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Parent-Child Interaction Therapy as a Family-Focused Approach for Young Children with Traumatic Brain Injury

Dainelys Garcia
Florida International University, dlina002@fiu.edu

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FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

PARENT-CHILD INTERACTION THERAPY AS A FAMILY-FOCUSED APPROACH FOR YOUNG CHILDREN WITH TRAUMATIC BRAIN INJURY

A dissertation submitted in partial fulfillment of

the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

PSYCHOLOGY

by

Dainelys Garcia

2016

To: Dean Michael R. Heithaus
College of Arts, Sciences and Education

This dissertation, written by Dainelys Garcia, and entitled Parent-Child Interaction Therapy as a Family-Focused Approach for Young Children with Traumatic Brain Injury, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

Paulo A. Graziano

Raul Gonzalez, Jr.

JoAnne M. Youngblut

Daniel M. Bagner, Major Professor

Date of Defense: June 6, 2016

The dissertation of Dainelys Garcia is approved.

Dean Michael R. Heithaus
College of Arts, Sciences and Education

Andrés G. Gil
Vice President for Research and Economic Development
and Dean of the University Graduate School

Florida International University, 2016

DEDICATION

To my wonderful family and friends for all their love and truly unconditional support.

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ABSTRACT OF THE DISSERTATION

PARENT-CHILD INTERACTION THERAPY AS A FAMILY-FOCUSED APPROACH FOR YOUNG CHILDREN WITH TRAUMATIC BRAIN INJURY

by

Dainelys Garcia

Florida International University, 2016

Miami, Florida

Professor Daniel M. Bagner, Major Professor

Traumatic Brain Injury (TBI) is the leading cause of death and disability in children and adolescents in the U.S. and disproportionately affects young children. The negative consequences of early childhood TBI include deficits in behavior and attention, cognitive abilities, and academic skills. Behavior problems in particular are one of the most common and persistent consequences following TBI in young children. Therefore, interventions are needed that target the adverse effects of TBI on behavior. The purpose of the current work was to examine the initial outcome, feasibility, acceptability, and satisfaction of a time-limited and intensive format of Parent-Child Interaction Therapy (PCIT) for families with a child aged 2 to 5 years who had sustained a TBI and displayed clinically elevated externalizing behavior problems. The open trial included 10 families that completed a baseline assessment, received the intervention over 5 weeks, and completed post-intervention and 2-month follow-up assessments. Results indicated that children who completed the intervention showed significant improvements in both externalizing and internalizing behavior problems at post-intervention and 2-month follow-up, with the exception of non-significant change in self-regulation at post-intervention and 2-month follow-up, and attention problems at 2-month follow-up. In addition, significant improvements were found on all cognitive measures examining working memory, receptive language, and executive functioning at post-intervention and 2-month follow-up. Similarly, caregivers who completed the intervention displayed significant improvements in their parenting skills during play with their child and reported significant reductions in overall caregiver stress and caregiver stress related to their child's difficult behaviors. Despite limitations inherent in an open trial (e.g., small sample, lack of a control group, generalizability), the current study addressed a relatively unexplored research question and suggests that an intensive format of PCIT may be a promising approach for improving domains commonly affected by early childhood TBI (e.g., behavioral, cognitive, and family functioning) prior to the development of more severe and persistent problems.

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I. INTRODUCTION

Traumatic Brain Injury in Children: A Significant Public Health Problem

Traumatic Brain Injury (TBI) is the leading cause of death and disability in children, affecting over 511,000 children between the ages of 0 and 14 years annually (Faul, Wald, Xu, & Coronado, 2010). Specifically, TBI in children results in over 2,000 deaths, 35,000 hospitalizations, and 473,000 emergency department visits per year in the United States, accounting for 92.7% of TBI-related emergency department visits. Falls are the leading cause of TBI, with the highest rates occurring in very young children under 5 years (Faul et al., 2010). Among preschoolers, unintentional falls are the predominant mechanism of injury (Faul et al., 2010) and account for 40% of head injuries and 5.9% of childhood deaths (Wang et al., 2001).

