THESIS

PEDIATRIC TRAUMATIC BRAIN INJURY: INVESTIGATING FACTORS ASSOCIATED WITH PROBLEMATIC BEHAVIORS

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ABSTRACT

PEDIATRIC TRAUMATIC BRAIN INJURY: INVESTIGATING FACTORS ASSOCIATED WITH PROBLEMATIC BEHAVIORS

Children with traumatic brain injury (TBI) are currently under-identified and under-served in the American school system. The present study investigated factors associated with problematic behaviors including gender, number of head injuries and reported symptoms. Parents of students in grade school (K-12) from three research groups (children with TBI, children with learning disabilities and typically developing children) rated their child's behaviors and symptoms, and provided an injury history using the Brain Check Survey. Contrary to current literature, in the present study boys were not found to have more severe behaviors than girls overall for the TBI group, but rather both genders were rated similarly on behaviors. Analysis between behaviors and number of injuries was not completed as the TBI sample lacked variability in the number of injuries sustained per child. More severe symptoms were correlated with more severe behaviors overall for all three groups, with the TBI group demonstrating the strongest associations and more severely rated behaviors overall. Occupational therapists should consider that girls with a TBI may exhibit behaviors as severe as boys when evaluating children in order to ensure a proper diagnosis. Symptoms associated with behaviors being exhibited in children also should be evaluated and treated, as such interventions may result in improved behaviors.

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Introduction

Recent data suggest that more than 500,000 children from birth to 14 years of age sustain a traumatic brain injury (TBI) annually in the United States (Faul, Xu, Wald & Coronado, 2010). Outcomes for children who have sustained a TBI are difficult to predict and vary based on severity of injury (Hawley, 2003, Schwartz et. al., 2003; Taylor et. al., 2003), age at time of injury (Lord-Maes & Obzrut, 1996; Savage, Pearson, McDonald, Potoczny-Gray, & Marchese, 2001), and length of time since the injury occurred (Hooper et. al., 2004; Nolin, Villemure, & Heroux, 2006).

Numerous facets of occupational performance are affected when a child sustains a TBI, including cognitive and communicative skills, social and behavioral skills, and sensory-motor skills (Savage et. al., 2001). Savage and colleagues have defined cognitive-communicative needs of children who have sustained a TBI as skills that include: attention, memory, motivation, ability to learn new information, ability to adjust to change, and problem solving. Children with TBI most commonly have difficulty with tasks requiring attention and memory (Ewing-Cobbs, Prasad, Landry, Kramer, & DeLeon, 2004; Hooper et. al., 2004; Lord-Maes & Obzrut, 1996; Taylor et. al., 2003). Cognitive and communication deficits can be problematic as they may not become evident immediately after the injury, but rather are realized as the child has difficulty learning new tasks (Savage et. al., 2001).

Children with a TBI often have difficulties socializing, due to challenges they have in controlling their behavior in social situations (Savage et. al., 2001). They may not be able to demonstrate adaptive behavior in social settings; instead exhibiting maladaptive or occasional aggressive behavior towards their peers (Andrews, Rose & Johnson, 1998). Childhood TBI can alter the developmental course of the child, leaving them behind their peers with regard to social and behavioral skills (Taylor et. al., 2002). The TBI often leaves children unable to control their behaviors in stressful situations and limits their abilities to respond appropriately to frustrating situations (Hooper et. al., 2004; Savage et. al., 2001). These social difficulties can lead to poor self-esteem and loneliness for the child (Andrews et. al., 1998).

Sensory-motor skills include vision and hearing, balance, motor function, hand-eye coordination, speech, and endurance (Savage et. al., 2001). Children with a TBI can be highly affected by their environment and the sensory input they receive from it, making it more difficult for them to attend to a task. Children can have difficulty tuning in to the voice of a parent or teacher when other noises are present; experience difficulties with visual tracking such as when reading; or become unusually sensitive to smells, touch or light (Pierangelo & Giuliani, 2007).

A child's ability to engage in school activities after sustaining a TBI can be limited significantly by these deficits. Educational performance is likely to become more difficult following a TBI when children present difficulties in any of the aforementioned performance areas (Jantz & Coulter, 2007). In one study, Hooper and colleagues (2004) found that approximately 87% of children with a TBI surveyed returned to school full time within one month of sustaining their TBI, with 100% of respondents returning to school within 10 months of their injury. Further, 10-15% of these children experienced new learning difficulties when they returned to school between one and ten months post injury.

Despite the fact that children with a TBI are eligible for school-based services under the Individuals with Disabilities Education Act (IDEA), the needs of students with TBI are not adequately being met due to under-identification of children with this disability (Glang, Tyler, Pearson, Todis & Morvant, 2004), and inadequate training of teachers and professional staff to provide interventions for TBI (Clark, 1996; Mohr & Bullock, 2005; Semrud-Clikeman, 2001). Symptoms and behaviors of TBI often overlap those seen in other learning disorders, such as ADHD (Lord-Maes & Obrzut, 1996). Taylor and colleagues (2003) found that many children surveyed with a TBI were receiving services while classified as having a specific learning disorder rather than a TBI classification, which they postulated as being indicative of inadequacies in the schools' identification systems. Glang and colleagues (2004) describe TBI as a “high incidence medical event” but a “low incidence disability in the field of special education” (p. 220), due to the under-identification of children with TBI in the school system.

