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ORIGINAL RESEARCH

The Role of Emotional Intelligence in Community Integration and Return to Work After Acquired Brain Injury

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Abstract

Objective: To investigate whether emotional intelligence (EI) skills measured via the Perceiving, Understanding, and Managing Emotions branches of the Mayer-Salovey-Caruso Emotional Intelligence Test V2.0 are associated with community integration (CI) and return to work (RTW) after moderate-to-severe acquired brain injury (ABI), after accounting for other established predictors.

Design: Retrospective cohort study.

Setting: Outpatient follow-up services within 2 specialist ABI rehabilitation centers in Melbourne, Australia.

Participants: Individuals (N=82) with moderate-to-severe ABI discharged from inpatient rehabilitation and living in the community (2mo to 7y postinjury).

Intervention: Not applicable.

Main Outcome Measures: Community Integration Questionnaire scores for the total sample (N=82; age range 18-80) and RTW status (employed vs not employed) for the subset of participants employed prior to ABI (n=71; age range 19-66).

Results: Hierarchical logistic and multiple regression analyses were used to examine the unique contribution of Perceiving, Understanding, and Managing Emotions scores to RTW and CI, after controlling for demographic, injury-related, psychological, and cognitive predictors. As a set, the 3 EI variables did not explain incremental variance in outcomes. However, individually, Understanding Emotions predicted RTW (adjusted odds ratio=3.10, $P=.03$), χ^2 (12)=35.52, $P<.001$, and Managing Emotions predicted CI ($\beta=0.23$, $P=.036$), $F_{12,69}=5.14$, $P<.001$.

Conclusion: Although the EI constructs in combination did not improve prediction beyond the effects of established variables, individual components of strategic EI may be important for specific participation outcomes after ABI.

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Moderate-to-severe acquired brain injury (ABI) is associated with a constellation of cognitive, emotional, and behavioral sequelae that can pose a barrier to successful community participation. Reduced community integration (CI), characterized by decreased participation in life roles (eg, independent home living, social participation, and involvement in productive activities, such as employment, volunteering, or study[1]), can lead to diminished social networks and poor quality of life.[2] Return to work (RTW; ie, paid employment postinjury) is an important participation marker among those employed prior to ABI[3-5] and is typically achieved in only 40% of cases within the first 2 years.[3]

Despite years of research, accurate prediction of these outcomes has proven elusive. Predictive utility has been established for some demographic variables, including marital status (for CI)[6,7] and educational background (for RTW).[8,9] Although age and preinjury employment have also been identified as occupational status predictors, these effects are typically seen in studies examining *general* employment outcome, rather than RTW among individuals employed preinjury.[9,10] Injury-related characteristics, including etiology, severity (eg, Glasgow Coma

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Scale [GCS] score), and time since injury, are pertinent predictors,[3,7,8] as are postinjury depression and anxiety.[11,12] Evidence for the utility of formal neuropsychological test scores assessing cognitive domains (eg, attention and processing speed) has been mixed, with the most support for tasks of executive function.[13,14] In total, existing prediction models typically explain only 20%-50% of variance in outcome.[15,16]

Recently, there has been increasing interest in the role of social cognition as a driver of psychosocial outcome after ABI,[17,18] of which emotion processing (the appraisal, use, expression, and regulation of emotions) is an important component.[19,20] Although conceptualized as a multifaceted concept,[20] emotion processing deficits in ABI have been primarily demonstrated using basic emotion perception tasks.[21] Knowledge of the contribution of higher-order facets of emotion processing to social and occupational functioning post-ABI remains limited. Using a multidimensional framework such as emotional intelligence (EI)[22,23] would allow the predictive utility of emotion processing to be systematically evaluated across multiple domains.

The current study used a performance-based measure of EI to investigate the incremental contribution of 3 related components of emotion processing—Perceiving, Understanding, and Managing Emotions—to community participation outcomes after moderate-to-severe ABI. The Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT) V2.0 has adequate psychometric properties and sensitivity to emotion processing deficits after ABI,[24] and its scores have been associated with adaptive work and social outcomes in healthy populations[25-27] and schizophrenia.[28,29]

Our research questions were as follows: after controlling for demographic, injury-related, psychological, and cognitive predictors, does inclusion of Perceiving, Understanding, and Managing Emotions scores improve statistical models over and above established predictors of RTW and CI both (1) individually and (2) as a set?

Methods

Participants

A total of 82 adults with moderate-to-severe ABI were recruited as outpatients through the Victorian ABI Rehabilitation Services, comprising the Royal Talbot Rehabilitation Centre (RTRC) ABI Unit, Austin Health (n=65), and the Caulfield Hospital ABI Rehabilitation Centre, Alfred Health (n=17). All participants resided in the community after a period of specialist ABI inpatient rehabilitation and were diagnosed with moderate-to-severe ABI (refer to box 1 for criteria for diagnosis and inclusion for participation). Table 1 presents demographic and injury-related characteristics. Consistent with the aforementioned RTW definition,[3-5] RTW analyses focused only on individuals employed pre-ABI (n=71). As shown, the age range of this participant subset is typical of the working population in country (19-66y).

List of abbreviations:

ABI	**acquired brain injury**
CI	**community integration**
CIQ	**Community Integration Questionnaire**
EI	**emotional intelligence**
GCS	**Glasgow Coma Scale**
MSCEIT	**Mayer-Salovey-Caruso Emotional Intelligence Test**
OR	**odds ratio**
RTW	**return to work**
WAIS	**Wechsler Adult Intelligence Scale**

Design and procedure

This was a retrospective cohort study. Independent variables (EI scores) and some control variables (psychological and cognitive functioning) were measured concurrently with outcomes (CI and RTW). Demographic and injury-related data were collected retrospectively.

Ethics approval was obtained from the human research ethics committees at Austin Health, Alfred Health and The University of Melbourne. Two hundred thirty-six individuals, as judged by a senior clinical neuropsychologist or rehabilitation consultant, met selection criteria from patient lists (eg, outpatients scheduled for upcoming medical reviews) and were provided with verbal and written study information in person or via telephone and mail. Of these, 154 declined to participate due to lack of transport, time, or interest in the project, or because they failed to attend their outpatient appointment and were uncontactable. In total, 82 individuals provided written informed consent. The 2-hour assessment included the brief structured sociodemographic interview, the computer-based MSCEIT V2.0, cognitive tasks, and self-report mood and CI questionnaires. Participants received a small financial reimbursement for travel expenses.