Childhood TBI was once referred to as a “silent epidemic” because of the lack of public awareness about prevalence rates and the negative impact of childhood TBI (Goldstein, 1990). In recent years, however, the long-term impact of TBI in childhood has received increased research attention. Specifically, research studies have focused on increasing the understanding of developmental trajectories for school-aged children with TBI and developing appropriate interventions to ameliorate post-injury problems, such as cognitive and behavioral deficits (Fay et al., 2009; Taylor et al., 2001, 2008). Despite the increased research attention currently directed toward childhood TBI, the negative consequences of TBI have been studied less frequently in children younger than 5 years compared to children older than 5 years (Coleman, 2011). Consequently, outcomes, developmental trajectories, and recovery patterns are not yet well established for very young children (Anderson et al., 2001), which is problematic given the increased vulnerability of young children experiencing a TBI (Anderson et al., 2009).

Purpose

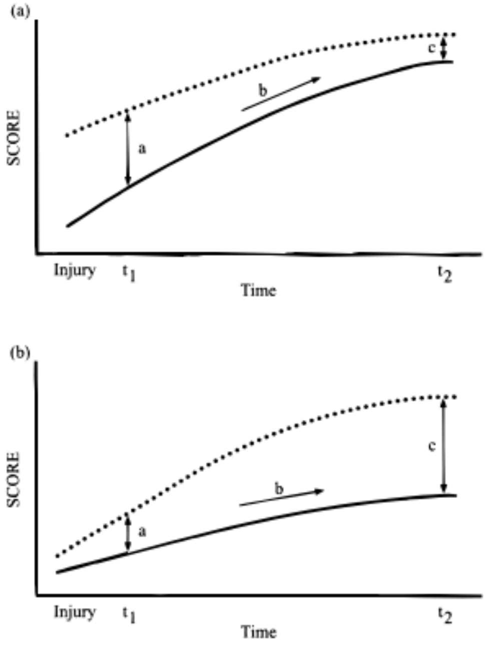
To date, the school-age literature has highlighted some of the negative consequences of TBI, which include deficits in behavior (Karver et al., 2012), attention (Schwartz et al., 2002), motor abilities (Anderson, Morse, Catroppa, Haritou, & Rosenfeld, 2004), language (Ewing-Cobbs et al., 2006), cognition (Taylor et al., 2008), and academic skills (Schwartz et al., 2002). However, research suggests that children injured in early childhood have more significant long-term consequences than children injured later in childhood (Donders, Jacobus, Warschausky, 2007). Specifically, adverse effects on behavioral functioning are especially common and represent one of the most troubling and persistent consequences following TBI in young children (Karver et al., 2012). As such, the purpose of the current study was to examine the initial outcome, feasibility, acceptability, and satisfaction of a time-limited and intensive format of Parent-Child Interaction Therapy (PCIT) targeting behavioral, cognitive, and family factors for families with a young child who previously sustained a TBI and displayed clinically elevated externalizing behavior problems.

Early Childhood TBI Associated with Increased Vulnerability

The course of recovery following TBI can vary greatly depending on certain injury characteristics, such as child age at injury (Wade, Oberjohn, Burkhardt, & Greenberg, 2009). Despite the commonly held view that young children’s brains are better able to adapt to the impact of head injuries, children younger than 5 years are especially susceptible to negative outcomes following injury given increased risk for generalized insults (i.e., diffuse brain injuries), particularly for infants and toddlers because of their relatively larger head and smaller neck size (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2005). In addition, when a TBI occurs in early childhood, underlying neurodevelopmental processes involving domains such as attention, memory, and visuospatial skills may be affected and lead to long-lasting neurocognitive deficits (Stiles, 2000). An early study by Taylor and Alden (1997) conceptualized the effects of TBI on underlying neurodevelopmental processes. Specifically, they postulated that skills that are not yet well developed at the time of an injury are more susceptible than established skills to negative effects and decreased neural recovery. Figure 1a depicts the hypothetical effects of a head injury on established skills, which are most apparent immediately post-injury (level a). Improvements in performance are thought to occur over time (level b) to level c, although they continue to lag behind, especially when new or complex learning is required. As such, the impact of TBI on developing skills, illustrated in Figure 1b, may not be readily apparent post-injury, but nevertheless, would become apparent when the child does not acquire skills at age-appropriate rates. Improvements in performance over time (level b) may occur less rapidly in children with TBI and result in greater deficits over time (level c) compared to uninjured children.

