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BRIEF COMMUNICATION

Community Integration in Traumatic Brain Injury: The Contributing Factor of Affect Recognition Deficits

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Abstract

Objective: Individuals with traumatic brain injury (TBI) can experience social isolation, which is damaging to well-being and counterproductive to successful rehabilitation. It has been proposed that social cognitive deficits that commonly result from TBI may contribute to weakened social integration. However, the consequences of specific social cognitive deficits in TBI are still being delineated. The current work sought to better characterize the relationship between community integration and facial affect recognition (FAR) in TBI. **Participants and Methods:** A total of 27 participants with moderate to severe TBI and 30 healthy controls (HCs) completed two tests of FAR, which employed either static photographic stimuli or dynamic video stimuli (The Awareness of Social Inference Test). The Community Integration Questionnaire was also administered to participants. **Results:** Participants with TBI were significantly impaired on both the static and dynamic FAR measures, yet the deficits were most pronounced within the dynamic task. Furthermore, participants with TBI reported lower community integration compared with HCs. FAR was positively associated with community integration in both groups, such that participants with proficient affect recognition skills were better integrated into their communities. **Conclusions:** FAR deficits may contribute to the lack of community integration often observed in TBI; thus, interventions designed to improve FAR may be beneficial to this population's ability to successfully reintegrate into society.

Keywords: TBI, Traumatic brain injury, Facial affect recognition, Emotion recognition, TASIT, Community integration, Social integration, Social cognition

INTRODUCTION

Individuals who have sustained a traumatic brain injury (TBI) are vulnerable to negative social consequences, including a reduction in social integration. One facet of social integration, community integration, is critical to rehabilitative efforts and optimal recovery. Community integration subsumes participation across a variety of social settings, including home, occupational, and social environments. For those with TBI, better community integration is associated with positive social outcomes, including greater self-esteem (Juengst, Arenth, Raina, McCue, & Skidmore, 2014), higher cognitive functioning (Cicerone, Mott, Azulay, & Friel, 2004), and better emotional and physical health (Doninger et al., 2003). TBI populations, however, are at a heightened risk of experiencing diminished community integration (Willer, Rosenthal, Kreutzer, Gordon, & Rempel, 1993), rendering individuals more susceptible to decreased life satisfaction and poorer quality of life (Cicerone et al., 2004).

Despite the fact that community integration is a hallmark goal of rehabilitation, there is a notable gap in our understanding of factors that contribute to diminished community integration within TBI populations. One potential barrier of community integration in TBI is impaired ability to identify facial emotions (facial affect recognition; FAR). It has been estimated that up to 39% of individuals with moderate to severe TBI suffer from FAR deficits (Babbage et al., 2011), which likely contributes to misinterpreting affective/social cues and responding inappropriately.

Research probing the explicit relationship between FAR and community integration has been inconsistent in TBI.

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In one TBI study, better FAR performance was related to higher scores on social and occupational aspects of integration (Knox & Douglas, 2009). By contrast, Milders et al. failed to find a significant relationship between FAR ability and home and social integration in TBI (Milders, Fuchs, and Crawford, 2003). However, their sample comprised higher functioning, ready-to-work individuals with TBI, so the findings may underestimate the emotional and social changes in a severe TBI population. Recently, May et al. (2017) found that better emotion recognition was related to higher scores on the productivity subscale of the Community Integration Questionnaire (CIQ; Willer et al., 1993), but not on the social or home integration subscale. However, the authors relied on a measure of FAR not validated in TBI. Additional research is needed to better characterize the link between TBI-acquired FAR deficits and community integration.

While there is some evidence linking FAR and constructs related to community integration, few studies have examined this relationship by testing FAR using both static (photographs) and dynamic (videos) displays of emotion. It has been argued that dynamic displays have better ecological validity and may be uniquely sensitive to deficits in TBI (McDonald & Saunders, 2005). Thus, in the current study, we included a dynamic measure, which was developed for use in TBI (The Awareness of Social Inference Test or TASIT; McDonald, Flanagan, Rollins, & Kinch, 2003). Furthermore, we investigated FAR proficiency for each of the basic emotions across both static and dynamic FAR tasks. We hypothesized that deficits in overall FAR—whether captured with static or dynamic displays, or both—would predict difficulties in community integration in individuals with TBI.