Measures

Outcome measures

Community integration

The Community Integration Questionnaire (CIQ)[1] is a 15-item pen-and-paper self-report scale measuring home integration (5 items), social activities (6 items), and productive activities (4 items). Most items are scored on a scale of 0-2, with higher scores indicating greater integration. Item scores are summed to yield an overall score (0-29). The CIQ has adequate internal consistency (α=.76), test-retest reliability (r=.91), interrater reliability (r=.89), and concurrent validity, and is used extensively in ABI.[1]

Return to work

RTW was operationalized as a return to any paid employment (full or part time) among those employed in any capacity preinjury.[3-5] Participants self-reported their current (at time of assessment) and previous (at time of sustaining the ABI) employment status. Responses were recorded as (1) unemployed; (2) retired; (3) student; (4) employed on a casual/part-time basis; or (5) full-time basis. Participants who were unemployed, retired, or full-time students at time of ABI were excluded from RTW analyses, leaving n=71.

Demographic and injury-related characteristics

Demographic information, including age, sex, years of formal education, marital status, psychiatric and substance abuse history, was collected from structured interview. Injury-related information was collected from medical records, including date of injury, etiology, GCS score within 24 hours of admission (lowest score not associated with intubation, sedation, or intoxication), duration of acute and rehabilitation admissions, and discharge FIM[30] score.

Box 1 Inclusion criteria for participation

1. Aged ≥18 y
2. A diagnosis of ABI as judged by at least one of the following: (1) initial GCS <13 (lowest score during the first 24h of admission not associated with intubation, sedation, or intoxication); (2) posttraumatic amnesia >24 h (for TBI); (3) evidence of ABI-related abnormalities on neuroimaging; and/or (4) clinical presentation consistent with moderate-to-severe injury requiring specialist inpatient rehabilitation.
3. Capacity to provide informed consent as determined by the treating rehabilitation consultant or clinical neuropsychologist.
4. Adequate English language skills.
5. No significant visual, hearing, or language impairment that would preclude neuropsychological testing.
6. No severe psychiatric comorbidities, such as active psychosis or delirium, or diagnosis of neurodegenerative disease.

Cognitive functioning

Cognitive assessment included estimation of general intellect using 1 of 2 brief measures: the Wechsler Test of Adult Reading (n=20)[31] or Wechsler Abbreviated Scale of Intelligence 2-Subtest Form (n=62).[32] Raw scores were converted to age-scaled scores (mean ± SD=100±15) using normative data in their respective testing manuals[31] prior to subsequent analyses. The Wechsler Abbreviated Scale of Intelligence full-scale intelligence quotient composite score has adequate internal consistency (α=.93), test-retest reliability (r=.88), and good convergence (r=.87) with the Wechsler Adult Intelligence Scale (WAIS-III) full-scale intelligence quotient.[32,33] The Wechsler Test of Adult Reading was developed and normed in conjunction with the WAIS-III and has demonstrated high test-retest reliability in brain-injured samples.[34] Working memory and information processing speed were assessed using WAIS-III digit span and digit-symbol coding scaled scores, respectively.[33] Verbal fluency was measured with the Controlled Oral Word Association Test,[35] using the raw score of the

Table 1 Participant demographic, injury-related, and cognitive characteristics

	Total Sample (N=82)		Employed Prior to ABI (n=71)	
Variable	Mean ± SD/Frequency (%)	Range	Mean ± SD/Frequency (%)	Range
Demographic characteristics				
Age	44.8 (14.85)	18-80	44.4 (13.59)	19-66
Sex (men)	66 (81)	NA	57 (80)	NA
Education (>year 12)	44 (54)	NA	40 (56)	NA
Marital status (married/de-facto)	40 (49)	NA	34 (48)	NA
Employed preinjury (full or part time)	71 (87)	NA	71 (100)	NA
History of psychiatric disorder (yes/no)	19 (23)	NA	16 (23)	NA
History of substance abuse (yes/no)	17 (21)	NA	14 (20)	NA
Injury-related characteristics				
Etiology				
TBI	52 (63)	NA	46 (65)	NA
Motor vehicle accident	11 (13)	NA	10 (14)	NA
Assault	10 (12)	NA	7 (10)	NA
Fall	32 (39)	NA	30 (42)	NA
Vascular	15 (18)	NA	13 (18)	NA
Hypoxic	6 (7)	NA	6 (9)	NA
Multiple	3 (4)	NA	2 (3)	NA
Other*	6 (7)	NA	4 (6)	NA
Initial GCS (score out of 15)	8.5 (4.06)	3-15	8.4 (4.06)	3-15
Length of acute hospital admission (d)	23.6 (19.16)	2-85	23.6 (19.30)	2-85
Length of inpatient rehabilitation (d)	40.9 (53.85)	1-328	41.1 (56.81)	1-328
FIM at discharge (total)	116.3 (10.03)	78-126	116.3 (10.27)	78-126
Time since injury (d)	531 (524.91)	62-2664	567.8 (552.33)	62-2664
Cognitive characteristics				
Estimated IQ	104.2 (10.91)	78-137	103.5 (10.88)	78-137
Working memory (digit span SS)	9.5 (2.53)	4-19	9.5 (2.67)	4-19
Processing speed (coding SS)	7.8 (2.65)	3-15	7.8 (2.67)	3-15
Verbal fluency (COWAT total)	30.5 (10.80)	9-59	30.1 (10.68)	9-54

NOTE. Cognition was assessed using the Wechsler Abbreviated Scale of Intelligence 2-Subtest Form[31] for estimated IQ, digit span, and coding subscales from the Wechsler Adult Intelligence Scale-III[32] for working memory and processing speed, and the COWAT[33] for verbal fluency.
Abbreviations: COWAT, Controlled Oral Word Association Test; NA, not applicable; SS, scaled score; TBI, traumatic brain injury.
* Etiology (other)=encephalitis (n=3), meningitis (n=2), and stroke-like migraine attacks after radiation therapy syndrome (n=1).

