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Social Problem Solving and Social Adjustment in Pediatric Traumatic Brain Injury

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Abstract

Objective—Little is known regarding the predictors of social deficits that occur following childhood traumatic brain injury (TBI). The current study sought to investigate social problem solving (SPS) and its relationship to social adjustment after TBI.

Methods—Participants included 8 to 13 year old children, 25 with severe TBI, 57 with complicated mild-to-moderate TBI, and 61 with orthopedic injuries (OI). Children responded to scenarios involving negative social situations by selecting from a fixed set of choices their causal attribution for the event, their emotional reaction to the event, and how they would behave in response. Parent ratings of social behaviours and classmate friendship nominations and sociometric ratings were obtained for a subset of all participants.

Results—Children with severe TBI were less likely than children with OI to indicate they would attribute external blame or respond by avoiding the antagonist; they were more likely to indicate they would feel sad and request adult intervention. Although several SPS variables had indirect effects on the relationship between TBI and social adjustment, clinical significance was limited.

Conclusions—The findings suggest that while children with TBI display atypical SPS skills, SPS cannot be used in isolation to accurately predict social adjustment.

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DECLARATIONS OF INTEREST

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Keywords

Friendship; Social Competence; Sociometrics; Head Trauma

INTRODUCTION

Although the neurocognitive profile of pediatric TBI is well established, comparatively less research has focused on social outcomes. Extensive overlap exists between the ‘social brain network’ and the brain regions affected by TBI.^{1–5} Thus, children with TBI may be more likely than other children to experience significant social deficits. Existing literature confirms that parents of children with TBI often report poor social adjustment (i.e., smaller friendship networks, increased behaviour problems, poorer social skills).⁶

Determining the predictors of social impairments is critical to the design of interventions for children with TBI. Social information processing is a broad construct posited to involve the interaction of cognitive-executive, social-affective, and social problem-solving abilities (SPS). According to models of social competence,^{7,8} social information processing is assumed to influence social behaviour, which in turn influences social adjustment. For example, children who interpret scenarios as threatening often select and implement more aggressive interaction styles and are then rejected by their peers.^{9–11} Children with TBI have demonstrated difficulties in correctly interpreting social situations (i.e., problem definition), generating multiple responses/solutions, selecting a problem-solving strategy, and evaluating response outcomes.^{12–15} Following pediatric TBI, children also tend to generate fewer prosocial assertive responses in favor of aggressive, avoidant, or irrelevant responses.^{12,15} Even after being matched on disruptive behaviour and attention problems, children who have sustained a TBI select more aggressive responses than non-injured children.¹⁶ These differences in situation interpretation, response selection (particularly aggressive responses), and evaluation of outcomes predict parent and teacher ratings of interpersonal skills, social participation, friendships, and social skills, as well as social reintegration in early adulthood.^{12–14,17} However, no research has specifically evaluated the links between SPS and sociometric peer ratings among children with TBI, despite evidence of associations in typically-developing populations.^{9,18,19}

The current study sought to determine the relationship between SPS and social adjustment in children with complicated-mild to severe TBI. Based on previous findings, children with TBI were expected to interpret situations as more hostile and prefer more aggressive, avoidant, or irrelevant response behaviours. In view of evidence from both pediatric TBI and typically developing populations on relationships between SPS and social adjustment, SPS also was expected to act as a mediator between injury status (TBI vs. orthopedic injury) and social adjustment. Specific expectations were that hostile attributions and greater preference for aggressive, avoidant, or irrelevant responses would be associated with deficits in parent-rated social functioning, lower peer acceptance, and fewer friendships.

METHODS

Participants

Participants included children who were hospitalized at least overnight after sustaining either a TBI or orthopedic injury (OI), were between the ages of 8 and 13 years, and whose injuries occurred 12 to 63 months prior to assessment. All children were injured after 3 years of age, with the majority injured after age 4. Potential participants were identified from reviews of hospital medical records and trauma registry at Nationwide Children's Hospital in Columbus, Ohio, Rainbow Babies and Children's Hospital and MetroHealth Medical Center in Cleveland, Ohio, and the Hospital for Sick Children in Toronto, Canada. Families were sent a letter that informed them about the study and allowed for an "opt out" if they did not wish to be contacted. If they did not opt out, they were contacted by phone. The most common reasons given for non-participation in both groups included the family being uninterested in participating, not having time to participate, and not wanting to travel the distance to the study site to participate.

