigm shift in the way that psychiatric symptoms are currently treated in individuals with and without TBI. Symptoms of MDD vary greatly between individuals [16] and it is clear that there is variability in individual patients' responses to treatment [34]. A large degree of the variability may be accounted for by differences in presenting symptoms. Depression, therefore, may be most effectively and efficiently treated by tailoring treatment methods to presenting symptoms. In light of the high prevalence of post-TBI depression and the considerable impact it has on many facets of functioning [7], it is important to further explore this promising new approach to treatment.

Conclusion & future perspective

Patients with MDD following a TBI are currently treated as a uniform group when considering treatment options. The present study suggests that these patients may be better served by prescribing a particular treatment based on patients' presenting symptoms, rather than diagnosis. Individualizing patient treatment based on their particular cluster of presenting symptoms may result in more efficient and effective alleviation of symptoms. The current

study found that CBT targeted mood symptoms, while SPT targeted symptoms related to behavioral disinhibition. Future research is needed to explore other treatment modalities and their differential impact on mood symptoms. Overall, a shift towards more individualized treatment for mental health problems is a promising new approach to treatment. It is hoped that this study will impact future research and clinical practices by contributing to a movement towards individualizing treatment for depression and other psychiatric illnesses. Additionally, it is anticipated that the present study will add to a body of literature exploring the specific strengths and weaknesses of different treatment modalities, with the end goal of creating treatment guidelines that will allow us to more effectively and efficiently treat symptoms of depression.

Financial & competing interests disclosure

This work was supported by grants H133B040033 and H133P100016/H133P050004 from the National Institute on Disability and Rehabilitation Research, US Department of Education. The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript apart from those disclosed.

No writing assistance was utilized in the production of this manuscript.

Ethical conduct of research

The authors state that they have obtained appropriate institutional review board approval or have followed the principles outlined in the Declaration of Helsinki for all human or animal experimental investigations. In addition, for investigations involving human subjects, informed consent has been obtained from the participants involved.

References

Papers of special note have been highlighted as:

- ■ of interest
- ■■ of considerable interest

1 Fann JR, Katon WJ, Uomoto JM, Esselman PC. Psychiatric disorders and functional ability in outpatients with traumatic brain injuries. *Am. J. Psychiatry* 152(10), 1433–1499 (1995).

2 Hibbard MR, Uysal S, Kepler K, Bogdany J, Silver J. Axis I psychopathology in individuals with traumatic brain injury. *J. Head Trauma Rehabil.* 13, 24–39 (1998).

3 Van Reekum R, Bolago I, Finlayson MS, Garner A, Links PS. Psychiatric disorders after traumatic brain injury. *Brain Injury* 10, 319–327 (1996).

4 Tsaousides T, Ashman TA, Gordon WA. Diagnosis and treatment of depression following traumatic brain injury. *Brain Impairment* 14(1), 63–76 (2013).

■ **Provides a narrative review and summary of all current diagnostic and treatment issues related to depression after traumatic brain injury (TBI). Discusses the need for more research examining behavioral treatments for post-TBI depression.**

5 Whelan-Goodinson R, Ponsford J, Schonberger M. Validity of the Hospital Anxiety and Depression Scale to assess depression and anxiety following traumatic brain injury as compared with the Structured Clinical Interview for DSM-IV. *J. Affect. Disord.* 114, 94–102 (2009).

6 Kessler RC, Chiu WT, Demler O, Walters EE. Prevalence, severity and comorbidity of twelve-month DSM-IV disorders in the national comorbidity survey replication (NCS-R). *Arch. Gen. Psychiatry* 62(6), 617–627 (2005).

7 Fann JR, Hart T, Schomer KG. Treatment for depression after traumatic brain injury: a systematic review. *J. Neurotrauma* 26(12), 2383–2402 (2009).

■ **Review of 57 papers examining treatment for post-TBI depression that supports the efficacy of serotonergic antidepressants and cognitive–behavioral therapy for post-TBI depression.**

8 Seel RT, Macciocchi S, Kreutzer JS. Clinical considerations for the diagnosis of major depression after moderate to severe TBI. *J. Head Trauma Rehabil.* 25(2), 99–112 (2010).

9 Hibbard MR, Ashman TA, Spielman LA, Chun D, Charatz HJ, Melvin S. Relationship between depression and psychosocial functioning after traumatic brain injury. *Arch. Phys. Med. Rehabil.* 85(4 Suppl. 2), S43–S53 (2004).

10 Rapoport MJ, McCullagh S, Streiner D, Feinstein A. The clinical significance of major depression following mild traumatic brain injury. *Psychosomatics* 44(1), 31–37 (2003).

11 Cuijpers P, van Straten A, Warmerdam L, Andersson G. Psychological treatment of depression: a meta-analytic database of randomized studies. *BMC Psychiatry* 8, 36 (2008).

12 Ashman TA, Cantor JB, Gordon WA *et al.* A randomized controlled trial of sertraline for the treatment of depression in persons with traumatic brain injury. *Arch. Phys. Med. Rehabil.* 90(5), 733–740 (2009).

13 Kennedy SH, Evans KR, Kruger S *et al.* Changes in regional brain glucose metabolism measured with positron emission tomography after paroxetine treatment of major depression. *Am. J. Psychiatry* 158, 899–905 (2001).