Bullock, Gable and Mohr (2005) suggest that TBI poses a unique challenge because the injury presents multiple challenges and results in demands on the educators. Arroyos-Juardo and Savage (2008) recently outlined vital components to successful intervention for children with TBI in a school setting including: modifications to the classroom, task analysis of cognitive and academic requirements of the student, assistive technology options for the student, and development of metacognitive abilities of the student. Occupational therapists (OTs) are typically trained in all of these treatment strategies and possess the skills and abilities to incorporate such strategies during intervention. Thus, OTs are in a unique position to provide interventions to children with TBI in the schools due to their advanced training and knowledge about working with children with complex health needs (Lowman et. al., 1999).

The purpose of the present study was to investigate factors that contribute to the severity of problematic cognitive, social and sensory motor behaviors exhibited in children with TBI in order to provide OTs with information to guide their intervention planning. Specifically, this study examined possible relationship associations between troublesome behaviors and gender, number of brain injuries sustained by the child, and problematic symptoms exhibited by the child.

Gender

Incidence of TBI is greater for males than for females across all age groups (Faul et. al., 2010). Males are at a greater risk for developing executive function deficits after sustaining a TBI, particularly with regards to analytical skills (Neimeier, Marwitz, Lesher, Walker, & Bushnik, 2007). Neimeier and colleagues found that this difference held true when controls were used for educational level and ethnic background, indicating an independent gender effect. Furthermore, males are more likely to exhibit behavioral problems in general than females (Petersen, Scherwath, Fink, & Koch, 2008).

As such, for the current study it is hypothesized that behaviors will be reported as being more severe for male students with a TBI than female students with a TBI.

Number of Injuries

Much of the current literature regarding the cumulative effects of sustaining multiple mild TBI or concussions is based on athletes and sport injuries with conflicting results. Iverson, Gaetz, Lovell, and Collins (2003) postulate that sustaining multiple concussions results in more severe symptoms, greater impacts to memory and decline of neuropsychological functioning over time. On the other hand, a meta-analysis of literature on the effects of multiple mild TBI found no overall impact of number of TBIs on neurocognitive functioning or symptom complaints (Belanger, Spiegel, & Vanderploeg, 2009). Associations were found, however, between number of TBIs and executive function performance and delayed memory.

Literature searches for the present study produced no results when searching for the effect of multiple concussions or TBI in children with regard to behavioral problems. The present study aimed to investigate the associations between multiple head injuries throughout the age span of students with one or more TBIs and the problematic behaviors they exhibit.

Symptoms

In addition to problematic behaviors, children with a TBI often display a variety of symptoms as a result of their injury. Symptoms frequently seen in children with TBI include, but are not limited to: headache, tiredness, vomiting, change in vision, dizziness, mood and personality changes, and amnesia (Falk, 2010; Hooper et. al., 2004). Little research has been done, however, to determine associations between symptoms a child displays and the problematic behaviors they exhibit.

Goals set for a child with TBI in the schools must not focus purely on academic, learning or social difficulties, but rather on the underlying processes that are contributing to any perceived deficits in these areas (Savage et. al., 2001). Thus, it is important to know if associations exist between symptoms and behaviors in children with TBI, so that the symptoms can be targeted in school-based interventions. The present study investigates these associations to determine if any meaningful relationships exist.

Methods

Participants

Participants were sampled from five school districts within the state of Colorado to include a variety of urban sizes within the state. Participants were sampled from three research groups: children with identified traumatic brain injury (TBI group), children currently receiving special education services for a learning disability (SPED group) and children who are typically developing and are not identified as having Individualized Education or 504 Plans (TYP group). Recruitment sample sizes for the groups within each of the five school districts were based on the overall size of the district, such that larger districts yielded larger recruitment samples. Stratified-random sampling procedures were used for the TYP and SPED groups from each school district such that equal numbers of males and females were chosen as well as equal numbers of students from each school level (elementary, middle and high schools). Whole group convenience sampling was used to obtain participants in the TBI sample due to the low incidence of TBI in schools.

When examining participant information for injuries (see below), it was found that a number of TYP participants had listed a history of head injury. Preliminary data analysis indicated that this subgroup of participants with possible head injury significantly differed from the remaining TYP participants without a history of head injury on 3 behavior rating items and 2 symptom rating items. Although the groups were not significantly different for a majority of the behavior and symptom items, the TYP participants with a possible history of head injury present a potential confound to the data within the overall TYP participant group and were excluded from the TYP group for data analysis for the present study. Henceforth, references to the TYP group will not include 67 students with a possible history of head injury.

A total of 479 participants returned surveys for the study, with sample sizes for each group as follows: TBI n=51, SPED n=34, TYP n=394. Participant demographics are displayed in Table 1. For the section of the BCS where the student's race was indicated, the "white" and "other" options both may include Hispanic participants.

Instrument

The Brain Check Survey (BCS) was developed as a screening tool to identify children who are struggling in school and who may be exhibiting signs or symptoms of a brain injury (Dettmer, Daunhauer, Detmar-Hanna, & Sample, 2007). The BCS (formally referred to as the Screening Tool for Identification of Acquired Brain Injury in School-Aged Children) was developed via exploration of research related to TBI in children as well as formal consultation with experts in the field of pediatric TBI; a process which ensured content and construct validity. In an earlier pilot study, the BCS was shown to accurately distinguish between populations of children with identified TBI, children currently enrolled in special education services, and typically developing children (Dettmer, et. al., 2007). Additionally, in that pilot study, the BCS demonstrated initial reliability when completed by parents for injuries (r_s=0.70), behaviors (r_s=0.85) and symptoms (r_s=0.60). The BCS is a parent report instrument and addresses three primary topic areas: history of injury and illness, behaviors currently observed in the child, and symptoms currently observed in the child. The survey also contains sections for parents to report demographic data related to the student and the family, the child's current strengths and weaknesses at school, and any related services the child currently receives that are being provided by the child's school or privately (i.e., occupational therapy, physical therapy, speech language therapy, or other).