Children with moderate to severe TBI were eligible (Glasgow Coma Scale [GCS] score < 13; lowest recorded post-resuscitation GCS score from emergency medical or hospital personnel used to determine eligibility), as were children with mild TBI (GCS scores of 13 and above) if their medical records documented intracranial abnormalities or a depressed skull fracture on MRI or CT scan. Moderate TBI was defined by a GCS score of 9 to 12, and severe TBI was defined by a GCS score of ≤ 8. Participants with complicated-mild and moderate TBI were combined into one group for the purposes of this study given the extensive literature suggesting their outcomes are quite similar.²⁰ Children with OI suffered fractures of the extremities and were enrolled as an "other injury" comparisons group. Children with any evidence of a head trauma or symptoms of possible concussion (e.g., loss of consciousness, post-traumatic amnesia, vomiting, nausea, headache, etc.) were excluded from the OI group. General exclusion criteria applying to both groups included a primary language other than English; any medical contraindication to MRI; previous head injury requiring medical treatment; history of severe psychiatric illness resulting in hospitalization; premorbid neurological disorders or mental retardation; hypoxia, hypertension, or shock during or following the injury; injury resulting from child abuse or assault; and injuries that would interfere with neuropsychological testing (e.g., fracture of preferred upper extremity).

Among children eligible to participate, 82 (47%) of those with TBI and 61 (26%) of those with OI agreed to enroll in the study. Participants and non-participants did not differ significantly in age at injury, age at initial contact about the study, sex, ethnic/racial minority status, or census tract measures of socioeconomic status (SES; i.e., census tract measures of mean family income, percentage of minority heads of household, and percentage of households below the poverty line). Participants and non-participants also did not differ on measures of injury severity (i.e., average length of stay, mean GCS score for children with TBI).

Among participants, children with severe TBI, complicated mild-to-moderate TBI, and OI did not differ significantly on age at injury, age at baseline assessment, time from injury to baseline assessment, sex, or ethnic/racial minority status (table 1). However, children with

TBI had lower IQ scores than children with OI. Additionally, children with severe TBI were more likely to receive both inpatient and outpatient rehabilitation services. Children with severe TBI were also more often involved in more motor vehicle accidents, and children with OI sustained more injuries in sports and recreational events. Group differences in SES were no longer significant when injury mechanism was taken into account. These findings are consistent with epidemiological studies showing that the risk of TBI, particularly those linked to motorized vehicles, is highest for children of lower SES and minority status.^{21–26} For that reason, we did not treat SES or discharge disposition as covariates in data analyses, because differences appeared to be intrinsic to the injury groups. When a covariate is an attribute of a disorder, or is intrinsic to the condition, “adjusting” for differences in the covariate is not meaningful and can be potentially misleading.²⁷

All 143 participating families completed a baseline visit. Of the total sample, 119 parents (83%) completed the measure of adaptive behaviour, 115 (80%) provided ratings of emotional and behavioural functioning, and 87 children (61%) completed classroom data collection. Comparisons of children with and without parent ratings showed proportionally more minority children without parent ratings. On the measure of adaptive behaviour, proportionally more ratings were obtained for children with OI than TBI. Among the subset of children for whom parent ratings were obtained, injury groups did not differ on demographic variables. Children with and without classroom data did not differ significantly in terms of age at injury, age at baseline assessment, time from injury to baseline assessment, sex, ethnic/racial minority status, IQ, SES, or injury group membership.

Procedure

Institutional review board approval was obtained for the study, and informed parental consent and child assent were elicited prior to participation. Children who met all inclusion/exclusion criteria and whose parents agreed to participate were scheduled for an initial assessment. At the initial assessment, children completed an assessment that included measures of SPS, and parents completed measures of adaptive behaviour and behavioural functioning (parent ratings were initially obtained at a second visit, but the procedure was changed based on attrition rates for the second visit). During the initial assessment, parents also provided written consent for study coordinators to contact the child’s school to arrange for classroom data collection. School principals were contacted to obtain permission to communicate with children’s primary teachers regarding data collection. Study coordinators then met with teachers to explain the study, obtain consent, and distribute consent forms to send home to the parents of each classmate. Children whose parents did not consent were not included in the activity on the day of data collection.