14 McGrath C, Kelley M, Holtzheimer P *et al.* Towards a neuroimaging treatment selection biomarker for major depressive disorder. *JAMA Psychiatry* 70(8), 821–829 (2013).

■■ **In an effort to begin to identify biomarkers for treatment response to psychotherapy versus psychopharmacology, depressed patients treated with cognitive–behavioral therapy or escitalopram oxalate displayed different patterns of brain glucose metabolism when examined after treatment with PET scans.**

15 Siegle GJ, Thompson WK, Collier A *et al.* Toward clinically useful neuroimaging in depression treatment: prognostic utility of subgenual cingulate activity for determining depression outcome in cognitive therapy across studies, scanners, and patient characteristics, sgACC and cognitive therapy outcome. *Arch. Gen. Psychiatry* 69(9), 913–924 (2012).

16 Grove WM, Andreasen NC. Concepts, diagnosis and classification. In: *Handbook of Affective Disorders (2nd Edition)*. Paykel ES (Ed.). Guilford Press, NY, USA, 25–41 (1992).

17 Mayberg HS, Brannan SK, Tekell JL *et al.* Regional metabolic effects of fluoxetine in major depression: serial changes and relationship to clinical response. *Biol. Psychiatry* 48, 830–843 (2000).

18 Passero S, Nardini M, Battistini N. Regional cerebral blood flow changes following chronic administration of antidepressant drugs. *Prog. Neuropsychopharmacol. Biol. Psychiatry* 19, 627–636 (1995).

19 Goldapple K, Segal Z, Garson C *et al.* Modulation of cortical–limbic pathways in major depression: treatment-specific effects of cognitive behavior therapy. *Arch. Gen. Psychiatry* 61(1), 34 (2004).

■■ **Functional imaging revealed regional changes following treatment of depressed patients with cognitive–behavioral therapy. These changes were in different regions than the changes seen in other studies following treatment of depressive symptoms with antidepressants.**

20 Rush AJ, Kovacs M, Beck A, Weissenburger J, Hollon S. Differential effects of cognitive therapy and pharmacotherapy on depressive symptoms. *J. Affect. Disord*. 3(3), 221–229 (1981).

■ **Depressed outpatients treated with cognitive therapy and antidepressants were compared. Individuals treated with cognitive therapy showed improvements in hopelessness, self-perception and mood.**

21 DiMascio A, Weissman MM, Prusoff BA, Neu C, Zwilling M, Klerman GL. Differential symptom reduction by drugs and psychotherapy in acute depression. *Arch. Gen. Psychiatry* 36(13), 1450–1456 (1979).

22 Bhar SS, Gelfand LA, Schmid SP *et al.* Sequence of improvement in depressive symptoms across cognitive therapy and pharmacotherapy. *J. Affect. Disord*. 110(1), 161–166 (2008).

■ **Depressed outpatients treated with cognitive therapy or antidepressants showed the same pattern of individual symptom response on the Beck Depression Inventory-II throughout the course of treatment.**

23 Beck AT, Steer RA, Brown GK. *Beck Depression Inventory (BDI-II).* Psychological Corporation, TX, USA (1996).

24 Vanheule S, Desmet M, Groenvynck H, Rosseel Y, Fontaine J. The factor structure of the Beck Depression Inventory-II: an evaluation. *Assessment* 15, 177–187 (2008).

25 Buckley TC, Parker JD, Heggie J. A psychometric evaluation of the BDI-II in treatment-seeking substance abusers. *J. Subst. Abuse Treat.* 20, 197–204 (2001).

26 Ziino C, Ponsford J. Selective attention deficits and subjective fatigue following traumatic brain injury. *Neuropsychology* 20, 383–390 (2006).

27 Ponsford J, Sloan S, Snow P. *Traumatic Brain Injury: Rehabilitation for Everyday Adaptive Living.* Psychology Press, Hove, UK (1995).

28 Vela-Bueno A, Bixler EOVAN. Sleep disorders in patients with traumatic brain injury. In: *Brain Injury Treatment: Theories and Practice*. Leon-Carrion J, Von Wild KRH, Zitnay GA (Eds). Taylor & Francis, PA, USA (2006).

29 Green A, Felmingham K, Baguley IJ, Slewa-Younan S, Simpson S. The clinical utility of the Beck Depression Inventory after traumatic brain injury. *Brain Injury* 15(12), 1021–1028 (2001).

30 Hill CE, O'Grady KE, Elkin I. Applying the collaborative study psychotherapy rating scale to rate therapist adherence in cognitive–behavior therapy, interpersonal therapy, and clinical management. *J. Consult. Clin. Psychol*. 60(1), 73 (1992).

31 Beck AT, Rush AJ, Shaw BF, Emery G. *Cognitive Therapy of Depression.* Guilford Press, NY, USA (1979).

32 Hibbard MR, Gordon WA, Egelko S, Langer K. Issues in the diagnosis and cognitive therapy of depression in brain-damaged individuals. In: *Cognitive Therapy: Applications in Psychiatric and Medical Settings*. Human Sciences Press, NY, USA (1987).

33 Benjamini Y, Yekutieli D. The control of the false discovery rate in multiple testing under dependency. *Annals Statistics* 29(4), 1165 (2001).

34 Warden D, Rush AJ, Trivedi MH, Fava M, Wisniewski SR. The STAR* D project results: a comprehensive review of findings. *Curr. Psychiatry Rep*. 9(6), 449–459 (2007).