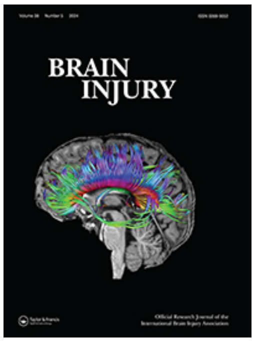

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Metacognitive accuracy predicts self-reported quality of life following traumatic brain injury

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ABSTRACT

Objective: Metacognition and quality of life (QoL) are both adversely affected by traumatic brain injury (TBI), but the relation between them is not fully understood. As such, the purpose of this study was to determine the degree to which metacognitive accuracy predicts QoL in individuals with TBI.
Methods: Eighteen participants with moderate-to-severe TBI completed a stimulus-response task requiring the discrimination of emotions depicted in pictures of faces and then provided a retrospective confidence judgment after each response. Metacognitive accuracy was calculated using participants' response accuracy and confidence judgment accuracy. Participants also completed the Quality of Life After Brain Injury (QOLIBRI) questionnaire to assess QoL in various areas of functioning.
Results: Performance of a linear regression analysis revealed that higher metacognitive accuracy significantly predicted lower overall QoL. Additionally, higher metacognitive accuracy significantly predicted lower QoL related to cognition and physical limitations.
Conclusion: The study results provide evidence of an inverse relation between metacognitive performance and QoL following TBI. Metacognitive changes associated with TBI and their relation to QoL have several clinical implications for TBI rehabilitation.

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Traumatic brain injury

Traumatic brain injury (TBI) is a prominent cause of morbidity in the United States. Estimates indicate that about two million individuals in the United States experience TBI each year, with an annual incidence of 180–250 people per 100,000 reported (1). Common symptoms include cognitive and sensory deficits, mood changes, motor impairment, endocrine and sleep dysregulation, and pain (2). Among the cognitive alterations observed following TBI is decreased metacognitive awareness (3).

Effects of TBI on metacognition

Metacognition refers to the interoceptive ability to observe, monitor, and make judgments about one's own cognitive status (4). It can also act as a regulatory process that calibrates an individual's perception of their cognitive performance to choreograph compensatory behavior, such as increasing or decreasing the effort given to a specific task (5). Theoretical models propose that metacognitive monitoring relies on two distinct processes. Prospective judgments refer to predictions made about how one will perform on a task, while retrospective judgments refer to one's assessment of their performance after completing a task (5). Metacognitive accuracy reflects the amount of discrepancy between one's subjective judgments and objective task performance, and is a useful indicator of metacognitive functioning (5).

Metacognition is a complex neuropsychological phenomenon that requires the cooperation of various brain regions to engage in the active monitoring and calibration of cognitive processes. Magnetic resonance imaging shows that areas within the prefrontal and cingulate cortices comprise a distinct neural network for metacognition (6). Additionally, functional activation of these structures is associated with confidence rating accuracy and response time following perceptual decision-making tasks (7). Notably, the neural structures implicated in metacognitive functioning are also those that are highly susceptible to injury in TBI. Thus, alterations to structure and functional activation of neural systems in TBI may lead to a greater risk of disrupted metacognitive processing. Indeed, in the TBI population, prefrontal gray matter volume and white matter microstructural integrity are linked with metacognitive accuracy after injury (3,8). Enhanced default mode network connectivity also correlates closely with greater metacognitive performance following TBI (9). New structural and functional imaging findings are likely to continue elucidating the precise neurobiological mechanisms by which TBI precipitates metacognitive impairment.

Complementing the findings of altered neural structure and functioning associated with post-injury metacognitive functioning, behavioral studies show that individuals with TBI exhibit poorer metacognitive accuracy than healthy controls (3,10). Additionally, the speed with which individuals with TBI

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render confidence judgments of their task performance is longer than that of healthy controls (11). These findings point to an underlying mechanism by which TBI induces a breakdown in metacognitive processing, either directly or via dysregulation of lower-order cognitive functions. Importantly, metacognitive impairments may threaten skills critical to daily functioning following TBI. Thus, studying changes in metacognition associated with TBI may help to better elucidate the role they play in functional outcomes for survivors, including responses to rehabilitative treatment and long-term prognoses (12,13).