Attributions and Coping Questionnaire

The Attributions and Coping Questionnaire (ACQ)²⁸ assesses several specific stages of SPS, including those that represent areas of weakness for children with TBI, specifically situation interpretation and response selection. Children were presented with a series of vignettes involving stressful but ambiguous social situations. They were asked three multiple-choice questions after each vignette. For the first question, children selected from one of four causal attributions 1) positive intentions (i.e., the other child was attempting to help); 2) external

blame (i.e., the other child had hostile intent); 3) internal blame (i.e., the target child blames him/herself); or 4) neutral (i.e., unintentional). For the second question, children chose from four emotional responses (i.e., okay, sad, angry, and embarrassed) indicating how they would feel in each scenario. The final question asked the child to choose how they would respond to the dilemma from four options: 1) avoidance (i.e., avoiding future interaction with the peer); 2) adult intervention (e.g., asking an adult to help fix the issue); 3) revenge; 4) distress; or 5) prosocial action (e.g., providing reassurance to the other child).

On Part 1 of the ACQ, the child was presented with five hypothetical scenarios involving a same-sex, unfamiliar peer. Responses were converted into proportions conveying the number of times the child selected a certain response across vignettes. For example, the number of times a child selected each possible attribution (e.g., external blame) was summed across vignettes, and converted to a proportion by dividing by 5. A similar process was followed for scoring emotional reactions and preferred responses. Part 2 of the ACQ was presented after a delay and involved the child's best friend being portrayed as the antagonist in each vignette. Scoring was identical for Part 2.

The response format of the ACQ makes responses to each question dependent (i.e., proportions of each response type sum to 1). To address the dependence among responses, composite variables were also generated to reflect children's overall preferences for attributions, emotional responses, and behavioural responses. Children were regarded as having a preference for a particular attribution, emotional response, or behavioural response if they chose a specific response alternative on a majority (≥ 3) of the stories. Thus, the categories were independent, because no child could be classified into more than one category.

Previous studies reveal good internal validity for the ACQ, demonstrating significant and theoretically-coherent associations between attributions, emotional responses, and behavioural responses (e.g., external blame with feelings of anger and vengeful actions).^{28–30} The ACQ also has successfully distinguished shy/withdrawn, anxious, and aggressive children.^{28,31} Responses on the ACQ are also related to friendship quality. Adolescents who attribute more hostile intent or select avoidant responses report greater conflict in their friendships and decreased friendship quality.^{29,32} Further, children who report feeling sad in response to social dilemmas tend to report higher positive friendship quality, while those who endorse feeling angry report lower positive friendship quality.^{29–31}

Measures of Social Adjustment

Parents rated children's adaptive functioning using the Adaptive Behavior Assessment System-Second Edition (ABAS-II).³³ The ABAS-II is a parent self-report of behavioural skills that are important in coping with the demands of daily life in multiple settings (e.g., home and school). It assesses multiple adaptive areas; in the current study, the Social subscale was used as a measure of social adjustment. Parents also rated their children's emotional and behavioural adjustment using the Behavior Assessment System for Children-Second Edition (BASC-2).³⁴ The BASC-2 provides multiple subscales; for the purposes of the current study, the Aggression, Withdrawal, Social Skills, Leadership, and Functional Communication scales were selected as measures of psychosocial adjustment, because they

focus on behaviours that are predominantly social in nature. Both the ABAS-II and BASC-2 are well standardized, demonstrate good reliability and internal consistency, and have been shown to be sensitive to developmental differences and clinical disorders.

During the school visit, all children in the class were asked to nominate their three best friends in the classroom. A nomination was considered mutual when the target child was reciprocally nominated by any of the three children who were named by the target child.³⁵ A measure of mutual or reciprocal friendships (ranging from 0 to 3) was then computed for the target child. In addition, each student was provided with a class roster and asked to rate how much they like each of their classmates on a 5-point scale.³⁶ Average peer acceptance ratings were computed for the target child, with higher scores indicating greater acceptance. Both ratings of reciprocal friendships and peer acceptance were standardized within gender and classroom.