METHOD

Participants

The current study included 27 individuals with moderate to severe TBI and 30 healthy controls (HCs). Individuals with TBI met the Mayo Classification System criteria for moderate/severe TBI (Malec et al., 2007) and were at minimum 1 year postinjury [mean time since injury = 112.47 months, standard deviation (SD) = 97.95]. Injury severity was confirmed through medical records; however, if records were not available, family members were required to confirm a loss of consciousness greater than 30 min. All participants were free from neurological disease/injury (apart from brain injury among TBI participants), psychotic disorders, such as schizophrenia, and substance abuse/dependence. Participants were recruited from our institution-wide database of eligible volunteers, who were originally recruited from the general community or referred by a partnering institution from the Northern New Jersey Traumatic Brain Injury System. The two groups did not significantly differ in age (years) (TBI: $M = 40.89$, $SD = 14.53$, range = 20–65; HC: $M = 38.27$, $SD = 13.85$, range = 21–63; $t(55) = .70$, $p = .49$), years of education (TBI: $M = 14.70$, $SD = 2.03$, range = 12–20; HC: $M = 15.43$, $SD = 1.85$, range = 11–18; $t(55) = 1.42$, $p = .16$), or gender composition (TBI = 4F/23M; HC = 9F/21M; $\chi^2(1) = 1.86$, $p = .17$).

Procedure

This work was approved by the Kessler Foundation Institutional Review Board and was conducted in accordance with the Declaration of Helsinki. Participants completed these measures as part of a larger neuroimaging study on social cognition in TBI whose findings will be presented elsewhere. All participants provided written informed consent prior to study participation and were compensated.

Static affect recognition

For static FAR, we used The Task of Facial Emotion Recognition—Kessler Foundation (Copyright© 2015 Kessler Foundation Inc. All rights reserved.) (TOFER-KF©; Genova et al., in press). In this task, participants were presented with 36 photos of different actors presented in random order and displaying each of six emotions: happiness, sadness, anger, surprise, fear, and disgust. During each trial, participants indicated via button press that which of the six basic emotions was being expressed. The proportion of correct responses out of 36 was computed for the total score, and the proportion of correct responses out of six was computed separately for each emotion.

Dynamic affect recognition

The Emotion Evaluation Test of the TASIT (McDonald et al., 2003) is designed to assess FAR through a series of videotaped vignettes. Each vignette features actors exhibiting one of seven emotions (happy, sad, surprised, angry, anxious, revolted, and neutral) in everyday situations. Each emotion was presented four times. The proportion of correct responses out of 28 was computed for the total score, and the proportion of correct responses out of four was computed separately for each emotion.

Community integration

The CIQ (Willer et al., 1993) yields three subscales: (1) home integration, related to functioning within a home setting, (2) social integration, referring to leisure activities and social interaction performed outside the home, and (3) productivity, assessing participation in employment, educational, and volunteer activities. Higher scores reflect higher levels of community integration.

Neuropsychological performance

To examine the possibility that group differences in FAR reflected more general effects of TBI on cognition,

Table 1. Group differences in percentage correct responses for static and dynamic FAR, and in community integration

	TBI mean (SD)	HC mean (SD)	t	p	d
Static recognition (TOFER-KF)					
Total correct	73.46 (6.51)	77.13 (6.75)	2.09	**0.02***†	0.56
Happy	94.33 (8.17)	96.67 (9.14)	1.01	0.16	0.27
Surprised	91.30 (11.66)	92.17 (12.95)	0.27	0.40	0.07
Sad	86.37 (16.00)	89.40 (19.78)	0.63	0.27	0.17
Afraid	14.85 (16.17)	24.43 (22.58)	1.82	**0.04***	0.49
Angry	79.56 (16.80)	82.20 (15.64)	0.62	0.27	0.17
Disgusted	74.07 (18.03)	77.70 (17.07)	0.78	0.22	0.21
Dynamic recognition (TASIT)					
Total correct	76.72 (17.48)	88.69 (6.16)	3.52	**<0.01****†	0.95
Neutral	61.11 (29.69)	70.00 (23.12)	1.27	0.11	0.34
Happy	84.26 (24.17)	95.83 (11.53)	2.35	**0.01***†	0.63
Surprised	87.04 (14.50)	87.50 (17.06)	2.12	**0.02***†	0.57
Sad	71.30 (24.71)	90.83 (15.37)	2.90	**<0.01****†	0.78
Anxious	77.78 (29.69)	86.67 (18.26)	2.12	**0.02***†	0.57
Angry	75.93 (28.81)	95.83 (9.48)	1.66	0.05	0.45
Revolted	79.63 (27.77)	94.17 (10.75)	3.01	**<0.01****†	0.81
Community integration (CIQ)					
Home integration	5.16 (2.69)	6.58 (2.63)	2.01	**0.02***†	0.54
Productivity	4.15 (1.88)	5.33 (1.60)	2.57	**0.01****†	0.69
Social integration	7.89 (2.53)	8.97 (1.87)	1.84	**0.04***†	0.50

**t* test is significant at the 0.05 level (one-tailed).
** *t* test is significant at the 0.01 level (one-tailed).
† *t* test is significant after FDR correction.
d = Cohen's *d* effect size.

performance on the California Verbal Learning Test —Second Edition (CVLT-II; Delis, Dean, Kramer, Kaplan, Ober, 2000) was also considered. Memory impairment is a well-documented consequence of TBI (Vanderploeg, Crowell, & Curtiss, 2001) and served as a proxy for more general effects of TBI on cognition. Performance on this measure was summarized by the raw score for total correct recall on the first five trials.