The behavioral component of the BCS contains 19 items rated using a Likert scale ranging from 0 (Not Applicable) to 6 (Extreme). Each item represents a behavior that is associated with pediatric TBI and is known to complicate the ability of the child to learn and participate in school. For the purposes of this study, these items have been classified using the categories of deficits described by Savage and colleagues (2001), as depicted in Table 2. Similarly, the 15 item symptom component is rated using the same Likert scale and has been categorized as displayed in Table 3.

The present study is a sub-study of a larger study aimed at further determining the reliability and validity of the BCS. The larger study has been approved by the Colorado State University Institutional Review Board and is funded by a grant from the Colorado Traumatic Brain Injury Trust Fund. Further, each of the five school districts' ethics committees gave approval for their district's participation in the study.

Procedure

Participants were selected by each of the five school districts. Surveys were mailed to participants along with an introduction letter explaining the purpose of the study, two copies of a consent form for the TBI and SPED groups, a stipend disbursement form and a self-addressed, stamped envelope for return of the survey to Colorado State University. In order to increase the response rate, all participants were offered a $10 stipend for return of their completed survey. Further, reminder packets were mailed, containing duplicate copies of the above materials, two weeks after the initial mailing date. Phone calls were made to participants who received surveys in the TBI group by occupational therapists within their district to encourage their participation in the study. In addition, Spanish versions of all survey materials were available upon request for participants in the 5th school district per requirement of the district's IRB team.

Despite these efforts to increase response rates, the overall sample represents only 28.79% of all distributed surveys. The TBI group had the largest return rate at 43.86% of surveys returned, while the TYP group (28.13%) and SPED group (22.67%) came in much lower.

In order to maintain confidentiality, consent forms were filed separately from each participant's survey. Further, surveys were identified with a code specific to each participant so that individual names were not placed on the survey.

Data Analysis

All data analyses were conducted using IBM SPSS Statistics version 19 on a Windows 7 operating system. Given the exploratory nature of the present study, statistical analyses were not subject to Bonferroni or other similar corrections for significance value corrections as noted by Perneger, 1998 and Rothman, 1990. Correlation coefficient strength was evaluated using a Behavioral scale such that a value of 0.10 is small, 0.30 is moderate, 0.50 is large and 0.70 is larger than typical (Cohen, 1988).

Specific data analysis procedures for each research question are outlined below.

Gender. Associations were examined between gender and the two main categories of behaviors in Table 2 as well as between gender and each individual behavior item to note if any significant associations were present for specific items. Further, associations were be examined between gender and a total behavior score achieved by addition of all individual behaviors scores for each participant. For the purposes of data entry, males were assigned a value of 1 with females assigned a value of 0, such that negative correlations indicate higher behavioral scores for females and positive correlations indicate higher behavioral scores for males.

A Spearman Rank Biserial Correlation was used to determine if an association existed between gender and individual behavior items. For comparisons between gender and the two categories of behaviors listed in Table 2 as well as between gender and the overall behavior score for each participant, a Pearson Point Biserial analysis was conducted. These statistical analyses were chosen as gender is a nominal data, while individual behavior ratings were an ordinal data. The total behavior score was treated as interval data for purposes of data analysis.

Number of injuries. Figure 1 displays a sample of questions from the injury/illness section of the BCS with the options available to parents for disclosing the severity of their child's injury. Parents could select injuries from any of the following categories: blow to head, whiplash, car crash, assault/violence, sustained high fever, brain tumor, anoxia, meningitis, encephalitis, seizures, overdose and two sections for other injuries. Many parents noted non-head injuries or illnesses in the available "other" space of this section of the BCS, such as broken bones or asthma. Multiple categories also were noted for numerous participants for the same injury incident, such as indicating both blow to head and car crash when the blow to head was a result of the car crash. Instances with injury overlap such as this were counted as only one unique injury. When questions arose, two or more researchers from the larger BCS study met and made a group decision regarding injury overlap.

Injury inclusion criteria. Inclusion criteria were established to determine which indicated items from the Illness and Injury section of the BCS would be classified as head injuries for this research. In order for a noted injury for a TYP or SPED participant to be classified as a head injury for the purposes of this research, the injury had to meet at least one of the following criteria: 1) resulted in a loss of consciousness for any duration of time; 2) resulted in a coma for any duration of time; 3) resulted in a concussion, even if it was noted to be minor in severity; or 4) resulted in confusion or altered mental state. Because many parents indicated that injuries occurred during school breaks, the "missed school" item was not used as an inclusion criteria component as it did not provide consistent information regarding various injuries. If parents indicated that the injury resulted in no problem without noting any of the aforementioned inclusion criteria, the injury was not counted. However, if parents indicated that the injury resulted in no problem while also indicating one or more of the inclusion criteria, the injury was counted.

The same inclusion criteria were applied to the TBI group unless there was a single injury noted. There were multiple participants in the TBI group who noted a single injury without indicating anything other than the injury type or that the injury resulted in no problem. Given that these participants had TBI as a primary diagnoses on their IEPs, it was assumed that their injuries did indeed result in problems and were counted towards their overall number of injuries. If multiple injuries were listed any injury that did not meet the inclusion criteria was not included.

In select cases, a decision was made by the two or more researchers whether to include or not include an injury based upon qualitative comments made by the parent regarding the injury in addition to the above criteria. For example, a participant in the TYP group noted an overdose injury that resulted in a confused or altered mental state and commented that the overdose was from alcohol. As such, it was deemed that the alcohol was the cause of the altered mental state and the injury did not qualify as a head injury.