Data Analysis

For all analyses, age at time of testing was always included as a covariate when evaluating ACQ data because the ACQ is not a standardized measure and SPS skills tend to change with age.^{37,38} Time since injury was found to be correlated with the ABAS-II Social and BASC-2 Aggression subscales. Time since injury was included as a covariate in analyses in which these variables served as outcome measures.

Two types of analyses were conducted to test the first hypothesis that injury groups would differ in SPS. Based on previous research with the ACQ,²⁸ a series of 3 (group) x 2 (ACQ peer type: peer vs. friend) repeated-measures ANOVAs were used to test for group differences on the ACQ, with peer type treated as a repeated measure. Dependent variables included the proportion of responses given to each response alternative for the three questions asked about each vignette, across all five vignettes. Thus, three repeated-measures ANOVAs were conducted, one for attributions, one for emotion responses, and one for behavioural responses.

In addition, a repeated-measures multinomial logistic regression (RMMLR) was used to assess group differences in preferred response style, again with peer type treated as a repeated measure. The dependent variables in these analyses were the composite variables generated to reflect children's overall preferences for attributions, emotional responses, and behavioural responses. Preliminary analyses revealed that certain responses were not preferred (i.e., not endorsed at least three times across the five vignettes): positive intentions and internal blame for attributions; embarrassed feelings; and avoidant, vengeful, and emotional/upset responses. These categories were dropped from the RMMLR analyses. Because children were often classified as non-specific responders (i.e., they did not show a preference across vignettes), additional categories were considered based on whether children displayed a consistent preference for two categories in each domain. For example, if a child selected external blame on two stories and internal blame on two stories, they would be classified as an External-Internal type for behavioural response. Only one additional category, a combination of positive intention and neutral attributions, met this criterion for at least 10% of the sample. For the RMMLR analyses, reference groups were specified as follows: unfamiliar peer stories for peer type, the OI group for injury group, and

the category most often chosen by the OI group (i.e., neutral attributions, non-specific emotional response, and prosocial actions) for the ACQ composites. The analyses were conducted in SAS (SAS Institute, Cary, NC, USA). A random effects model was specified using PROC NLMIXED, used for nonlinear mixed models, following guidelines set forth by Kuss and McLerran.³⁹ This procedure estimates the maximum likelihood of the parameters through integration methods while allowing for correlated/repeated measures (i.e., ACQ peer type: peer vs. friend). Initial parameter estimates were identified using PROC LOGISTIC.

Mediation analyses were conducted to evaluate the second hypothesis that SPS would account for a portion of the relationship between injury status (TBI vs. OI) and peer relations. Only ACQ variables demonstrating significant group differences were used in the mediation analyses. Because multi-categorical variables (e.g., ACQ composite scores) cannot be employed in mediation analyses, only the continuous ACQ proportion scores were included as mediators. Separate models were constructed for each outcome variable. Mediation was assessed using the MEDIANTE macros developed by Andrew Hayes (<http://www.afhayes.com/spss-sas-and-mplus-macros-and-code.html>).^{40,41} MEDIANTE does not include an option to conduct ‘normal theory’ tests of significance, such as the Sobel test. Instead, confidence intervals for point estimates of the indirect effect are generated using bootstrapping methods. This study utilized stratified bootstrapping with the number of samples set to 100,000. If the confidence interval did not include 0, the indirect effect was considered significant.

RESULTS

Social Problem Solving

Injury group—Injury groups differed on several ACQ variables (table 2). According to both repeated-measure ANOVA and RMMLR analyses, children with severe TBI were less likely than children with OI to make attributions of external blame (RMANOVA: post-hoc comparison $p < 0.01$ /RMMLR: odds ratio [OR] = 0.01; $p < 0.05$). Other group differences were found on either the repeated-measure ANOVA or RMMLR analyses, but not both. Relative to the OI group, children with severe TBI were less likely to be non-specific in their attributions (i.e., lack a consistently selected attribution) than to show a preference for neutral attributions (RMMLR: OR = 0.14; $p = 0.05$). For sad responses, a significant interaction was found between injury group and peer type. Children with severe TBI were more likely to endorse sadness as a preferential response than they were to be non-specific in their emotional responses when asked about dilemmas with friends (RMMLR: OR = 20.82; $p = 0.05$). Lastly, children with severe TBI selected avoidant responses less frequently than children with OI (RMANOVA: post-hoc comparison $p < 0.05$), but chose adult intervention more frequently than the other injury groups (RMANOVA: post-hoc comparison vs. complicated mild-to-moderate TBI $p < 0.05$, vs. OI $p < 0.10$).