Table 2 Results of assessment of emotional intelligence, psychological functioning, cognitive functioning, community integration and employment status

Variable	Normative Mean ± SD	Total Sample (N=82) Mean ± SD/Frequency (%)	Employed Pre-ABI (n=71) Mean ± SD/Frequency (%)
Emotional intelligence			
Perceiving Emotions	100 (15)	94.29 (20.03)	95.06 (19.05)
Understanding Emotions	100 (15)	85.26 (13.93)	86.29 (14.32)
Managing Emotions	100 (15)	87.77 (13.68)	88.82 (13.65)
Psychological functioning			
HADS-D (/21)	3.68 (3.07)	5.24 (3.50)	5.23 (3.60)
HADS-A (/21)	6.14 (3.76)	6.95 (4.02)	7.03 (4.06)
Cognitive functioning			
Estimated IQ	100 (15)	104.22 (10.91)	103.49 (10.88)
COWAT Total	34.78 (12.83)	30.53 (10.80)	30.14 (10.68)
Community integration			
CIQ total (/29)	NA	16.19 (4.69)	16.49 (4.55)
Employment status			
Employed post-ABI	NA	27 (33)	26 (37)

NOTE. Details of normative samples provided in Mayer et al[38] for emotional intelligence, Crawford et al[46] for the Hospital Anxiety and Depression Scale, Wechsler[32] for estimated IQ, and Loonstra et al[45] for COWAT.
Abbreviations: COWAT, Controlled Oral Word Association Test; HADS-A, Hospital Anxiety and Depression Scale-anxiety subscale; HADS-D, Hospital Anxiety and Depression Scale-depression subscale; NA, not applicable.

total number of words generated for the letters F, A, and S. The Controlled Oral Word Association Test has high internal reliability (r=.83) and high test-retest reliability (r=.74)[36] and has been shown to be sensitive to the presence and severity of TBI.[37,39]

Psychological functioning

Depression and anxiety symptoms were assessed using the Hospital Anxiety and Depression Scale, a 14-item self-report screening questionnaire comprising two 7-item subscales measuring anxiety and depression.[40] Items are rated on a 4-point scale (0-3) to indicate how an individual has been feeling over the past week, with each total subscale score ranging from 0 to 21. The Hospital Anxiety and Depression Scale is considered a valid and reliable mood screening tool in ABI.[41]

Emotional intelligence

EI was assessed using the MSCEIT V2.0, a standardized 141-item performance-based test.[42] It assesses Salovey and Mayer's theoretical model, which conceptualizes EI as a set of 4 skills, or branches: the ability to perceive and use emotions (*experiential* skills) and to understand and manage emotions (*strategic* skills).[22] The MSCEIT V2.0 consists of 8 tasks, with 2 tasks assessing the 4 EI branches.[42] Perceiving Emotions involves identifying emotions in pictures of facial expressions, landscapes, and abstract designs. Using Emotions asks how emotions relate to sensations and can facilitate cognitive and social tasks. Understanding Emotions asks how a person's emotions coexist and change over time, and Managing Emotions asks the respondent to choose the most effective action for achieving a personal or social goal from a vignette of an emotional situation. Item response formats vary across tasks, consisting of 5-point Likert scales with words or pictures and multiple-choice format with 3-5 response options.[42] Responses are scored relative to the proportion of experts (21 members of the International Society for Research on Emotions) endorsing that response as the correct answer.[42] Item weights are summed to yield 8 task-level scores, 4 branch-level scores, 2 area-level scores, and an overall score. These raw scores are standardized relative to a normative sample of 5000 individuals (mean ± SD=100±15).[42] The psychometric properties of the MSCEIT V2.0 in this ABI sample are described in detail in Hall and colleagues. In brief, our analysis aligned with a revised 3-factor model of EI,[23] omitting the Using Emotions branch due to evidence of statistical redundancy.[43]

Statistical analysis

SPSS version 22[a] was used for all analyses. Criterion alpha was set at $P<.05$ (2-sided). Missing data totaled less than 2% of the dataset overall, and Little's missing completely at random test indicated that data were missing completely at random, χ^2 (199)=204.43, P=.381. Missing data were imputed using the expectation maximization algorithm, and analyses were conducted with and without the imputed values, with no change to the interpretation of findings. Thus, results for the complete dataset are reported.

Prediction of RTW outcome (0=unemployed, 1=employed in part or full-time work) was conducted using hierarchical logistic regression. Consistent with previous studies and operationalization of RTW,[3-5] analysis was limited to the subset of participants employed preinjury (n=71). Predictors of CI were examined using hierarchical multiple regression for the total sample.

In each regression analysis, a set of control variables were entered at Step 1. These were selected a priori based on previous literature and included injury etiology, initial GCS, verbal fluency, depression and anxiety symptoms, education (for RTW), and marital status (for CI). Rehabilitation site and time since injury were entered to account for the cross-sectional, multisite study design. Because EI tends to show small to moderate correlations with general intellect,[27,44] we also controlled for estimated IQ before evaluating the incremental contribution of EI.

The 3 EI branches were entered as Z scores at Step 2. Model change statistics from Step 1 to Step 2 (R^2 for multiple regression,

Table 3 Bivariate correlations between demographic, injury-related, psychological, cognitive, emotion processing, and outcome variables used in regression analyses