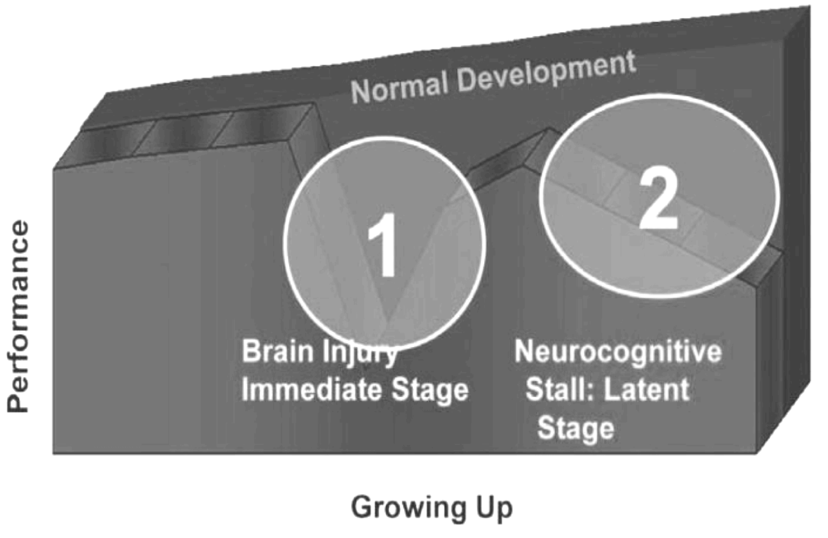
Recent research using advanced imaging techniques has continued to enhance our understanding of brain development and shown that brain development is a complex process that involves both linear and non-linear structural and functional changes (Taki & Kawashima, 2012). In particular, early childhood is a period of rapid brain growth. By 5 years of age, the brain has achieved 90% of its adult weight (Lenroot & Giedd, 2006), suggesting the degree of impairment related to TBI is likely to be highest at this young age when parts of the brain (e.g., motor, spatial, speech/language, and attention systems) are undergoing peak development. To date, research has found support for Taylor and Alden's (1997) conceptualization of injury recovery; showing immediate post-injury effects on performance and delayed effects on skill development (Chapman, 2006). However, research also has shown that deficits following TBI may be stable or worsen over time, while others may show a transient lag or partial catch-up (shown in Figure 2), making the extent to which young children recover from TBI unclear (Ewing-Cobbs et al., 2006). Overall, research suggests children who sustain head injuries at earlier ages are at a higher risk of adverse changes in functioning over time, including impairments in behavior, attention, language abilities, and overall cognitive functioning, relative to older children (Anderson et al., 2009; Karver et al., 2012).

Figure 1. Hypothetical Developmental Change in Skills Post-Injury



Note. Figure 1a depicts developmental changes in established skills and Figure 1b depicts developmental changes in developing skills in children with TBI (solid line) and in uninjured children (broken line).

Figure 2. Immediate and Delayed Effects of Early TBI on Brain Development



Injury Severity and Considerations for Assessing TBI in Young Children

In addition to the association between younger age at injury and injury recovery (Anderson et al., 2005), injury severity has been found to moderate this relationship, such that children who sustain *more severe* injuries at an *earlier age* are not only at a higher risk of mortality, but display the most negative long-term deficits (Anderson et al., 2006). Researchers and clinicians differ in their use of diagnostic strategies to diagnose TBI (Quayle et al., 1997). To date, numerous clinical measures have been developed to categorize TBI severity. Measures typically assess loss of consciousness and post-traumatic amnesia. Loss of consciousness refers to the length of time between injury and when the child regains consciousness, as reported by the child or witness (Langlois, 2000). Post-traumatic amnesia is typically divided into two types: retrograde and anterograde. Retrograde amnesia refers to partial or total loss of the ability to recall events prior to the injury, while anterograde amnesia refers to difficulty forming new memories after the injury. Traumatic Brain Injury also may present with a multitude of physical symptoms, such as headache, balance difficulties, blurred vision, personality changes, inability to perform daily activities, sleep disturbances, and motor or sensory symptoms (Palchak et al., 2004). Although post-traumatic amnesia has been found to be a strong predictor of functional outcomes in school-age children (i.e., 5 to 18 year) who sustained a TBI (Briggs, Brookes, Tate, & Lah, 2015), there is research suggesting that loss of consciousness and/or amnesia in the absence of other signs or symptoms are not predictive of TBI findings on a computerized tomography (CT) scan or TBI requiring acute intervention (Palchak et al., 2004). In contrast, recent literature has shown that post-traumatic amnesia, when measured with a start time of when commands can be followed, is associated with short- and long-term post-injury outcomes. However, these effects have found to be driven by time to follow commands and child level of functioning, making post-traumatic amnesia less predictive for children, especially during acute recovery (Austin, Slomine, DeMatt, Salorio, & Suskauer, 2013).