Metacognition and quality of life after TBI

Quality of life (QoL), as a unitary measure, captures one's overall opinion of their ability to enjoy and participate fully in daily activities (14). Many QoL surveys incorporate items that distinguish between separate, but interrelated, domains of wellbeing; subscales used to assess these domains require individuals to rate their self-perceptions about cognitive, physical, psychosocial, and occupational functioning (15). Decreases in QoL following TBI are well-documented (16) and are strongly associated with injury severity (17) and functional autonomy (18). The extent of TBI-related cognitive impairment is also a robust predictor of QoL, with worse QoL ratings associated with more extensive cognitive impairment (19–21) Alterations in self-awareness, more broadly, are consistent phenomena associated both with TBI and poor QoL (22,23). Self-awareness changes also hinder the development of coping skills during the rehabilitation process (24). Given that metacognition is a facet of self-awareness (25) and that the two constructs potentially share underlying neural mechanisms (26), it is highly possible that a direct link exists between metacognition and QoL after TBI.

Documented relationships between metacognition and QoL in other neuropsychiatric conditions also support the notion that such an association may be present in TBI. Metacognition may mediate the effect of neurocognitive decline on functional outcomes related to QoL in psychotic disorders (27). Individuals with schizophrenia who possess greater metacognitive insight also exhibit improved motivation and willingness to reengage in social and occupational activities (27). In individuals with mild cognitive impairment and Alzheimer's disease, metacognitive functioning corresponds with preserved daily living activities and higher QoL (28,29). Integrity of metacognitive functioning also correlates with better self-efficacy, response to rehabilitative treatment, and QoL after ischemic stroke (30). Although a majority of the existing literature suggests a direct positive relationship between metacognition and QoL measures, a subset of research has found inverse effects. For example, one study of individuals with mild cognitive impairment and Alzheimer's disease revealed that those with better awareness of their cognitive deficits endorsed more struggles with daily functioning and worse QoL (31). Similar results appeared in a study of individuals with schizophrenia in which greater insight predicted higher levels of self-stigma and reduced QoL (32). Extending speculation to survivors of TBI, metacognitive performance may impact ratings of QoL after injury in one of two ways. First, those with better preserved metacognitive performance may more easily identify their cognitive limitations and rely on behavioral strategies and resources to compensate for them, leading to higher QoL. Alternatively, such individuals may be more aware of and bothered by injury-related impairments, thus causing greater dissatisfaction and poorer QoL. The greater number of findings confirming a positive relation between metacognitive performance and QoL in other neuropsychiatric conditions suggests that the first scenario is the more likely of the two.

This study sought to capitalize on the convergence of existing research to identify and characterize interactions between metacognitive functioning and QoL in a TBI sample. Towards this goal, the study evaluated (1) correlations between metacognitive performance and post-injury QoL, and (2) the predictive utility of metacognitive performance for quantifying post-injury QoL. Given that a positive relation occurred more frequently than negative ones in studies of similar clinical populations, our initial hypothesis was that worse metacognitive performance would be associated with and predictive of poorer QoL after TBI. A broader study objective was to provide evidence about the relation between metacognition and QoL in TBI given that such information could have implications for TBI assessment and rehabilitation.

Methods

Participants

Eighteen adults with a history of moderate to severe TBI served as study participants. Recruitment took place on the University of Nebraska – Lincoln campus, at local area hospitals, rehabilitation facilities, and in public community spaces. Included participants were between the ages of 19 and 70 years, were fluent in spoken and written English, and possessed sufficient gross motor function to make basic keyboard inputs. Reviews of medical record confirmed participants' TBI history. Injury severity was determined by documented Glasgow Coma Scale scores of 13 or under, post-traumatic amnesia for greater than one hour, and/or positive findings on neuroradiological exams. To accommodate the elevated rates of mood disorders in the TBI population, a current or past psychiatric diagnosis did not prohibit study participation. Instead, we assessed the influence of mood symptoms on study outcomes in post-hoc analyses. Performance of experimental tasks occurred during a single session in which participants provided informed consent, completed a series of computerized tasks, and answered several demographic and mood-related questionnaires. The study procedures were completed in compliance with the protocol approved by the University of Nebraska – Lincoln Institutional Review Board (IRB Approval Code: 20180618123EP).