Peer type—For all injury groups, responses varied by antagonist in several domains. Children were less likely to be non-specific in their responses (RMMLR: OR = 0.06; $p < 0.001$) or show a preference for external blame (RMMLR: OR = 0.02; $p < 0.001$) than to

endorse neutral attributions in dilemmas with friends relative to dilemmas involving unfamiliar peers. Children were more likely to feel okay (RMANOVA: $F [1, 134] = 4.66$; $p < 0.05$; RMMLR: OR = 17.63; $p < 0.001$) and less likely to feel sad (RMANOVA: $F [1, 134] = 47.73$; $p < 0.01$) when social dilemmas involved friends rather than unfamiliar peers. Finally, children were more likely to be non-specific in their responses (RMMLR: OR = 0.04; $p < 0.001$) than to preferentially endorse prosocial responses in stories with unfamiliar peers relative to dilemmas involving friends.

Social Adjustment

Parents rated children with severe TBI as less socially competent (ABAS-II Social subscale), displaying fewer leadership qualities (BASC-2), and having fewer functional communication skills (BASC-2) than both children with OI and those with complicated mild-to-moderate TBI ($ps > 0.05$; all Cohen's ds between -0.58 and -0.76 ; table 3). The injury groups did not differ in number of reciprocal friendships or ratings of peer acceptance, despite medium effect sizes in favor of the children with OI relative to those with severe TBI (Cohen's $ds = -0.61$ and -0.48 for reciprocal friendships and peer acceptance respectively).

Mediation Analyses

Mediation analyses were conducted for the four responses on the ACQ that differed between groups: attributions of external blame, feelings of sadness, and behavioural responses of avoidance and adult intervention. In the absence of interactions between injury group and peer type for external blame, avoidance, and adult intervention responses, summary scores representing responses across all 10 stories were used. For feelings of sadness, separate analyses were conducted for responses to dilemmas involving unfamiliar peers and those involving friends, as well as for performance across the entire ACQ. Based on existing literature showing that attributions of external blame and avoidant responses are negatively related to friendship quality, while feelings of sadness are positively correlated with friendship quality,^{29–31} we specified our expected directions of effect a priori. Therefore, 90% confidence intervals were employed for analyses of peer relationships using those mediators. In all other cases, where the direction of effect could not be specified based on existing research, 95% confidence intervals were used. Although injury groups did not differ significantly on most measures of social adjustment, all were treated as possible outcomes, because the presence of a direct effect is not a necessary prerequisite for mediation (e.g., inconsistent mediation; suppression effect).^{42–45}

Significant indirect effects are displayed in table 4 and a sample mediation diagram is provided in figure 1. For both TBI groups, children who attributed more external blame were rated as less socially skilled by parents (figure 1). Attributions of external blame were somewhat negatively related to friendships, but an indirect effect was only apparent in the severe TBI (relative to OI) group.

Preliminary analyses revealed a negative correlation between feelings of sadness and peer relationships (i.e., reciprocal friendship and peer acceptance) that was contrary to past findings and thus warranted a stricter 95% confidence interval. Using the stricter criterion,

the indirect effect of TBI on reciprocal friendships through feelings of sadness was significant for the severe TBI group. Specifically, children with severe TBI were more likely to report feelings of sadness and more sadness, in turn, was associated with fewer reciprocal friendships.

Behavioural responses of avoidance showed the most consistent indirect effect of TBI on social adjustment. Children with severe TBI showed a trend to select fewer avoidant responses. Avoidant responses were negatively related to BASC-2 Social Skills scores, with trends towards a negative relationship with ABAS-II Social subscale scores and a positive relationship with parent ratings of aggression. Among children with classroom data, all children with TBI showed a trend to select fewer avoidant responses. The indirect effect of TBI on peer relationships via avoidant responses was significant for both TBI groups, with avoidance predicting fewer reciprocal friendships and lower ratings of peer acceptance.