To date, one of the earliest and most commonly used measures of TBI severity is the Glasgow Coma Scale (GCS), which assesses the level of consciousness after the injury through motor, verbal, and eye-opening responses (Teasdale & Jennett, 1974). A severe TBI is defined as a GCS score of 8 or less; a moderate TBI is defined as a GCS score of 9 to 12 or a higher GCS score accompanied with evidence of trauma-related abnormalities on imaging studies; and a mild TBI is defined as a GCS score of 13 to 15 (Teasdale & Jennett, 1974). Although the GCS objectively measures depth of coma, estimates of severity, especially for mild cases, are likely influenced by how quickly a child receives medical attention. For instance, a child may receive a more severe score if medical attention is received rapidly, as opposed to a child who receives medical attention the following day, and is more likely to be conscious and alert at the time of the evaluation (McKinlay, 2010). Finally, while the GCS can be a useful indicator of severity, it is not a reliable indicator for younger children (especially those younger than age 5) given limited language skills to produce a verbal response and difficulty obtaining GCS scores immediately following the injury as a result of other treatments and procedures (Westbrook, 1997; J. Youngblut, Caicedo, & Brooten, 2013). Additionally, the GCS has been shown to be a poor predictor of long-term functional outcomes in pediatric TBI (Austin et al., 2013).

In order to address limitations of the GCS, modified versions have been developed for pediatric populations (Mooray, 1985; Raimondi & Hirschauer, 1984; Reilly, Simpson, Sprod, & Thomas, 1988; Simpson, Cockington, Hanieh, Raftos, & Reilly, 1991; Tatman, Warren, Williams, Powell, & Whitehouse, 1997; Yager, Johnston, & Seshia, 1990). These scales are meant to be sensitive to the child's developmental level and include observations of behavior or affect (e.g., crying appropriately) for preverbal children (Langlois, 2000). However, modified versions of the GCS have been found to be less sensitive to changes in consciousness level and therefore may not adequately capture acute changes post-injury (Reilly et al., 1988). For instance, scores were found to indicate improvements in 60% of pediatric patients with intracranial hemorrhages whose level of consciousness was considered to be deteriorating (Wang, Griffith, & Sterling, 2000).

Behavioral Outcomes Following Early Childhood TBI

In addition to challenges associated with assessing TBI in early childhood, younger children with more severe injuries are at increased risk for negative long-term behavioral outcomes. Specifically, externalizing behavior problems have been reported to develop within 1 year following the injury for a large percentage of children with TBI (Catroppa, Anderson, Morse, Haritou, & Rosenfeld, 2008) and persist well beyond the post-acute recovery phase (i.e., 3 to 6 months post-injury) for up to 50% of children with severe TBI (Fay et al., 2009; Yeates, Taylor, Walz, Stancin, & Wade, 2010). Furthermore, studies have found that children who display pre-injury behavior problems are at greater risk for increased severity in post-injury behavior problems, while those without a history of behavioral difficulties are also at risk for developing new disruptive behaviors. In addition, TBI in early childhood has been associated with increased rates of

ADHD (Max et al., 2004), oppositional defiant disorder (Bloom et al., 2001), and internalizing symptoms (e.g., withdrawn, anxiety, depression; Anderson et al., 2006).

Research suggests adverse effects of TBI on child disruptive behavior disorders may be related to post-injury neurocognitive deficits (e.g., attention and executive functioning) that are more prominent among children injured at younger ages (Karver et al., 2012) and are believed to be associated with difficulty regulating behavior and affect (Ganesalingam, Sanson, Anderson, & Yeates, 2006). Specifically, one study found that children injured before age 3 years performed lower than an uninjured control group on an executive functioning measure of attentional control (Crowe, Catroppa, Babl, & Anderson, 2013).

Moderating Factors Related to Post-Injury Behavior Problems

As noted briefly above, injury severity is a moderating factor of post-injury behavior problems, such that children who are injured at an earlier age *and* sustain a more severe injury are at a higher risk for negative long-term behavioral deficits (e.g., externalizing behavior problems; Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2005). Catroppa and colleagues (2008) compared preschool-aged children who sustained mild, moderate, and severe TBIs to a healthy control group and examined functional outcomes at 6 months, 30 months, and 5 years post-injury. The authors found that adaptive abilities were influenced by injury severity, where children with moderate and severe injuries were more likely to perform at lower levels compared to children with mild injuries, with the greatest decrease in performance at the 5-year follow-up. Findings also indicated more residual behavior problems at the 30-month and 5-year follow-up assessments, with clinically elevated scores for children with more severe injuries.