Data Analysis

Independent samples *t* tests were used to analyze group differences between TBI and HC groups, and multiple regression was used to examine a subset of group differences after controlling for neuropsychological performance. A mixed design analysis of variance (ANOVA) was run to compare relative performance on static and dynamic tests between groups. Pearson correlation coefficients were computed to test the association between performance on FAR tasks and CIQ. Statistical tests (with the exception of demographic differences) were one-tailed, with the hypothesis that TBI participants should perform worse than HCs on FAR and CIQ. Additionally, we expected that FAR should correlate positively with CIQ for all participants. To guard against inflation of type I error, the Benjamini–Hochberg procedure (Benjamini & Hochberg, 1995), for controlling false discovery rate (FDR), was applied. Results surviving correction for multiplicity are labeled in *Tables 1* and *2*.

RESULTS

Group Differences

Means, SDs, and *t* tests for each measure are presented in *Table 1*. Results from *t* tests revealed group differences on both FAR measures. For static FAR, the TBI group performed significantly worse than controls on total identification. For the dynamic FAR task (TASIT), the TBI group was also significantly less accurate than controls on all variables except for recognition of neutral and angry expressions. Finally, for each CIQ subscale, the TBI group reported significantly lower community integration than the control group. As presented in *Table 1*, nearly all of the significant differences survived FDR correction for multiple comparisons.

The TBI group performed significantly worse on the CVLT-II than HCs, $t(55) = 1.90$, $p = .03$. In order to test whether the group differences in FAR persisted after controlling for neuropsychological performance, we conducted two linear regression analyses, each with the static or dynamic FAR total correct score as the dependent variable. The independent variables were case status (HC *vs.* TBI) and performance on the CVLT-II. Results indicated that case status was the only significant predictor of FAR performance on the static recognition task, $\beta = .27$, $t(54) = 1.97$, $p = .03$, and also on the dynamic recognition task, $\beta = .43$, $t(54) = 3.22$, $p < .01$, suggesting that the FAR deficits we observed in TBI are not explained by one's level of cognitive impairment. Furthermore, demographic variables, such as age, education,

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Table 2. Associations between FAR performance and community integration

	TBI			HC		
	Community integration			Community integration		
	Home	Productivity	Social	Home	Productivity	Social
Static recognition (TOFER-KF)						
Total correct	−0.24	**0.34***	0.25	−0.16	**0.47****	0.14
Happy	0.13	0.31	−0.16	−0.17	0.24	−0.14
Surprised	0.08	0.03	0.30	−0.16	0.27	0.13
Sad	−0.27	**0.37***	−0.13	0.12	0.03	0.13
Afraid	−0.36	−0.05	0.15	−0.09	0.18	**0.45****
Angry	−0.12	−0.09	0.22	−0.17	**0.47****	−0.08
Disgusted	0.05	**0.36***	0.19	−0.04	0.09	−0.35
Dynamic recognition (TASIT)						
Total correct	−0.15	**0.34***	0.28	−0.30	**0.33***	−0.14
Neutral	0.24	0.32	**0.32***	−0.14	0.12	0.00
Happy	−0.13	0.18	0.19	0.13	−0.02	0.03
Surprised	−0.01	0.07	0.25	0.10	**0.37***	0.03
Sad	−0.05	0.16	0.01	−0.12	−0.06	−0.42
Anxious	−0.15	0.11	0.02	−0.10	0.09	−0.01
Angry	−0.25	0.20	**0.36***	−0.36	**0.39***	0.09
Revolted	−0.32	**0.50****	0.17	−0.25	0.04	−0.11

*Correlation is significant at the 0.05 level (one-tailed).
** Correlation is significant at the 0.01 level (one-tailed).
† Correlation is significant after FDR correction.

and gender, were not significantly associated with performance on the static or dynamic FAR tasks, and did not change the pattern of results described above when included as covariates in the regression models.

Differential Deficits

Performance on the two tests of FAR was highly correlated, $r(55) = .47$, $p < .001$; yet, we wished to examine whether the TBI-related deficits were more apparent on one of the tasks. To this end, we conducted a 2 × 2 mixed ANOVA with case status (TBI *vs.* HC) as a between-subjects factor and the total correct score for each measure of FAR (static *vs.* dynamic) as a within-subjects factor. A significant interaction indicated that the performance difference between groups was larger for the dynamic task than the static task, $F(1,55) = 7.03$, $p = .01$. Follow-up simple effects testing further revealed that this effect was driven by the HC group, which obtained significantly higher scores on the dynamic task (89%) than the static task (77%), $p < .01$. In contrast, the TBI group's performance did not significantly differ between the dynamic task (77%) and the static task (73%), $p = .156$.