Overall, the results indicate that the preference that children with TBI (particularly those with severe TBI) displayed for fewer attributions of external blame and fewer avoidant responses actually acted to offset the negative effects of TBI on social adjustment, while feelings of sadness appeared to partially mediate the relationship between severe TBI and number of reciprocal friends.

DISCUSSION

Compared to children with OI, children with TBI displayed several differences in SPS. Children with severe TBI were less likely to choose outright avoidance but more likely to prefer the behavioural response of adult intervention (confirmed in post-hoc RMMLR analyses using an alternative reference category; OR = 8.04). Adult intervention responses involve the child asking an adult to solve social problems, rather than dealing with the peer directly. Endorsements of adult intervention may be viewed as a type of avoidant behaviour, as the child chooses to avoid interacting with the peer to solve the dilemma. Furthermore, younger children displayed a preference for adult intervention relative to older children (RMMLR: OR = 0.72; $p < 0.10$; RMANOVA: $F [1, 134] = 5.45$; $p < 0.05$), and thus endorsements of adult intervention on the ACQ can also be viewed as developmentally immature.

Contrary to past research, children with TBI did not demonstrate a preference for aggressive responses. The groups did not differ on vengeful actions, and the pattern of differences for attributions of external blame was opposite previous findings, such that children with severe TBI were less likely to choose external blame. While these results run contrary to the literature, children with TBI in this sample were more likely to be characterized by their peers as rejected/victimized, but not as aggressive.⁴⁶ This social profile is more consistent with that of children with other central nervous system disorders.^{47,48} Therefore, the SPS profile documented here (i.e., avoidant/immature rather than aggressive) may more accurately characterize the everyday functioning of children with TBI.

Children with TBI generally modified their responses based on antagonist type in a fashion similar to children with OI. This finding suggests that children with TBI can appropriately

distinguish between different social relationships (e.g., friends vs. strangers) and recognize that interactions vary by relationship type. One notable exception, however, involved feelings of sadness. Children with severe TBI endorsed feelings of sadness at the same rate whether the antagonist was an unfamiliar peer or a friend; in contrast, children with complicated mild-to-moderate TBI or OI endorsed sadness less often when dilemmas involved friends. Although we did not formulate specific hypotheses regarding emotional responses, differences in emotional regulation have previously been found to mediate the relationship between TBI and social adjustment.⁴⁹ In this sample, feelings of sadness were the only measure of SPS to truly mediate the relationship between TBI and social adjustment. Feelings of sadness were negatively related to sociometric peer ratings (i.e., acceptance and reciprocal friendship), and thus helped account for the direct effect of severe TBI on reciprocal friendships. However, feelings of sadness were not a significant mediator for any other measure of social adjustment, suggesting that this finding is not robust or may only explain a small portion of the difficulties in social adjustment experienced by children with TBI. Thus, our data confirm the existing notion that children with TBI struggle with emotion regulation,^{50–53} but do not demonstrate a consistent negative effect of poor emotional control on social adjustment.

For all other models in which indirect effects were significant, the direct effect of injury group on social adjustment was either not significant or was actually strengthened by the inclusion of a mediator. Even when the results were statistically significant, the clinical significance of the findings was limited. For example, the tendency for children with TBI to make fewer attributions of external blame and choose avoidant responses less often was ‘protective’ with regards to parent and sociometric ratings. However, children with severe TBI who never chose external blame had scores on BASC-2 Social Skills scale and number of reciprocal friendships that fell approximately half a standard deviation below those for children with OI. Similarly, children with severe TBI who never chose avoidance had average scores that were from 0.36 to 0.85 standard deviations more deviant (lower for adjustment, higher for aggression) than those in the OI group. This suggests that children with severe TBI benefited only minimally from the ‘protective’ effect.