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Education (0=≤year 12, 1=tertiary)															
2. Marital status (0=single, 1=married/de-facto)	.17														
3. Rehabilitation site	.05	−.08													
4. Time since ABI (d)	.04	−.14	−.16												
5. Initial GCS (/15)	.19	.21	.05	−.10											
6. Etiology of injury (0=TBI, 1=nTBI)	−.08	.15	−.06	−.07	.03										
7. Depression symptoms (HADS-D)	−.08	.00	−.02	.07	.04	−.05									
8. Anxiety symptoms (HADS-A)	.07	−.07	.07	.07	−.06	.04	.72*								
9. Estimated IQ (WTAR/WASI)	.20	.20	−.05	−.01	.30*	.14	−.15	−.03							
10. Verbal fluency (COWAT)	.21	.02	.08	.04	.29*	.05	.02	.21	.50*						
11. Perceiving Emotions (MSCEIT-PE)	−.01	−.15	.20	.04	.23†	.05	.06	−.03	.18	.25†					
12. Understanding Emotions (MSCEIT-UE)	.37*	.08	−.05	.01	.28†	.01	−.04	.03	.49*	.39*	.21				
13. Managing Emotions (MSCEIT-ME)	.09	.13	.12	.12	.26†	.07	−.14	−.12	.23†	.24†	.38*	.41*			
14. CIQ	−.04	−.23†	−.28†	.25†	.08	−.25†	−.38*	−.27†	.05	.04	−.02	.17	.22†		
15. Return to work (n=71)	.02	.03	−.20	.18	−.13	−.11	−.44*	−.23	.14	.13	−.11	.27†	.12	.46*	

NOTE. Spearman ρ reported for non-normal variables of time since ABI and initial GCS. Pearson product-moment correlation coefficients reported for all remaining normally distributed continuous variables. The point-biserial correlation coefficients reported for dichotomous variables.

Abbreviations: HADS-A, Hospital Anxiety and Depression Scale-anxiety subscale; HADS-D, Hospital Anxiety and Depression Scale-depression subscale; MSCEIT-ME, Mayer-Salovey-Caruso Emotional Intelligence Test - Managing Emotions branch; MSCEIT-PE, Mayer-Salovey-Caruso Emotional Intelligence Test - Perceiving Emotions branch; MSCEIT-UE, Mayer-Salovey-Caruso Emotional Intelligence Test - Understanding Emotions branch; nTBI, non-traumatic brain injury; TBI, traumatic brain injury; WASI, Wechsler Abbreviated Scale of Intelligence; WTAR, Wechsler Test of Adult Reading.

* $P<.01$, 2-tailed.

† $P<.05$.

Table 4 Logistic regression models predicting RTW (n=71)

Variable	B	SE	Wald	*df*	*P*	Adj OR	95% CI (adj OR)		χ^2	*df*	*P*
Hierarchical models											
Model 1	NA	NA	NA	NA	NA	NA	NA	NA	28.22	9	.001
Constant	−1.68	4.37	0.15	1	.701	0.19	NA	NA	NA	NA	NA
Level of education	−0.53	0.68	0.60	1	.438	0.59	0.16	2.24	NA	NA	NA
Rehabilitation site	−1.17	0.84	1.95	1	.163	0.31	0.06	1.61	NA	NA	NA
Time since injury (d)*	1.30	0.88	2.21	1	.137	3.68	0.66	20.55	NA	NA	NA
Initial GCS	−0.07	0.09	0.57	1	.449	0.93	0.78	1.11	NA	NA	NA
Injury etiology	−0.92	0.72	1.63	1	.202	0.40	0.10	1.64	NA	NA	NA
Depression symptoms	−0.48	0.16	8.83	1	.003	0.62	0.45	0.85	NA	NA	NA
Anxiety symptoms	0.10	0.13	0.57	1	.449	1.10	0.86	1.42	NA	NA	NA
Estimated IQ	0.01	0.04	0.06	1	.812	1.01	0.94	1.09	NA	NA	NA
Verbal fluency	0.03	0.03	0.86	1	.354	1.03	0.97	1.10	NA	NA	NA
Model 2	NA	NA	NA	NA	NA	NA	NA	NA	35.52	12	.000
Constant	3.70	5.61	0.44	1	.510	40.49	NA	NA	NA	NA	NA
Level of education	−1.13	0.78	2.08	1	.149	0.32	0.07	1.50	NA	NA	NA
Rehabilitation site	−1.09	0.96	1.27	1	.260	0.34	0.05	2.23	NA	NA	NA
Time since injury (d)*	1.31	0.94	1.93	1	.165	3.71	0.58	23.60	NA	NA	NA
Initial GCS	−0.10	0.10	1.01	1	.315	0.90	0.74	1.10	NA	NA	NA
Injury etiology	−1.04	0.76	1.90	1	.169	0.35	0.08	1.56	NA	NA	NA
Depression symptoms	−0.54	0.18	8.79	1	.003	0.58	0.41	0.83	NA	NA	NA
Anxiety symptoms	0.13	0.14	0.86	1	.354	1.14	0.87	1.50	NA	NA	NA
Estimated IQ	−0.03	0.05	0.35	1	.554	0.97	0.89	1.06	NA	NA	NA
Verbal fluency	0.03	0.04	0.44	1	.506	1.03	0.95	1.10	NA	NA	NA
Step 2	NA	NA	NA	NA	NA	NA	NA	NA	7.30	3	.063
Perceiving Emotions	−0.23	0.28	0.64	1	.422	0.80	0.46	1.39	NA	NA	NA
Understanding Emotions	1.13	0.52	4.70	1	.030	3.10	1.12	8.60	NA	NA	NA
Managing Emotions	0.05	0.42	0.02	1	.902	1.05	0.46	2.40	NA	NA	NA
Final model	NA	NA	NA	NA	NA	NA	NA	NA	20.79	2	.000
Constant	1.58	0.59	7.28	1	.007	4.87	NA	NA	NA	NA	NA
Depression symptoms	−0.35	0.11	10.91	1	.001	0.71	0.58	0.87	NA	NA	NA
Understanding Emotions	0.64	0.31	4.08	1	.043	1.89	1.02	3.50	NA	NA	NA

Abbreviations: 95% CI, 95% confidence interval; NA, not applicable.
* Logarithmic transformation used due to variable non-normality.

χ^2 for logistic regression) were examined to determine whether EI scores significantly improved each statistical model. The unique contributions of 12 individual predictors within each model were evaluated using the Wald criterion and odds ratios (ORs) (for logistic regression) and beta weights and semipartial correlations (for multiple regression). Testing of assumptions for multiple regression revealed approximately normally distributed residuals and no evidence of heteroscedasticity or multicollinearity (variance inflation factor of 4 or greater).