Associations between FAR and Community Integration

Static FAR. As illustrated in *Table 2*, performance on the static FAR task was positively associated with community integration, with significant correlations restricted to CIQ productivity subscale. Total identification and recognition of sadness and disgust were positively associated with CIQ productivity. ***Dynamic FAR***. Better recognition of neutral affect and anger were correlated with higher CIQ social integration. Total identification and recognition of revulsion were positively associated with CIQ productivity. While many of the correlation coefficients were moderate or large in magnitude, it is worth noting that due to the high number of tests, none of the correlations survived FDR correction and thus, this pattern of results should be interpreted with caution.

DISCUSSION

The purpose of the current study was to investigate the relationship between community integration in TBI and impairments in FAR. In line with prior research, the TBI group demonstrated deficits in FAR and poorer community integration, relative to HCs. As hypothesized, we observed moderate-to-large correlations between both the static and dynamic measures of FAR and community integration, suggesting that deficits in FAR may contribute to social isolation documented in individuals with TBI (Hoofien, Gilboa, Vakil, & Donovick, 2001; Morton & Wehman, 1995).

One aim of this study was to explore TBI-related deficits in FAR across multiple forms of measurement. While the overall pattern of results was similar across the two FAR tasks, deficits in the TBI group were more pronounced on the dynamic task. These results provide further support for the argument that the TASIT is especially sensitive to TBI-related FAR deficits (Knox & Douglas, 2009; McDonald et al., 2003; McDonald & Saunders, 2005). For HCs, performance on the dynamic task was relatively better than performance on the static task. By comparison, scores on the two

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tasks did not differ significantly for the TBI group. As facial processing capacity is already reduced in individuals with TBI (McDonald et al., 2003), they may not benefit from the additional detail and rich sensory information that accompanies dynamic displays. Given that dynamic displays are more ecologically valid, they may be more illustrative of the difficulties that individuals with TBI face in everyday life.

Across the two FAR tasks, participants' overall proficiency in FAR was associated with community integration, as measured by CIQ. One unanticipated finding was that FAR was most consistently associated with the CIQ productivity subscale, a pattern we observed in both samples (TBI and HC). This mirrors the results of May et al. (2017), who showed that FAR performance was associated solely with CIQ productivity. One possible explanation for the subscale-specific effects concerns the divergent social groups represented in each construct. The home integration subscale is primarily composed of questions regarding the division of labor in the household (e.g., "who usually cares for the children in your home?"), and thus likely depends heavily on the dynamics of a limited number of intimate relationships. The social integration subscale taps into participation in leisure activities and time spent with close others, and the productivity subscale measures participation in schooling, volunteer work, and employment. The relationship between FAR and productivity suggests that difficulties in FAR could be most impactful for social interactions with others with whom one does not have a close personal relationship (e.g., coworkers).

The current work is limited in that as it is underpowered relative to the scope of the analyses, some of which did not meet the threshold for significance after correction for multiple comparisons (despite effect sizes in the moderate-to-large range). While our findings are consistent with a body of research linking FAR and social integration in TBI (e.g., Knox & Douglas, 2009), future research would most certainly benefit from utilizing larger samples. Additionally, the lack of a control task for our FAR measures limits their construct validity. It could be argued that the FAR deficits measured are attributable to a more global deficit in face recognition or some other TBI-related perceptual disturbance. Additional research employing a perceptual control task would likely improve the validity of these results. Other potential areas for future research include using informant-based reports from family members to verify aspects of social integration, employing longitudinal designs, and better phenotyping research participants. These strategies would improve the accuracy of assessing social integration, better delineate how the relationship between social cognitive deficits and social integration in TBI may evolve over time, and identify additional factors that may moderate or mediate the difficulties observed in both of these domains.

CONCLUSION

Although numerous studies have detailed the prevalence of impaired FAR in TBI, few studies have examined the extent to which these impairments predict one's ability to integrate into the community. While the current research is correlational in nature, the association between FAR and community integration suggests that social cognitive deficits in TBI may contribute to social isolation of this population. While the literature on the relationship between difficulties with FAR and social integration has been inconsistent (e.g., Knox & Douglas, 2009; Milders et al., 2003), the current study's use of a task validated in TBI (TASIT) lends support to research showing that such a relationship exists. Existing social cognitive interventions (e.g., Neumann, Babbage, Zupan, & Willer, 2015) could help to prevent difficulty with community integration post-TBI and reduce the well-documented burden of isolation and decreased quality of life. Given that rehabilitation success is so closely tied with strong social networks and social support (Izaute et al., 2008), a clearer understanding of the issues leading to reduced community integration for individuals with TBI should be a priority in future research.

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