It must be noted that the results should be re-evaluated using a larger sample size. The modest sample included here represented a diverse group (e.g., age at injury, time from injury to testing). However, we attempted to control for heterogeneity by covarying for age and time since injury, as well as limiting the sample to children who were at least one year post-injury (i.e., those out of the acute phase of recovery where most change occurs). The modest sample size, especially in the severe TBI group, also limited the ability to detect significant direct and indirect effects, particularly in analyses of classroom data. Because only 61% of the total sample completed the classroom visit, the analyses were at best powered to detect medium effect sizes.⁵⁴ In contrast to previous research and the findings reported here using parent report, the results using peer ratings showed injury groups did not differ significantly on number of reciprocal friendships or peer acceptance. Results were not significant even when contrasting the severe TBI and OI groups. Nevertheless, despite the lack of statistical significance, effect sizes suggest a moderate difference between the groups.

The ACQ itself imposed perhaps the greatest limitation on the study. The ACQ only evaluates attributions, emotional reactions, and response selection. Although previous research indicates that children with TBI differ from children with OI on these SPS steps, they also differ in response generation (i.e., quantity of responses generated) and evaluation of outcomes,^{14,15,55} which are not assessed by the ACQ. In addition, the multiple-choice format of the ACQ requires fixed responses and does not allow any other response alternatives. For instance, a child who avoids stressful situations by ‘walking away’ would not find this option listed, and so might endorse a different response style. Furthermore, this format may assess knowledge of social skills rather than social skill itself. The test may not be assessing how children would actually act in these situations, but only their knowledge of socially appropriate responses. On the other hand, the relationships between SPS on the ACQ and social adjustment were consistent with those reported in both typically-developing and other TBI samples, with hostile (i.e., external) attributions and avoidant responses being negatively correlated with ratings of social adjustment. Future research on SPS will likely move away from artificial paper-and-pencil tasks in favor of more realistic scenarios presented via immersive virtual environments.⁵⁶ The use of virtual environments purportedly increases participant engagement in the task and more closely mimics social interaction. Virtual environments also can include non-relevant avatars and dialogue to increase task difficulty,⁵⁵ which may also prove critical in the study of SPS following TBI.

In summary, the current study provides evidence of deficits in SPS in children with TBI, who demonstrated greater difficulties with emotion regulation and were more likely to select indirect means of solving problems. On the other hand, the study provides only limited support for the hypothesis that SPS mediates the relationship between TBI and social adjustment. This does not invalidate the model of social competence set forth by Yeates et al. (2007), but does suggest that the aspects of SPS assessed in this study do not have strong indirect effects on social adjustment. Future research will be needed to determine if other aspects of SPS and social information processing are stronger mediators of adjustment. In the long run, randomized clinical trials involving interventions that promote SPS skills in children with TBI will provide the strongest test of whether SPS is a critical mediator of social adjustment.

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* $p < 0.01$

Figure 1.

Sample diagram of mediation analyses – indirect effect of injury severity on parent-rated social skills via attributions of external blame

Table 1

Demographic and injury characteristics

Variable	Severe TBI (n = 25)	Mild-Moderate TBI (n = 57)	OI (n = 61)
Age at injury in years	7.48 (2.07)	7.98 (1.88)	7.79 (1.80)
Age at test in years	9.94 (1.52)	10.55 (1.46)	10.61 (1.68)
Time since injury in years	2.46 (1.21)	2.57 (1.23)	2.82 (1.00)
Sex (% male)	64%	67%	61%
Race (% white)	76%	79%	89%
Full Scale IQ ^a **	97.67 (14.28)	99.77 (14.60)	109.85 (13.40)
SES, M (SD) *	-0.41 (0.77)	-0.14 (1.00)	0.30 (1.01)
Mechanism of injury (%) **			
Falls	20%	30%	25%
Sports/Recreation	24%	40%	70%
Motor Vehicle Accident	56%	30%	5%
Discharge			
Inpatient Rehabilitation **	44%	4%	0%
Outpatient Therapies **	68%	28%	7%

Note: Data displayed as M (SD) unless otherwise indicated

* $p < 0.01$;

** $p < 0.001$

^aIQ measured using the two-subtest version of the Wechsler Abbreviated Scale of Intelligence