Data analysis. Possible associations were examined between number of injuries and the two main categories of behaviors in Table 2, as well as between number of injuries and each individual behavior item to note if any significant results were present for specific items. Potential associations were explored between the number of head injuries and the total behavior score for each participant.

Spearman's Rank Biserial Correlation was used to investigate associations between number of injuries and individual behavior items, the total behavior scores for the behavior categories listed in Table 2, and for the overall behavior scores. This analysis was chosen as a more conservative measure due to the lack of ability to assume normal distributions, despite both the total behavior scores and number of injuries being considered interval level data.

Symptoms. A Spearman Rank Biserial correlation was conducted to determine if an association existed between the total symptom score (sum of all symptom items) and the total behavior score as previously defined. In addition, the total scores for the behavior items as categorized in Table 2 were compared with the total scores for the symptom item categories depicted in Table 3, also using a Spearman Rank Biserial correlation. This analysis was chosen as a more conservative measure due to the lack of ability to assume normal distributions, despite both the total symptom and behavior scores being considered interval level data.

Results

Gender

Correlation coefficients were computed between gender and the total behavior score, behavior score groups as indicated in Table 2 and each individual behavior item. The results of these analyses are presented in Table 4.

TBI group. No significant correlations were found between gender and the behavioral scores for the TBI group. Small correlations were found for the majority of the individual behavior items for the TBI group, with a small-to-moderate correlation found for the ‘learns new things easily’ (r_s=-0.261) item. Negative correlations for half of the individual behavior items as well as the Social-Behavioral category score indicated that females had more severe behaviors than males on these items.

SPED group. No significant correlations were found between gender and the behavioral scores for the SPED group. The majority of the individual behavior items, as well as the total behavior score and the behavior score categories, resulted in small correlations. Three individual behavior items (‘thinks before acting/speaking’: r_s=-0.254, ‘listens without interrupting’: r_s=-0.254 and ‘remembers lists’: r_s=-0.296) resulted in small-to-moderate correlations with one item (‘waiting for his/her turn’: r_s=-0.320) indicating a moderate effect size. In addition, the majority of the individual behavior items, the total behavior score and both behavior score categories were negatively correlated with gender for the SPED group.

TYP group. Significant correlations were found for the TYP group between gender and the following individual behavior items: ‘focusing and maintaining attention’ (p=.001), ‘getting started on activities’ (p<.001), ‘letting go of one activity to attend to another’ (p=.003), ‘monitoring own progress’ (p<.001) and ‘remembers lists’ (p=.050). The total behavior scores, behavior score categories and the majority of the individual behavior items were weakly correlated with gender for the TYP group. Small correlations were found only for the aforementioned individual items which were statistically significant.

Negative correlations were found for the following individual behavior items for the TYP group: ‘understanding others’ (r_s=-0.048), ‘coping with change’ (r_s=-0.001), ‘maintaining relationships’ (r_s=-0.022), ‘listens without interrupting’ (r_s=-0.005) and ‘learns new things easily’ (r_s=-0.042). These correlations were weak and not statistically significant.

Number of Injuries

Upon examination of the TBI sample, it was determined that the sample lacked variation in the number of head injuries each participant sustained. One parent listed 5 head injuries for his or her child, with the remaining parents reporting either one (n=41) or two (n=9) injuries for their children. Four participants in the SPED group indicated a single head injury while the aforementioned exclusion of TYP participants with head injuries resulted in zero injuries for the resulting TYP participant group, limiting our ability to meet assumptions to run correlations between samples for this research question. As a result of minimal variability in number of injuries within and between groups, this research question was not explored.

Symptoms

Correlation coefficients were computed between the total symptom and behavior scores, as well as between each of the behavior and symptom groups outlined in Tables 2 and 3, respectively. The results of these analyses are depicted in Table 5.

TBI group. Significant correlations were found between the total behavior and symptom scores (p=.006) as well as between the Cognitive-Communicative behaviors category and both the Neurocognitive (p=.002) and Behavioral/Psychological (p=.004) symptom category. Only the comparison between Social-Behavioral behaviors and Neurological symptoms resulted in a negative correlation

(r_s=-0.470), with all other analyses resulting in positive correlations. Moderate effect sizes were obtained for the analyses between the total behavior and symptom scores (r_s=0.379), as well as between Cognitive-Communicative behavior score category and the Neurocognitive (r_s=0.428) and Behavioral/Psychological (r_s=0.398) symptom score categories. A moderate-to-large effect size was obtained between the Social-Behavioral scores and the Neurological symptom scores (r_s=0.470).

SPED group. All correlations were positive for the SPED group with no significant correlations obtained between the behavior and symptom comparisons. Small effect sizes were found for correlations between the Cognitive-Communicative behavior category and the Neurological symptom category (r_s=0.151) as well as the Social-Behavioral category with both the Neurological (r_s=0.177) and Behavioral/Psychological (r_s=0.149) symptom categories. Small-to-moderate associations were found between the total behavior and symptom scores (r_s=0.228) and between the Social-Behavioral behavior category and Neurocognitive symptom category (r_s=0.290). The Cognitive-Communicative behavior category scores are moderately associated with Neurocognitive symptom category scores (r_s=0.322).

TYP group. Significant correlations were obtained for the TYP group for the following comparisons: total behavior and symptom scores (p<.001), Cognitive-Communicative behaviors and Neurocognitive symptoms (p=.001), Social-Behavioral behaviors and Neurocognitive symptoms (p=.032) and Social-Behavioral behaviors and Behavioral/Psychological symptoms (p<.001). Small effect sizes were obtained for all correlations, except for between Cognitive-Communicative behaviors and Neurological symptoms (r_s=0.042), and Social-Behavioral behaviors and Neurological symptoms (r_s=0.002) for which the correlations were weak.