Results

Descriptive statistics for EI, psychological, cognitive, CI, and employment variables are presented in table 2 alongside normative data where available.[32,42,45,46] Mean EI scores were significantly lower compared to normative sample across all branches ($P<.05$), with the greatest differences for Understanding and Managing Emotions ($t=-9.58$ and -8.99, respectively). Depression and anxiety symptoms were typically subclinical, with mean scores below diagnostic thresholds (≥ 8). Estimated general intellect was in the *average* range. Mean level of CI was moderate, and 26 previously employed participants (37%) had returned to work at the time of the assessment. Table 3 presents bivariate correlations between predictor and outcome variables used in regression analyses. EI variables were significantly correlated with initial GCS, cognitive test scores, RTW (Understanding Emotions only), and CI (Managing Emotions only).

Prediction of RTW

Table 4 presents the results of the logistic regression models predicting RTW. At Step 1, the combination of education, rehabilitation site, time since injury, GCS, injury etiology, depression symptoms, anxiety symptoms, IQ, and verbal fluency resulted in a significant reduction in model error, χ^2 (9)=28.22, $P=.001$, Nagelkerke $R^2=45\%$, 76% correct classifications. Within this model, depression was the only significant individual predictor of outcome (B=−0.48, SE=0.16, adjusted OR=0.62). At Step 2, inclusion of the 3 EI variables resulted in a nonsignificant increase in percentage of correct classifications (82%) and Nagelkerke R^2 (54%), χ^2 (3)=7.3, $P=.063$. Examination of individual variables revealed that Understanding Emotions (B=1.13, SE=0.52, adjusted OR=3.10) was a significant predictor of RTW ($P=.030$) indicating that the likelihood of RTW is 3.10 times higher with each 1 Z-score increase in Understanding Emotions. After

Table 5 Multiple regression models predicting community integration (N=82)

Variable	B	SE	β	*t*	*P*	sr	F	*df*	*P*	R^2	ΔR^2	ΔF	*P*
Hierarchical models													
Model 1	NA	NA	NA	NA	NA	NA	5.88	9,72	.000	.42	NA	NA	NA
Constant	18.07	5.78	NA	3.13	.003	NA	NA	NA	NA	NA	NA	NA	NA
Marital status	−2.07	0.88	−0.22	−2.34	.022	.21	NA	NA	NA	NA	NA	NA	NA
Rehabilitation site	−3.57	1.07	−0.31	−3.35	.001	.30	NA	NA	NA	NA	NA	NA	NA
Time since injury (d)*	2.24	1.12	0.19	2.00	.049	.18	NA	NA	NA	NA	NA	NA	NA
Initial GCS	0.21	0.11	0.19	1.87	.065	.17	NA	NA	NA	NA	NA	NA	NA
Injury etiology	−2.45	0.90	−0.25	−2.73	.008	.24	NA	NA	NA	NA	NA	NA	NA
Depression symptoms	−0.61	0.18	−0.46	−3.34	.001	.30	NA	NA	NA	NA	NA	NA	NA
Anxiety symptoms	0.07	0.16	0.06	0.45	.651	.04	NA	NA	NA	NA	NA	NA	NA
Estimated IQ	−0.01	0.05	−0.02	−0.21	.837	.02	NA	NA	NA	NA	NA	NA	NA
Verbal fluency	0.02	0.05	0.04	0.34	.732	.03	NA	NA	NA	NA	NA	NA	NA
Model 2	NA	NA	NA	NA	NA	NA	5.14	12,69	.000	.47	.05	2.12	.106
Constant	22.18	6.39	NA	3.47	.001	NA	NA	NA	NA	NA	NA	NA	NA
Marital status	−2.48	0.90	−0.27	−2.76	.007	.24	NA	NA	NA	NA	NA	NA	NA
Rehabilitation site	−3.66	1.08	−0.32	−3.40	.001	.30	NA	NA	NA	NA	NA	NA	NA
Time since injury (d)*	1.86	1.11	0.15	1.68	.098	.15	NA	NA	NA	NA	NA	NA	NA
Initial GCS	0.18	0.11	0.16	1.59	.117	.14	NA	NA	NA	NA	NA	NA	NA
Injury etiology	−2.44	0.89	−0.25	−2.75	.008	.24	NA	NA	NA	NA	NA	NA	NA
Depression symptoms	−0.56	0.18	−0.42	−3.02	.004	.26	NA	NA	NA	NA	NA	NA	NA
Anxiety symptoms	0.07	0.16	0.06	0.41	.680	.04	NA	NA	NA	NA	NA	NA	NA
Estimated IQ	−0.02	0.05	−0.05	0.46	.650	.04	NA	NA	NA	NA	NA	NA	NA
Verbal fluency	0.01	0.05	0.01	0.10	.925	.01	NA	NA	NA	NA	NA	NA	NA
Step 2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Perceiving Emotions	−0.36	0.37	−0.10	−0.98	.329	.09	NA	NA	NA	NA	NA	NA	NA
Understanding Emotions	0.31	0.55	0.06	0.56	.581	.05	NA	NA	NA	NA	NA	NA	NA
Managing Emotions	1.18	0.55	0.23	2.14	.036	.19	NA	NA	NA	NA	NA	NA	NA
Final model	NA	NA	NA	NA	NA	NA	11.18	5,76	.000	.42	NA	NA	NA
Constant	17.78	2.98	NA	5.96	.000	NA	NA	NA	NA	NA	NA	NA	NA
Marital status	−2.39	.83	−.26	−2.88	.005	.06	NA	NA	NA	NA	NA	NA	NA
Rehabilitation site	−4.09	1.01	−.36	−4.03	.000	.12	NA	NA	NA	NA	NA	NA	NA
Injury etiology	−2.65	.86	−.27	−3.07	.003	.07	NA	NA	NA	NA	NA	NA	NA
Depression symptoms	−.48	.12	−.36	−4.10	.000	.13	NA	NA	NA	NA	NA	NA	NA
Managing Emotions	.09	.03	.27	2.96	.004	.07	NA	NA	NA	NA	NA	NA	NA

Abbreviations: NA, not applicable; sr, semipartial correlation.
* Logarithmic transformation used due to variable non-normality.

removing all nonsignificant predictors, the final model consisted of only depression symptoms and understanding emotions, χ^2 (2)=20.79, P<.001, Nagelkerke R^2=35%, 80% correct classifications.