Table 2

Selected ACQ results by injury group and peer type

Variable	Severe TBI		Mild-Moderate TBI		OI	
	Peer	Friend	Peer	Friend	Peer	Friend
Proportion of all responses						
Attribution						
External Blame ^a	0.13 (0.17)	0.03 (0.07)	0.23 (0.24)	0.04 (0.14)	0.31 (0.31)	0.08 (0.19)
Emotional Response						
Okay ^b	0.30 (0.26)	0.48 (0.32)	0.29 (0.21)	0.55 (0.30)	0.27 (0.24)	0.50 (0.30)
Sad ^b	0.34 (0.24)	0.30 (0.29)	0.29 (0.22)	0.22 (0.21)	0.29 (0.24)	0.24 (0.21)
Behavioral Response						
Avoidance ^a	0.06 (0.12)	0.00 (0.00)	0.08 (0.12)	0.04 (0.10)	0.13 (0.18)	0.04 (0.10)
Adult Intervention ^a	0.42 (0.32)	0.39 (0.34)	0.33 (0.22)	0.24 (0.23)	0.33 (0.20)	0.29 (0.25)
Percent showing preferred response style						
Attribution						
External blame ^{a,b}	4%	0%	16%	2%	23%	7%
Neutral	48%	65%	31%	57%	29%	57%
Non-specific ^b	24%	15%	42%	30%	38%	13%
Emotion						
Okay ^b	20%	52%	16%	59%	15%	48%
Sad ^{a * b}	24%	26%	14%	9%	17%	8%
Non-specific	44%	13%	49%	20%	42%	31%
Behavioral Response						
Prosocial action	24%	61%	46%	68%	37%	66%
Non-specific ^b	12%	4%	25%	11%	36%	8%

Note: Proportion data displayed as M (SD). Reference category *italicized* for preferred response style data.

^a Injury groups significantly differed.

^b Significant differences by peer type.

Table 3

Social adjustment by injury severity

Variable	Severe TBI	Mild-Moderate TBI	OI
ABAS-II (Scaled score)	(n = 20)	(n = 42)	(n = 57)
Social subscale (Scaled score) **	7.75 (4.20)	10.52 (3.01)	9.95 (3.06)
BASC-2 (T-scores)	(n = 20)	(n = 41)	(n = 54)
Aggression	53.30 (13.34)	52.10 (12.23)	49.08 (7.32)
Withdrawal	52.35 (12.30)	49.41 (9.49)	48.89 (11.02)
Social Skills	47.85 (12.59)	52.51 (11.36)	51.24 (9.81)
Leadership *	46.90 (12.78)	54.29 (10.80)	53.69 (9.60)
Functional Communication *	45.21 (11.23)	51.39 (9.93)	52.27 (8.78)
Classroom data (Z-scores)	(n = 15)	(n = 40)	(n = 32)
Reciprocal Friendships	-0.36 (0.94)	0.07 (0.94)	0.19 (0.86)
Peer Acceptance	-0.21 (1.04)	0.05 (1.07)	0.25 (0.89)

Note: Data displayed as M (SD)*
 $p < 0.05$;**
 $p < 0.01$

Table 4

Significant indirect effects

Mediator	Outcome	TBI Group	Indirect Effect	Std Error	Confidence Interval
External Blame	BASC-2 Social Skills	Severe	1.659	1.049	(0.079, 4.259)
		Mild-to-Moderate	1.196	0.826	(0.036, 3.319)
Sadness	Reciprocal Friendships	Severe	0.108	0.084	(0.005, 0.288) ^b
	Reciprocal Friendships	Severe	-0.129	0.094	(-0.391, -0.004)
Avoidance	ABAS-II Social subscale ^a	Severe	0.403	0.206	(0.079, 0.916)
	BASC-2 Aggression ^a	Severe	-1.335	0.703	(-3.133, -0.250)
	BASC-2 Social Skills	Severe	1.421	0.755	(0.295, 3.346)
	Reciprocal Friendships	Severe	0.146	0.109	(0.016, 0.387) ^b
Peer Acceptance		Mild-to-Moderate	0.113	0.087	(0.011, 0.308) ^b
		Severe	0.150	0.126	(0.007, 0.431) ^b
		Mild-to-Moderate	0.101	0.090	(0.001, 0.310) ^b

Note: Confidence intervals 95% unless otherwise indicated;

^aTime since injury included as covariate.

^b90% confidence interval