Scatterplot graphs were created for items in which the TBI and TYP group both had significant correlations (total behavior and symptom scores, Cognitive-Communicative behaviors and Neurocognitive symptoms, and Cognitive-Communicative behaviors and Behavioral/Psychological symptoms). For all three graphs, the TBI group's behavior scores were higher overall than the TYP group's scores, with little overlap between the groups, as depicted in Figures 2-4.

Discussion

Gender

The hypothesis that male students with a TBI would be associated with more severely rated behaviors than female students with a TBI was not conclusively supported. While male students were rated as more severe on the total symptom score, the total score for Cognitive-Communicative behaviors and just over half of the individual behavior items, many of these correlations were of negligible or small strength and indicate rather that the two groups are more likely to be rated with behaviors at a similar severity. Of note is the behavior item “Learns new things easily,” for which female students were shown to be rated with behaviors considered more severe, with a small-to-moderate effect size, indicating that this item may represent the largest gender disparity for the TBI group. These results are especially surprising given the low proportion of TBI participants who are female (n=16 of 51). Behavior items demonstrating a trend towards an even more severe rating for females may produce stronger effects if the number of female participants were increased.

The SPED and TYP groups did not replicate the results of the TBI group. Rather, females were rated as having more severe behaviors for the large majority of items for the SPED group, with only three behavior items being more severely rated for males (focusing/maintaining attention, getting started on task and understanding others). In addition, all behavior score totals for the SPED group (total score, Cognitive-Communicative and Social-Behavioral) resulted in more severe total ratings for females. The TYP group, on the other hand, was shown to have behaviors rated more severely for males for all total score comparisons and all but 5 behavior items, for which the correlations were of negligible or small strength. These differences among the groups indicate that the effect seen within the TBI group may likely be specific to that population and therefore be a result of the presence of the TBI.

These results are inconsistent with current literature and, while exploratory in nature, should be taken into consideration by OTs as they work with children who have sustained a TBI as well as during evaluation of children without a known history of TBI. If OTs and other school professionals expect boys with a TBI to demonstrate more problematic behaviors than girls, they may be less likely to attribute problematic behaviors seen in girls to a possible TBI and, as a result, further perpetuate the under-identification of TBI in school aged children. In addition, OTs and school professionals will need to struggle to release themselves from any preconceived notions regarding behaviors in either males or females with a TBI and be open to considering that problematic behaviors exhibited by either gender may be a result of their injury and warrant attention during intervention.

Symptoms

Overall, more severe ratings of symptoms were associated with more severe ratings of behaviors for the TBI group. Of note is the negative correlation between the Social-Behavioral category of behaviors and the Neurological category of symptoms. These results indicate that as ratings for the Neurological symptom increase, ratings for the Social-Behavioral behaviors decrease. This effect was not only significant, but was also of moderate-to-large strength. These findings may support recent findings by Jones and colleagues (2011), that more severe brain injuries in adults resulted in increased interactions with social networks that existed prior to their injury. The researchers postulated greater injury severity caused adults with brain injuries to draw more heavily on their social resources for support, resulting in positive social outcomes after their injury. The symptoms contained in the Neurological category are much more "medical" in nature than other symptoms on the BCS, and may be viewed as associated with injury severity both by the children with a TBI and their parents who filled out the survey. As such, an increase in problems in these areas may yield greater reliance on social relationships for coping strategies, resulting in children exhibiting less severe problems with social behaviors.

Similar relationships were also found for the SPED and TYP groups, with some associations reaching significance for the TYP group. However, for most analyses the TBI group demonstrated stronger strength correlations and had more severely rated behaviors compared to either other group. Thus, while associations between symptoms and behaviors may be present within all three participant groups, overall they are more profound for the TBI group.

As previously stated, IEP goals for children with TBI need to address underlying components of behaviors rather than academic success only (Savage et. al., 2001). Cognitive-Communicative behaviors demonstrated a moderate association with both Neurocognitive and Psychological/Behavioral symptom items. When working with children demonstrating problematic behaviors in the Cognitive-Communicative category, OTs may need to evaluate symptoms in these categories to determine if interventions can be addressed at the symptom level in hopes of producing a change in behaviors. For example, Neurocognitive symptoms such as noise and light sensitivity or blank staring/daydreaming may be addressed by environmental modifications within the classroom. Children with a TBI can become easily distressed in noisy environments or have difficulty ignoring irrelevant visual information (Galvin, Froude & Imms, 2009). Reducing light or glare, creating a quiet area in which the child can complete assignments and reducing the amount of visual distraction in the classroom may alleviate difficulties with these symptoms and allow for the child to improve on Cognitive-Communicative behaviors such as focusing/maintaining attention and getting started on activities.

OTs also may want to note that symptoms which are commonly treated by medication in the Neurological category, such as seizures and headaches, are not strongly associated with the Cognitive-Communicative behaviors and, as previously mentioned, are negatively associated with the Social-Behavioral behaviors. Thus, while medication may alleviate these symptoms it is not likely to result in improvement in problematic behaviors when used alone. Rather, intervention targeting Neurocognitive or Psychological/Behavioral symptoms, which were found to have moderate associations to Cognitive-Communicative behaviors, may produce improvement in these behaviors. Similar findings have been postulated for children with ADHD (Purdie, Hattie & Carroll, 2002). In a meta-analysis of school based interventions for children with ADHD targeting executive outcomes, these researchers found that medication alone was not enough to produce long-term academic gains; rather a combination of medical treatment with intervention was most effective.