Prediction of CI

Table 5 presents the results of the multiple regression models predicting CI. Control variables entered at Step 1 (marital status, rehabilitation site, time since injury, GCS, injury etiology, depression symptoms, anxiety symptoms, IQ, verbal fluency) explained 42% of the variance in CI, $F_{9,72}$=5.88, P<.001, R^2=42%. As a set, the 3 EI variables entered at Step 2 did not make a significant contribution to the model, explaining an additional 5% of variance, $F_{change3,69}$=2.12, P=.106. When examined individually, however, Managing Emotions was a significant predictor of CI (β=.23, P=.036), conferring an increase of 0.23 SD on the CIQ for each 1 SD increase in Managing Emotions. After removing nonsignificant predictors, the final model consisted of marital status, rehabilitation site, injury etiology, depression symptoms, and Managing Emotions, which together explained 42% of the variance in outcome.

Discussion

This study is the first to examine whether skills in Perceiving, Understanding, and Managing Emotions, as measured by a test of EI, relate to participation outcomes in a moderate-to-severe ABI sample. As a set, the 3 EI variables did not improve statistical models for RTW or CI beyond the effects of established predictors. However, when examined individually, Understanding Emotions made a unique contribution to RTW, and Managing Emotions explained unique variance in CI, after controlling for demographic, injury-related, psychological, and cognitive variables.

In studies of the healthy population, evidence for the incremental predictive utility of the EI construct has been mixed.[27,47] Increasingly, there has been a shift toward conceptualizing EI as distinct branches rather than an overall construct, based on factor analytic findings[43] and advances in EI theory.[23] In the current study, 2 individual branches—Understanding and Managing

Emotions—incrementally improved the prediction of RTW and CI, respectively. These branches have also emerged as most predictive of psychosocial function in the healthy population[48,49] and schizophrenia.[28,50]

Theoretically, strategic EI skills are proposed to build on lower-level competencies to directly influence social and occupational outcomes.[51] Understanding Emotions assesses skills pertinent to adaptive interpersonal functioning, with organizational behavior studies highlighting how employees with difficulties in this skill may misinterpret emotional cues conveying important messages about work expectations and performance.[26,52] Managing Emotions is considered most proximal to social functioning, with dysregulation of this skill (eg, venting or losing one's temper) having direct negative consequences for interpersonal relations within the community.[48] Clinically, these difficulties may map onto problems with emotion interpretation and dysregulation observed by clinicians and employers of individuals with ABI.[53]

Of the 3 EI constructs, Perceiving Emotions was the only domain not associated with outcome. Several studies have failed to find a relation between scores on basic tests of emotion perception and social and occupational outcomes,[54-56] possibly reflecting known psychometric limitations of existing tests. Although the MSCEIT V2.0 uses more complex emotional stimuli and standardized scoring, the ongoing development of more sophisticated emotion perception tests (eg, incorporating context and movement)[57,58] will help to clarify the relevance of this skill for outcome.

Depressive symptoms emerged as the most salient predictor of outcome in both models. The importance of depression has been well-established in previous literature,[12,59] and further exploration of how EI and depression may interact to influence outcome is warranted. Other significant predictors included marital status, injury etiology, and time since injury, consistent with the clinical course of recovery after ABI and established determinants of outcome.[12,59-64] Markers of injury severity were not related to outcome, which may reflect the high concentration of severe injuries in this sample, or limitations of the GCS index described elsewhere.[65] Despite correlating with the EI branches, cognitive test scores also did not predict outcome. This is broadly consistent with mixed findings in the literature, particularly when cognition is measured concurrently with outcome,[66,67] but may also reflect the limited scope of our cognitive assessment and warrants further investigation.

Study limitations

Sample size was modest, constraining the number of control variables included in analyses. The combination of small sample size, numerous predictors, and low response rate also raise the likelihood of type I error.[68] Replication with a larger sample is recommended given marginal statistical power. This would also permit inclusion of a more comprehensive range of injury severity and cognitive variables. EI, cognitive, and psychological predictors were measured concurrently with outcomes, limiting our ability to draw conclusions about the direction of relations. The use of a binary RTW outcome variable precluded more detailed analyses of the RTW process (eg, changes in work roles pre- to post-ABI); this remains an important avenue for future research. Assessment of emotion processing was based on a single EI measure, and further examination of how these scores relate to other aspects of social cognition is warranted. Finally, our findings may not generalize to adults with ABI with very severe cognitive impairment (ie, lacking capacity to consent) or language, sensory or psychiatric disturbance, due to their exclusion from this study.

Conclusions

Although combined EI scores did not improve prediction of outcome beyond the effects of established variables, individual domains of Understanding Emotions and Managing Emotions were found to be concurrent predictors of RTW and CI, respectively. These strategic EI skills have not been examined in previous ABI studies, underscoring the importance of comprehensive approaches to emotion processing assessment in this population.

Supplier

a. SPSS statistics for Macintosh, version 22.0; IBM Corp.

Keywords

Brain injuries; Community integration; Emotional intelligence; Rehabilitation; Return to work

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References

1. Willer B, Rosenthal M, Kreutzer JS, Gordon WA, Rempel R. Assessment of community integration following rehabilitation for traumatic brain injury. J Head Trauma Rehabil 1993;8:75-87.
2. McLean A, Jarus T, Hubley AM, Jongbloed L. Associations between social participation and subjective quality of life for adults with moderate to severe traumatic brain injury. Disabil Rehabil 2014;36:1409-18.
3. van Velzen JM, van Bennekom CA, Edelaar MJ, Sluiter JK, Frings-Dresen M. How many people return to work after acquired brain injury?: a systematic review. Brain Inj 2009;23:473-88.
4. van Velzen JM, van Bennekom CA, Edelaar MJ, Sluiter JK, Frings-Dresen M. Prognostic factors of return to work after acquired brain injury: a systematic review. Brain Inj 2009;23:385-95.
5. Garrelfs SF, Donker-Cools B, Wind H, Frings-Dresen M. Return-to-work in patients with acquired brain injury and psychiatric disorders as a comorbidity: a systematic review. Brain Inj 2015;29:550-7.
6. Brown M, Gordon WA, Spielman L. Participation in social and recreational activity in the community by individuals with traumatic brain injury. Rehabil Psychol 2003;48:266-74.
7. Sandhaug M, Andelic N, Langhammer B, Mygland A. Community integration 2 years after moderate and severe traumatic brain injury. Brain Inj 2015;29:915-20.
8. Cuthbert JP, Pretz CR, Bushnik T, et al. Ten-year employment patterns of working age individuals after moderate to severe traumatic