Metacognitive task design

We assessed metacognitive accuracy using a stimulus-response, computerized task requiring the discrimination of emotions expressed by pictures of faces and collection of retrospective confidence judgments. Each stimulus picture was a face that had a blend of two of the following emotions: happiness, sadness, anger, disgust, fear, and surprise. Face stimuli were from the Karolinska Directed Emotional Faces (KDEF; https://www.emotionlab.se/kdef/), a database of human expressions of emotion originally developed for psychological and medical research purposes (33). Two images of faces expressing different emotions were overlaid to form a single composite image using Abrosoft FantoMorph software such that one emotion was more prominent than the other. Using a button-push, participants indicated whether or not ('yes' or 'no') the prominent emotion of a stimulus matched the name of the emotion prompted above it (e.g., 'Happy?'). Participants had to identify the prominent emotion in four task runs displaying different combinations of the six emotions. To minimize potential response bias and promote variability in confidence judgments, each run contained three trial conditions of increasing difficulty based on the extent of emotion blending. Easy trials did not have any blend of emotions, medium difficulty trials had a blend of 80%/20% of two emotions, and difficult trials had a blend of 60%/40% of two emotions. Directly following each response, participants used a button-push to select 'confident' or 'not confident' to describe how they felt about their response accuracy. Participants completed 4 task runs consisting of 36 items each, for a total of 128 items. Task data were collected and analyzed for all of the 18 participants.

Calculation of metacognitive task accuracy

We evaluated participants' response accuracy and confidence judgment accuracy following task administration using type 2 signal detection theory (SDT) analysis. This analysis uses an equation (see Maniscalco & Lau (34) for the mathematical equation and access to MATLAB code) that compares hit rates (i.e., confidence judgments correctly match response accuracy) to miss rates (i.e., confidence judgments are discrepant from response accuracy) (34). The degree to which participants' confidence reflects their actual performance is calculated using two levels of data: 'type 1' data (i.e., correct and incorrect discrimination of emotions), and 'type 2' data (participants' confidence in response accuracy) (34,35) The value produced by the analysis, called meta-d', represents participants' metacognitive accuracy for each task trial. Specifically, a higher meta-d' corresponds to better metacognitive accuracy. For every participant, meta-d' for each of the four runs was averaged to form a composite meta-d' for use in subsequent statistical analyses.

Questionnaires

Participants completed the Quality of Life After Brain Injury (QOLIBRI) questionnaire to provide a self-report rating of their QoL. The QOLIBRI is a 37-question survey that encompasses satisfaction with functioning after TBI in the areas of cognition, self-esteem, autonomy, social relationships, emotions, and physical limitations (36). A higher score denotes a better QoL rating. In addition to the total QOLIBRI score, we used QOLIBRI subscale scores to determine if metacognition differentially affects QoL in each of the six functional areas. Participants also completed the Chicago Multiscale Depression Inventory (37) (CMDI) and State-Trait Anxiety Inventory (38) (STAI) to measure levels of depression and anxiety, respectively. We used CMDI and STAI scores to control for the effect of mood symptoms on the metacognition-QoL relation.

Statistical analyses

We computed the bivariate correlation to identify the relation between participants' composite meta-d' and their total and subscale QOLIBRI scores. We expected the composite meta-d' to correlate positively with total and subscale QOLIBRI scores based on the direct relation between metacognitive performance and QoL frequently observed in other studies. Given its thematic relatedness to metacognition, we expected the cognitive subscale score to show the strongest correlation with composite meta-d' compared to the other subscale scores. We also computed a hierarchical linear regression to assess whether participants' composite meta-d' predicted their total and subscale QOLIBRI scores when accounting for their CMDI and STAI scores. We expected the composite meta-d' to predict total and subscale QOLIBRI scores above and beyond the effects of CMDI and STAI scores.

Results

Sample characteristics

The sample characteristics are displayed in Table 1. Participants had a mean age of 35.9 years ($\sigma = 10.3$), 14.3 years ($\sigma = 2.2$) of education, and were 3.5 years ($\sigma = 6.5$) post injury. 66.7% of participants identified as male and 33.3% as female. The mechanism of participants' most severe TBI consisted of 45.5% falls, 27.3% hits, and 27.3% motor vehicle accidents. On average, participants scored 13.9 ($\sigma = 6.0$) on the CMDI. Average STAI State and STAI Trait scores were 36.8
($\sigma = 13.5$) and 38.4 ($\sigma = 13.7$), respectively.