Limitations

A potential limitation to the present study is the design of the Brain Check Survey's behavior and symptom components. Nolin, Villemure, and Heroux (2006) found that when given a list of symptoms from which to choose, adults with a mild TBI were more likely to report a greater number of symptoms within a given category as well as more symptoms overall as being problematic than when asked to report symptoms without a list of possibilities. It is possible that in providing parents with a list of common behaviors and symptoms seen in children with TBI, they were more likely to report behaviors or symptoms as being problematic than if they were asked to list the items without suggestions. This may have resulted in an over-reporting of problematic symptoms or behaviors that they would not otherwise consider to be severe. This may be especially true for the TYP group as numerous parents reported problematic behaviors and symptoms that would not be expected in typically developing children.

In addition, return rates may have been impacted by language barriers as the Spanish version of the BCS was only available for the 5th and final school district. Had this version been available for the other school districts, more data may have been received from primarily Spanish-speaking house-holds.

Lastly, the small number of participants in the SPED and TBI groups limit the statistical power of the results. Further, both samples had a low representation of female students, which likely skewed the correlations for comparison between genders. Nevertheless, even with a very small representation of females within both groups, the results of the present study present new findings that warrant further investigation.

Conclusions and Recommendations for Future Research

The present study presents new findings with regard to gender and behaviors in children with TBI as boys were not found to exhibit more severe behaviors than girls across the board.

Further research is needed, however, to explore this idea and investigate gender differences even further. Future research would benefit from a larger sample size of children with TBI and a more equal representation of males and females within the sample, possibly by over-sampling females from a larger available sample of children with a known TBI.

Overall, moderate associations between symptoms and behaviors were found for the TBI group with some symptoms demonstrated as being less associated with behaviors, such as the Neurological symptoms. Further research into these associations is needed, particularly regarding intervention strategies for the symptoms to determine if such intervention will truly produce gains in associated behaviors. The negative association between Neurological symptoms and Social-Behavioral behaviors warrants further investigation to determine why such a relationship exists. Future studies would benefit from a larger sample size of children with TBI and perhaps increasing the number of behaviors rated in the Social-Behavioral category.

Table 1: *Participant Demographics*

Demographic	TBI	SPED	TYP
N	51	34	394
Gender			
Males	35	22	201
Females	16	12	193
Age			
Range	5-20	5-17	5-18
Mean	12.703	11.947	12.652
Standard Deviation	3.944	3.165	3.360
Race			
American Indian/Alaskan Native	n=0, 0%	n=1, 2.9%	n=6, 1.5%
Asian	n=0, 0%	n=1, 2.9%	n=11, 2.8%
Native Hawaiian/Pacific Islander	n=0, 0%	n=1, 2.9%	n=0, 0%
Black or African American	n=3, 5.9%	n=2, 2.9%	n=21, 5.3%
White	n=33, 64.7%	n=20, 58.5%	n=285, 72.3%
Other	n=9, 17.6%	n=8, 23.5%	n=55, 14%
Ethnicity			
Hispanic or Latino	n=12, 23.5%	n=7, 20.6%	n=74, 18.8%
Non-Hispanic of Latino	n=36, 70.6%	n=25, 73.5%	n=281, 71.3%
Other/No Response	n=3, 5.9%	n=2, 5.9%	n=39, 9.9%

Age in table represents the child's age at the time of survey completion and is indicated in years.

Table 2: *Categorization of Problematic Behaviors as Measured by the Brain Check Survey*

Category	Behavioral Item
Cognitive-Communicative Needs	Focusing and maintaining attention
	Getting started on activities, tasks, chores, homework and the like, on his or her own
	Coping with change or transitions
	Letting go of one activity to attend to another
	Reaction to simple problems
	Monitoring own progress on homework, assignments, chores and the like
	Solving everyday problems (example: thinking of different options when something is not working for him/her)
	Learns from past mistakes or behavior
	Thinks before speaking or acting
	Handles a change in plans
	Demonstrates good judgement
	Learns new things easily
	Remembers lists
	Remembers day-to-day events
	Being understood (speech is easy to understand, speaks clearly)
	Understanding Others
Social and Behavioral Needs	Maintaining family and friend relationships
	Listens without interrupting others often
	Waiting for his or her turn in a game

Adapted from Savage et. al. (2001).

Table 3: *Categorization of Symptom Items as Measured by the Brain Check Survey*

Category	Symptom Item
Neurological	Dizziness
	Headaches/Migraines
	Seizures
	Loss of muscle coordination
	Blackouts/Fainting
Neurocognitive	Change in vision
	Noise sensitivity
	Light sensitivity
	Slurred Speech
	Confusion
	Trouble finding the “right” word
	Blank staring/Day dreaming
Psychological/Behavioral	Sleepiness
	Mood Swings
	Fatigue

Adapted from Hooper et. al. (2004).