brain injury: a National Institute on Disability and Rehabilitation Research Traumatic Brain Injury Model Systems Study. Arch Phys Med Rehabil 2015;96:2128-36.
9. Keyser-Marcus LA, Bricout JC, Wehman P, et al. Acute predictors of return to employment after traumatic brain injury: a longitudinal follow-up. Arch Phys Med Rehabil 2002;83:635-41.
10. Grauwmeijer E, Heijenbrok-Kal MH, Haitsma IK, Ribbers GM. A prospective study on employment outcome 3 years after moderate to severe traumatic brain injury. Arch Phys Med Rehabil 2012;93:993-9.
11. Bertisch HC, Long CJ, Langenbahn DM, Rath JF, Leonard D, Ashman TA. Anxiety as a primary predictor of functional impairment after acquired brain injury: a brief report. Rehabil Psychol 2013;58:429-35.
12. Hibbard MR, Ashman T, Spielman L, Chun D, Charatz HJ, Melvin S. Relationship between depression and psychosocial functioning after traumatic brain injury. Arch Phys Med Rehabil 2004;4:43-53.
13. Spikman JM, Boelen DH, Lamberts KF, Brouwer WH. Effects of a multifaceted treatment program for executive dysfunction after acquired brain injury on indications of executive functioning in daily life. J Int Neuropsychol Soc 2010;16:118-29.
14. Spitz G, Ponsford J, Rudzki D, Maller JJ. Association between cognitive performance and functional outcome following traumatic brain injury: a longitudinal multilevel examination. Neuropsychology 2012;26:604-12.
15. Dahdah MN, Barnes S, Buros A, et al. Variations in inpatient rehabilitation functional outcomes across centers in the Traumatic Brain Injury Model Systems Study and the influence of demographics and injury severity on patient outcomes. Arch Phys Med Rehabil 2016;97:1821-32.
16. Corrigan JD, Horn S, Barrett RS, et al. Effects of patient preinjury and injury characteristics on acute rehabilitation outcomes for traumatic brain injury. Arch Phys Med Rehabil 2015;96(8 Suppl 3):S209-21.
17. Burridge AC, Williams WH, Yates PJ, Harris A, Ward C. Spousal relationship satisfaction following acquired brain injury: the role of insight and socio-emotional skill. Neuropsychol Rehabil 2007;17:95-105.
18. Ubukata S, Tanemura R, Yoshizumi M, Sugihara G, Murai T, Ueda K. Social cognition and its relationship to functional outcomes in patients with sustained acquired brain injury. Neuropsychiatr Dis Treat 2014;10:2061-8.
19. Keltner D, Haldt J. Social functions of emotions. In: Mayne TJ, Bonanno GA, editors. Emotions: current issues and future directions. New York: Guilford; 2001. p 192-213.
20. Lemerise EA, Arsenio WF. An integrated model of emotion processes and cognition in social information processing. Child Dev 2000;71:107-18.
21. Babbage DR, Yim J, Zupan B, Neumann D, Tomita MR, Willer B. Meta-analysis of facial affect recognition difficulties after traumatic brain injury. Neuropsychology 2011;25:277-85.
22. Salovey P, Mayer JD. Emotional intelligence. Imagin Cogn Pers 1990;9:185-211.
23. Joseph DL, Newman DA. Emotional intelligence: an integrative meta-analysis and cascading model. J Appl Psychol 2010;95:54-78.
24. Hall SE, Wrench JM, Wilson SJ. Assessment of emotion processing skills in acquired brain injury using an ability-based test of emotional intelligence. Psychol Assess 2018;30:524-38.
25. Di Fabio A. Beyond fluid intelligence and personality traits in social support: the role of ability based emotional intelligence. Front Psychol 2015;6:395.
26. Rosete D, Ciarrochi J. Emotional intelligence and its relationship to workplace performance outcomes of leadership effectiveness. Leadership Org Dev J 2005;26:388-99.
27. Rossen E, Kranzler JH. Incremental validity of the Mayer-Salovey-Caruso Emotional Intelligence Test Version 2.0 (MSCEIT) after controlling for personality and intelligence. J Res Pers 2009;43:60-5.
28. Dawson S, Kettler L, Burton C, Galletly C. Do people with schizophrenia lack emotional intelligence? Schizophr Res Treatment 2012;2012:495174.
29. Fett A, Viechtbauer W, Dominguez M, Penn DL, Os J, Krabbendam L. The relationship between neurocognition and social cognition with functional outcomes in schizophrenia: a meta-analysis. Neurosci Biobehav Rev 2011;35:573-88.
30. Keith RA, Granger CV, Hamilton BB, Sherwin FS. The functional independence measure. Adv Clin Rehabil 1987;1:6-18.
31. Wechsler D. Wechsler Test of Adult Reading: WTAR. San Antonio: Psychological Corporation; 2001.
32. Wechsler D. Wechsler Abbreviated Scale of Intelligence. San Antonio: The Psychological Corporation; 1999.
33. Wechsler D. Wechsler Adult Intelligence Scale—Third Edition. San Antonio: The Psychological Corporation; 1997.
34. Green RE, Melo B, Christensen B, Ngo L, Monette G, Bradbury C. Measuring premorbid IQ in traumatic brain injury: an examination of the validity of the Wechsler Test of Adult Reading (WTAR). J Clin Exp Neuropsychol 2008;30:163-72.
35. Benton AL, Hamsher K. Multilingual aphasia examination manual. Iowa City: University of Iowa; 1976.
36. Tombaugh TN, Kozak J, Rees L. Normative data stratified by age and education for two measures of verbal fluency: FAS and animal naming. Arch Clin Neuropsychol 1999;14:167-77.
37. Henry JD, Crawford JR. A meta-analytic review of verbal fluency performance in patients with traumatic brain injury. Neuropsychology 2004;18:621-8.
38. Mayer JD, Salovey P, Caruso DR. Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT): User's Manual. Toronto, Ontario: Multi-Health Systems, Inc; 2002.
39. Iverson GL, Franzen MD, Lovell MR. Normative comparisons for the Controlled Oral Word Association Test following acute traumatic brain injury. Clin Neuropsychol 1999;13:437-41.
40. Zigmond AS, Snaith RP. The Hospital Anxiety and Depression Scale. Acta Psychiatr Scand 1983;67:361-70.
41. Dawkins N, Cloherty ME, Gracey F, Evans JJ. The factor structure of the Hospital Anxiety and Depression Scale in acquired brain injury. Brain Inj 2006;20:1235-9.
42. Mayer JD, Salovey P, Caruso DR, Sitarenios G. Measuring emotional intelligence with the MSCEIT V2.0. Emotion 2003;3:97-105.
43. Fan H, Jackson T, Xinguo Y, Tang W, Zhang J. The factor structure of the Mayer-Salovey-Caruso Emotional Intelligence Test V2.0 (MSCEIT): a meta-analytic structural equation modeling approach. Pers Individ Dif 2010;48:781-5.
44. Newman DA, Joseph DL, MacCann C. Emotional intelligence and job performance: the importance of emotion regulation and emotional labor context. Ind Organ Psychol 2010;3:159-64.
45. Loonstra AS, Tarlow AR, Sellers AH. COWAT metanorms across age, education and gender. App Neuropsychol 2001;8:161-6.
46. Crawford JR, Henry JD, Crombie C, Taylor EP. Normative data for the HADS from a large non-clinical sample. Br J Clin Psychol 2001;40:429-34.
47. Rode JC, Mooney CH, Arthaud-day ML, et al. An examination of the structural, discriminant, nomological, and incremental predictive validity of the MSCEIT V2.0. Intelligence 2008;36:350-66.
48. Lopes PN, Salovey P, Cote S, Beers M. Emotional regulation abilities and the quality of social interaction. Emotion 2005;5:113-8.
49. Lopes PN, Nezlek JB, Extremera N, et al. Emotion regulation and the quality of social interaction: does the ability to evaluate emotional situations and identify effective responses matter? J Pers 2011;79:429-67.
50. Eack SM, Greeno CG, Pogue-Geilie MF, Newhill CE, Hogarty GE, Keshavan MS. Assessing social-cognitive deficits in schizophrenia with the Mayer-Salovey-Caruso Emotional Intelligence Test. Schizophr Bull 2010;36:370-80.
51. Mayer JD, Roberts RD, Barsade SG. Human abilities: emotional intelligence. Ann Rev Psychol 2008;59:507-36.
52. Lopes PN, Grewal D, Kadis J, Gall M, Salovey P. Evidence that emotional intelligence is related to job performance and affect and attitudes at work. Psicothema 2006;18:132-8.