When the three difficulty trials were combined across all four task runs, participants' task accuracy was 47.1% ($\sigma = 17.7$) and they gave 'confident' retrospective judgments at a rate of 71.4% ($\sigma = 23.0$). By subtracting task accuracy from the rate of confident retrospective judgments, the positive value produced (24.3) shows that participants tended to respond overconfidently. Averaging participants' meta d' across all four task runs revealed a mean composite meta d' of 0.237 ($\sigma = 0.538$). Participants' average total QOLIBRI score was 63.401 ($\sigma = 17.609$). An examination of the QOLIBRI subscales showed the following averages in each area: cognition = 3.341 ($\sigma = 1.047$), self-esteem = 3.341 ($\sigma = 1.047$), autonomy = 3.378 ($\sigma = 1.069$), social relationships = 3.815 ($\sigma = 0.840$), emotions = 3.900 ($\sigma = 0.786$), and physical limitations = 3.267 ($\sigma = 0.876$).

Correlational results

Bivariate correlations, shown in Table 2, revealed that higher composite meta d', indicative of better metacognitive accuracy, was significantly associated with lower total QOLIBRI scores, or poorer overall QoL ($r = -0.495$, $p = 0.037$). Significant

Table 1. Sample demographics, TBI Characteristics, and psychiatric symptom severity.

Characteristic ($n = 18$)	Mean (σ)/Frequency
Age (years)	35.9 (10.3)
Gender	
Male	66.7%
Female	33.3%
Education (years)	14.3 (2.2)
Time since injury (years)	3.5 (6.5)
Mechanism of Injury	
Fall	45.5%
Hit	27.3%
Motor vehicle accident	27.3%
CMDI score	13.9 (6.0)
STAI State score	36.8 (13.5)
STAI Trait score	38.4 (13.7)

Table 2. Correlations between meta d' and QOLIBRI scores.

Score ($n = 18$)	Mean (σ)	Pearson's r	p
Total Sum	63.401 (17.609)	−0.495	0.037
Cognition	3.341 (1.047)	−0.542	0.020
Self-Esteem	3.341 (1.047)	−0.368	0.133
Autonomy	3.378 (1.069)	−0.220	0.397
Social Relationships	3.815 (0.840)	−0.097	0.700
Emotions	3.900 (0.786)	−0.438	0.069
Physical Limitations	3.267 (0.876)	−0.693	0.001

inverse associations were also present between composite meta d' and the cognition and physical limitations subscale scores ($r = -0.542$, $p = 0.020$; $r = -0.693$, $p = 0.001$, respectively), suggesting that greater metacognitive accuracy was associated with lower satisfaction of cognitive and physical functioning. In contrast, metacognitive accuracy was not related to one's satisfaction with their sense of independence, nor their social and emotional functioning, as the self, autonomy, social, and emotions subscale scores did not correlate significantly with composite meta d'.

Prediction of QoL using metacognitive accuracy

Performance of linear regression analyses before accounting for mood symptoms revealed that higher composite meta d' significantly predicted lower total QOLIBRI scores ($\beta = -0.495$, $p = 0.037$) and lower cognition and physical limitations subscale scores ($\beta = -0.542$, $p = 0.020$; $\beta = -0.693$, $p = 0.001$, respectively). When we added CMDI and STAI scores to the regression model, as shown in Table 3, composite meta d' remained significantly predictive of the subscale scores but not of the total score (Total: $\beta = -0.487$, $p = 0.099$; Cognition: $\beta = -0.507$, $p = 0.050$; Physical limitations: $\beta = -0.649$, $p = 0.016$), indicating that the relationship between metacognitive accuracy and certain domains of QoL is not entirely dependent upon psychiatric functioning.

Discussion

The purpose of this study was to evaluate the relation between metacognitive performance and self-assessment of QoL by individuals with TBI. Our hypothesis that lower metacognitive accuracy would correspond with reduced self-reported QoL was not confirmed. Instead, statistical results revealed a significant negative correlation between participants' metacognitive accuracy and self-reported QoL such that lower metacognitive accuracy correlated with better self-reported QoL. A second aim of this study was to determine whether participants' metacognitive accuracy was predictive of their self-rated QoL following injury. Ignoring the influence of mood symptoms, results from regression analyses revealed that better metacognitive accuracy significantly predicted worse overall QoL and QoL specific to participants' cognition and physical limitations. Metacognitive accuracy no longer predicted overall QoL after accounting for participants' depression and anxiety symptoms, but its ability to predict QoL specific to cognition and physical limitations persisted.