Table 4: *Correlations between Gender and Behavioral Measures*

Behavior Measure	TBI	SPED	TYP
Total Behavior Score	$r(49)=0.016$	$r(32)=-0.176$[1]	$r(392)=0.063$
Cognitive-Communicative Score	$r(49)=0.021$	$r(32)=-0.161$[1]	$r(392)=0.071$
Social-Behavioral Score	$r(49)=-0.006$	$r(32)=-0.220$[1]	$r(392)=0.008$
Focusing/Maintaining Attention	$r_s(48)=0.114$[1]	$r_s(32)=0.167$[1]	$r_s(388)=0.168$*[1]
Getting Started on Task	$r_s(48)=0.203$[1]	$r_s(32)=0.071$	$r_s(390)=0.177$*[1]
Being Understood	$r_s(48)=-0.002$	$r_s(32)=-0.063$	$r_s(390)=0.041$
Understanding Others	$r_s(48)=0.131$[1]	$r_s(32)=0.167$[1]	$r_s(391)=-0.048$
Coping With Change	$r_s(48)=0.046$	$r_s(32)=-0.061$	$r_s(388)=-0.001$
Maintaining Relationships	$r_s(47)=-0.100$[1]	$r_s(31)=-0.114$[1]	$r_s(391)=-0.022$
Letting Go of Activity	$r_s(48)=0.187$[1]	$r_s(32)=-0.217$[1]	$r_s(388)=0.150$*[1]
Reaction to Simple Problems	$r_s(47)=0.162$[1]	$r_s(32)=-0.162$[1]	$r_s(391)=0.012$
Monitoring Own Progress	$r_s(49)=-0.001$	$r_s(31)=-0.135$[1]	$r_s(390)=0.191$*[1]
Solving Everyday Problems	$r_s(47)=0.075$	$r_s(32)=-0.084$	$r_s(389)=0.073$
Waiting for Turn	$r_s(49)=-0.012$	$r_s(32)=-0.320$[3]	$r_s(390)=0.057$
Learns From Past Mistakes	$r_s(49)=0.120$[1]	$r_s(32)=-0.168$[1]	$r_s(390)=0.038$
Thinks Before Acting/Speaking	$r_s(49)=0.182$[1]	$r_s(32)=-0.254$[2]	$r_s(390)=0.027$
Listens Without Interrupting	$r_s(49)=0.125$[1]	$r_s(32)=-0.254$[2]	$r_s(390)=-0.005$
Handles Change in Plans	$r_s(47)=0.197$[1]	$r_s(32)=-0.107$[1]	$r_s(389)=0.011$
Demonstrates Good Judgment	$r_s(48)=-0.015$	$r_s(32)=-0.134$[1]	$r_s(390)=0.034$
Learns New Things Easily	$r_s(49)=-0.261$[2]	$r_s(32)=-0.164$[1]	$r_s(390)=-0.042$
Remembers Lists	$r_s(49)=-0.165$[1]	$r_s(31)=-0.296$[2]	$r_s(390)=0.099$*[1]
Remembers Day-to-Day Events	$r_s(49)=-0.186$[1]	$r_s(32)=-0.143$[1]	$r_s(390)=0.047$

* $p<0.05$. [1] indicates small correlation strength. [2] indicates small-to-moderate correlation strength. [3] indicates moderate correlation strength.

Table 5: *Correlations between Symptom and Behavioral Measures*

Comparison	TBI	SPED	TYP
Total Behavior Score to Total Symptom Score	$r_s(49)=0.379$*[3]	$r_s(32)=0.228$[2]	$r_s(392)=0.182$*[1]
Cognitive-Communicative Score to Neurological Score	$r_s(49)=0.153$[1]	$r_s(32)=0.151$[1]	$r_s(392)=0.042$
Social-Behavioral Score to Neurological Score	$r_s(49)=-0.470$[4]	$r_s(32)=0.177$[1]	$r_s(392)=0.002$
Cognitive-Communicative Score to Neurocognitive Score	$r_s(49)=0.428$*[3]	$r_s(32)=0.322$[3]	$r_s(392)=0.170$*[1]
Social-Behavioral Score to Neurocognitive Score	$r_s(49)=0.169$[1]	$r_s(32)=0.290$[2]	$r_s(392)=0.108$*[1]
Cognitive-Communicative Score to Behavioral/ Psychological Score	$r_s(49)=0.398$*[3]	$r_s(32)=0.067$	$r_s(392)=0.227$*[1]
Social-Behavioral Score to Behavioral/ Psychological Score	$r_s(49)=0.105$[1]	$r_s(32)=0.149$[1]	$r_s(392)=0.188$*[1]

* $p<0.05$. [1] indicates small correlation strength. [2] indicates small-to-moderate correlation strength. [3] indicates moderate correlation strength. [4] indicates moderate-to-large correlation strength.

Injuries or Illnessess		
Injury or Illness	**Age**	**Outcomes**
Please check all that apply		
☐ **Blow to Head** (from sports, playing, biking, falling, getting hit by an object, etc.)	At what age?____	Check all that apply: ☐ Concussion ☐ Loss of consciousness, *for how long?______ ☐ Coma, *for how long? ________ ☐ Confusion or altered mental state ☐ Missed school ☐ Resulted in no problem
☐ **Whiplash**	At what age?____	Check all that apply: ☐ Concussion ☐ Loss of consciousness, *for how long?______ ☐ Coma, *for how long? ________ ☐ Confusion or altered mental state ☐ Missed school ☐ Resulted in no problem
☐ **Car accident** (resulting in any degree of injury or lack of injury)	At what age?____	Check all that apply: ☐ Concussion ☐ Loss of consciousness, *for how long?______ ☐ Coma, *for how long? ________ ☐ Confusion or altered mental state ☐ Missed school ☐ Resulted in no problem

Figure 1: Sample of the Injury/Illness section of the Brain Check Survey.