53. Yeates G, Rowberry M, Dunne S, et al. Social cognition and executive functioning predictors of supervisors' appraisal of interpersonal behaviour in the workplace following acquired brain injury. NeuroRehabilitation 2016;38:299-310.
54. Croker V, McDonald S. Recognition of emotion from facial expression following traumatic brain injury. Brain Inj 2005;19:787-99.
55. Milders MV, Fuchs S, Crawford JR. Neuropsychological impairments and changes in emotional and social behaviour following severe traumatic brain injury. J Clin Exp Neuropsychol 2003;25:157-72.
56. Saxton ME, Younan SS, Lah S. Social behaviour following severe traumatic brain injury: contribution of emotion perception deficits. NeuroRehabilitation 2013;33:263-71.
57. McDonald S. New frontiers in neuropsychological assessment: assessing social perception using a standardised instrument, the Awareness of Social Inference Test. Aust Psychol 2012;47:39-48.
58. Zupan B, Neumann D. Exploring the use of isolated expressions and film clips to evaluate emotion recognition by people with traumatic brain injury. J Vis Exp 2016;53774.
59. Ayerbe L, Ayis S, Wolfe CD, Rudd AG. Natural history, predictors and outcomes of depression after stroke: systematic review and meta-analysis. Br J Psychiatry 2013;202:14-21.
60. Sander AM, Kreutzer JS, Rosenthal M, Delmonico R, Young ME. A multicenter longitudinal investigation of return to work and community integration following traumatic brain injury. J Head Trauma Rehabil 1996;11:70-84.
61. Avesani R, Roncari L, Khansefid M, et al. The Italian National Registry of severe acquired brain injury: epidemiological, clinical and functional data of 1469 patients. Eur J Phys Rehabil Med 2013;49:611-8.
62. Chiavaroli F, Derraik JG, Zani G, et al. Epidemiology and clinical outcomes in a multicentre regional cohort of patients with severe acquired brain injury. Disabil Rehabil 2016;38:2038-46.
63. Colantonio A, Gerber G, Bayley M, Deber R, Yin J, Kim H. Differential profiles for patients with traumatic and non-traumatic brain injury. J Rehabil Med 2011;43:311-5.
64. Cullen NK, Park YG, Bayley M. Functional recovery following traumatic vs non-traumatic brain injury: a case-controlled study. Brain Inj 2008;22:1013-20.
65. Zuercher M, Ummenhofer W, Baltussen A, Walder B. The use of Glasgow Coma Scale in injury assessment: a critical review. Brain Inj 2009;23:371-84.
66. Ownsworth T, Fleming J. The relative importance of metacognitive skills, emotional status, and executive function in psychosocial adjustment following acquired brain injury. J Head Trauma Rehabil 2005;20:315-22.
67. Draper K, Ponsford J, Schonberger M. Psychosocial and emotional outcomes 10 years following traumatic brain injury. J Head Trauma Rehabil 2007;22:278-87.
68. Babyak MA. What you see may not be what you get: a brief, nontechnical introduction to overfitting in regression-type models. Psychosom Med 2004;66:411-21.