Relationships between metacognitive performance and post-morbid QoL in other neurocognitive disorders typically demonstrate a positive association. Given that TBI shares many clinical features of these disorders, including impaired metacognition, we incorrectly hypothesized results conforming to the cross-diagnostic consensus that better-preserved metacognitive functioning bodes well for one's QoL. Instead, the inverse association aligns with a subset of reports that link greater metacognitive awareness to worse self-assessment of daily functioning and increased self-stigmatization (31,32). A possible explanation for this paradoxical finding is that individuals with TBI who retain metacognitive insight are sensitive to and bothered by injury-related cognitive impairments, leading to lower self-reported QoL. Conversely, those with limited deficit awareness are unlikely to report difficulties with functioning that cause distress, thus leading to a higher self-reported QoL by comparison.

Examination of individual domains of functioning assessed by the QOLIBRI revealed that participants' perceptions of their cognitive functioning and physical limitations correlated most strongly with and were predictive of their metacognitive accuracy. The relation observed between metacognitive accuracy and cognition-related QoL is not surprising given that the role of metacognition is to monitor cognitive processes. However, as with overall QoL, its inverse relation to metacognitive performance contradicts the bulk of findings from existing literature. Although additional research is necessary, this result supports the conjecture that cognitive deficits are more salient to individuals with TBI who possess intact metacognition, thus leading to greater distress and lower self-reported QoL.

The identified association between metacognitive accuracy and QoL pertaining to physical limitations requires careful consideration. One possibility for the strength of this relation is that, in addition to their cognitive symptoms, those with sharper metacognitive faculties are more perceptive of and troubled by somatic TBI symptoms that limit daily activities, such as chronic pain and fatigue. Alternatively, this finding may represent a type of response bias in which individuals tend to group cognitive and physical complaints under the umbrella of health-related QoL, thus contributing to similar associations with metacognitive functioning. Overlapping verbiage between some QOLIBRI cognition and physical limitation items supports this speculation. For example, the sixth question about cognition, that is, 'How satisfied are you with your ability to find your way around?,' may be comparable to the

Table 3. Prediction of QOLIBRI scores using meta d'.

Regression Model ($n = 18$)	*SE*	ß	*p*	*F*	R^2
Total Sum					
Overall Model				1.596	0.367
CMDI Score	1.199	−0.055	0.847		
STAI State Score	0.484	0.283	0.462		
STAI Trait Score	0.466	−0.584	0.135		
Meta d'	9.162	−0.487	0.099		
Cognition					
Overall Model				1.585	0.366
CMDI Score	0.072	−0.049	0.865		
STAI State Score	0.028	−0.442	0.248		
STAI Trait Score	0.029	−0.296	0.442		
Meta d'	0.547	−0.507	0.050		
Self-Esteem					
Overall Model				0.728	0.209
CMDI Score	0.069	−0.164	0.612		
STAI State Score	0.027	−0.436	0.305		
STAI Trait Score	0.028	0.408	0.345		
Meta d'	0.528	−0.334	0.292		
Autonomy					
Overall Model				1.913	0.433
CMDI Score	0.079	0.095	0.730		
STAI State Score	0.028	−0.897	0.031		
STAI Trait Score	0.030	0.416	0.275		
Meta d'	0.559	−0.333	0.232		
Social Relationships					
Overall Model				1.277	0.317
CMDI Score	0.060	−0.154	0.608		
STAI State Score	0.023	−0.366	0.352		
STAI Trait Score	0.024	−0.161	0.683		
Meta d'	0.458	0.100	0.727		
Emotions					
Overall Model				1.080	0.282
CMDI Score	0.057	−0.179	0.561		
STAI State Score	0.022	0.539	0.190		
STAI Trait Score	0.023	0.347	0.398		
Meta d'	0.433	−0.346	0.255		
Physical Limitations					
Overall Model				3.250	0.542
CMDI Score	0.052	0.059	0.808		
STAI State Score	0.020	0.356	0.273		
STAI Trait Score	0.021	−0.269	0.412		
Meta d'	0.400	−0.657	0.016		

first question about physical limitations, that is, 'How bothered are you by slowness and/or clumsiness of movement?'