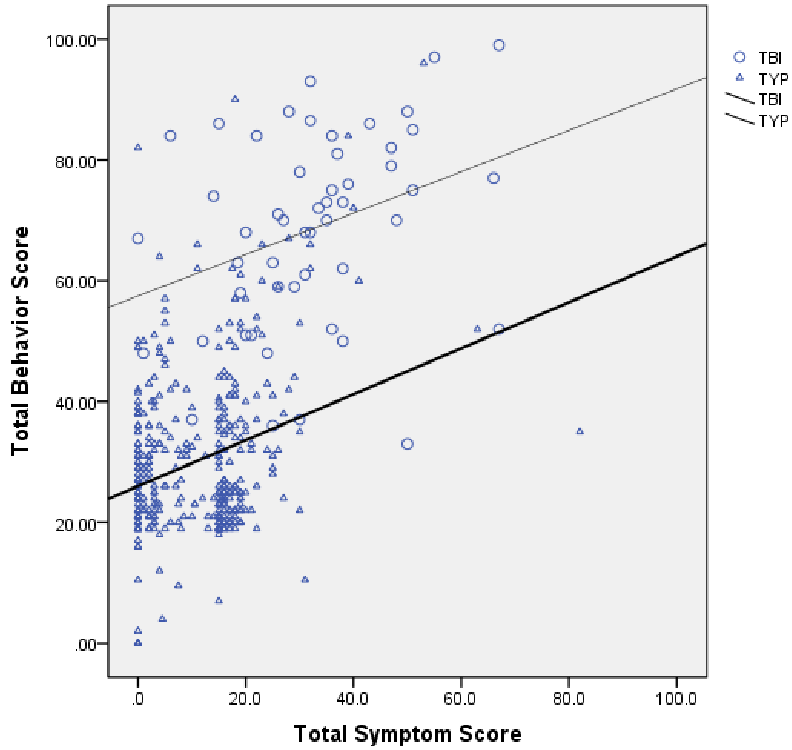

Figure 2: Scatterplot comparison of Total Behavior and Total Symptom scores for the TBI and TYP groups.

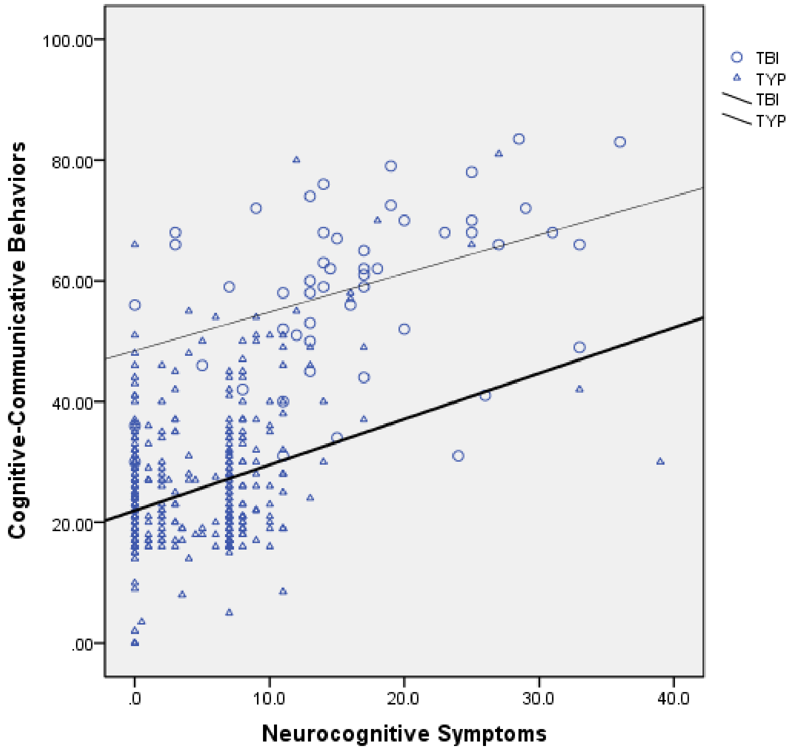

Figure 3: Scatterplot comparison of Cognitive-Communicative Behaviors and Neurocognitive Symptom scores for the TBI and TYP groups.

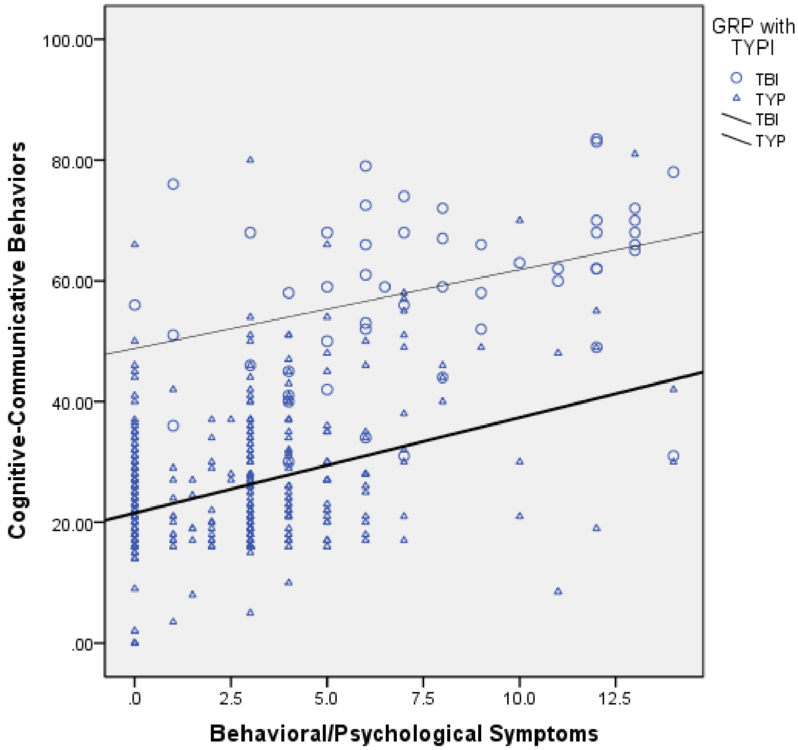

Figure 4: Scatterplot comparison of Cognitive-Communicative Behaviors and Behavioral/Psychological symptom scores for the TBI and TYP groups.

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