While the associations observed between metacognitive accuracy and QoL in this study differ from those more-commonly described in the broader metacognition literature, they parallel some findings, including those specific to TBI, that involve overarching processes like self-awareness. Better-preserved self-awareness is linked to more depressive symptomology and poorer QoL in several studies of individuals with chronic moderate-to-severe TBI (22,39). One study utilizing the QOLIBRI determined that greater self-awareness was associated with lower scores on the cognition and self-perception subscales (39). Another study found that greater self-awareness was linked to more self-reported memory complaints and cognitive impairment following TBI (22). On the other hand, better-preserved executive functioning, another process important for metacognition, is more often correlated with higher QoL following TBI (40,41). Improvements in executive functioning appear to coincide with increases in QoL during TBI recovery (40). Intact executive functioning also predicts engagement in coping strategies after TBI that facilitate better QoL (41). Along with the current results, the irregular pattern of findings involving these broader processes suggests that the relationship between metacognition and QoL following TBI may be more complex than previously thought.

Metacognitive accuracy also appeared as a viable predictor of participants' self-reported QoL. Inclusion of the contribution of mood symptoms boosted the predictive value of metacognitive accuracy scores to overall QoL; however, metacognitive accuracy predicted QoL in the domains of cognition and physical limitations independent of these symptoms. Although researchers have identified emotional dysregulation as a factor impacting post-TBI QoL (16), the current finding suggests that metacognition influences some aspects of QoL through a separate mechanism. Future researchers may wish to explore more precisely how metacognition affects these aspects of QoL in the context of TBI.

From a clinical perspective, the results of this study highlight the importance of assessing metacognitive functioning as a routine part of neuropsychological examinations following TBI. The inverse relation between metacognition and QoL warrants consideration when pursuing rehabilitation strategies that focus on developing metacognitive abilities. Although these interventions may improve functional prognoses and promote successful community re-integration, the possibility exists that they may also have a detrimental effect on satisfaction with life after injury. Elevated discontent may hinder engagement with rehabilitation, illustrating a potential mismatch between clinicians' treatment priorities and survivors' perceptions about treatment benefits. Additionally, people with TBI may expect that improvements in metacognition will generalize to improvements in other areas of functioning. When this expectation is not met, subsequent disappointment may promote a bleak outlook on life after injury. Clinicians need to take care to set realistic expectations with their clients to minimize this unintended risk.

Some limitations of this study warrant discussion. First, the metacognitive task only measured participants' judgments about their emotion discrimination capabilities. Meta-emotion recognition is one form of metacognition, but there are others that may also be related to self-reported QoL, such as meta-memory. Because the task design did not examine these other metacognitive subtypes, how each interacts differently with QoL remains an open question. Similarly, only the accuracy of participants' retrospective confidence judgments was used to describe their metacognitive performance. Other aspects of metacognitive monitoring that this study did not evaluate, such as prospective prediction of task performance, may possess different relationships with QoL. We also calculated participants' metacognitive accuracy across all face stimuli without differentiating between individual emotions. Some emotions may be easier or harder to identify and may therefore give more or less weight to the value of meta d'. Additional research is necessary to better understand how the emotional valence of face stimuli affects metacognitive accuracy. To our knowledge, this is also the first task in the TBI literature to examine metacognitive judgments made about emotion recognition. While utilization of this task has facilitated the investigation of a novel metacognitive domain ('meta-emotional recognition'), additional studies in the future should be undertaken to validate the experimental task. Beyond the limitations of the task, the small sample size of this study is important to acknowledge, and should be bolstered in future studies to help replicate and strengthen the current results. Additionally, this study did not investigate how metacognition-QoL associations differ in individuals with TBI when compared to the general population. Future studies should incorporate a healthy control group to help characterize these differences and their relation to impaired metacognitive functioning after TBI.

Conclusion

This current study findings showed that people with TBI reported worse QoL when they performed more accurately on a test of metacognition. This contributes to the otherwise scarce literature concerning metacognition and QoL in the TBI population. However, additional research is needed to test hypotheses that explain why people with better preserved metacognitive performance endorse lower QoL. Future researchers may also wish to examine the specific mechanisms by which TBI-induced metacognitive changes impact survivors' daily functioning and how they perceive their QoL. Beyond the scope of academic research, the results of this study spur clinical considerations relating to survivors' metacognitive functioning. A more complete understanding of the connection between metacognition and QoL after TBI will help clinicians forecast how novel treatment strategies targeting metacognitive impairments affect perceptions about QoL during and after rehabilitation.

Disclosure statement

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