Similarly, Karver and colleagues (2012) examined the moderating effects of injury severity, age at injury, and time since injury on behavioral, social, and executive functioning in children ages 3 to 7 years with severe TBI, complicated mild to moderate TBI (i.e., either a GCS score of 9–12 or a GCS score of 13–15 accompanied by evidence of abnormality on imaging), and orthopedic injury that required hospitalization. Consistent with Catroppa and colleagues (2008), injury severity, age at injury, and time since injury moderated symptoms of both ADHD and anxiety reported by the child's primary caregiver on the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2000; Achenbach & Rescorla, 2001) up to two years post-injury. Specifically, children who sustained more severe injuries at an earlier age had significantly increased levels of caregiver-reported symptoms that worsened with increasing time since the injury. Interestingly, age at injury did not moderate some behavioral outcome variables, such as social competence, executive dysfunction, and overall internalizing and overall externalizing behavior problems. Thus, it is possible that neurocognitive deficits in attentional and executive functioning domains are more common than other deficits among children injured at younger ages (Anderson et al., 2009; Karver et al., 2012).

Despite evidence for negative behavioral outcomes following early childhood TBI (Karver et al., 2012), some studies have found no adverse post-injury behavioral outcomes among young children with TBI (Wetherington, Hooper, Keenan, Nocera, & Runyan, 2010). Further, some studies have shown that children injured at younger ages have poorer outcomes regardless of injury severity (Verger et al., 2000), whereas others have shown a severity-dependent relationship among children injured at younger ages, such that children who sustain more severe injuries at earlier ages are at a higher risk of poorer outcomes than children who sustain less severe injuries at earlier ages. These inconsistent findings highlight the need for further research to clarify the relationship between age at injury and long-term outcomes across injury severity, particularly mild TBI. To date, intervention studies have typically excluded children with mild TBI despite being the most prevalent form of head trauma in children, accounting for approximately 90% of all TBIs, and some evidence to support clinically elevated levels of post-injury externalizing behavior problems in this population (Evans, 2006; McKinlay, Grace, Horwood, Fergusson, & MacFarlane, 2010; McKinlay, 2010).

Cognitive Outcomes Following Early Childhood TBI

Early childhood TBI also has been associated with increased post-injury cognitive impairments (Catroppa et al., 2008), that have been noted to persist up to 10 years post-injury for adaptive ability and processing speed domains, and subtle trends for other cognitive domains (i.e., verbal, non-verbal, executive). Similar to the negative post-injury behavioral outcomes described above, studies have shown that the degree of cognitive impairment is likely to be highest for younger children (Anderson, Godfrey, Rosenfeld, & Catroppa, 2012), who are more likely to sustain more complicated brain injuries (e.g., diffuse brain injuries, shearing injuries, injuries to multiple brain regions) during a time when the brain is undergoing peak development (Stiles, 2000). Therefore, damage to the developing brain is likely to disrupt the development of skills and abilities at age-appropriate rates (Anderson, Morse, Catroppa, Haritou, & Rosenfeld, 2004; Crowe, Catroppa, Babl, & Anderson, 2012), which can lead to future attentional, language, executive functioning, learning, and academic problems (Anderson et al., 2009; Anderson et al., 2009; Chapman et al., 2010). Specifically, studies have found that up to 48% of children injured in early childhood fail a grade or are placed in special education classrooms, and 39% require therapeutic support in elementary school (e.g., speech and language therapy; Ewing-Cobbs et al., 2006).

Younger age at injury also has been associated with poorer post-injury recovery of intellectual functioning. In a recent study by Coleman (2011), earlier age-at-injury was associated with decreased cognitive functioning across injury severity levels. Specifically, Ewing-Cobbs and colleagues (2006) found that among children assessed on average 5.7 years following a TBI sustained in childhood, those injured prior to the age of 6 years demonstrated significantly lower IQ and achievement scores than healthy children from similar sociodemographic backgrounds, with limited recovery of cognitive abilities over time. Furthermore, studies have found that preschool children who were injured before age 3 years performed significantly lower on measures of intelligence compared to an uninjured control group (Crowe et al., 2012). These findings suggest that injuries occurring in early childhood may have a more negative effect on subsequent development than injuries occurring at later in childhood (Karver et al., 2012; Moses & Stiles, 2002), and certain cognitive skills may be more vulnerable to disruption during this early stage of development, such as attention and executive functioning (Ewing-Cobbs, Prasad, Landry, Kramer, & DeLeon, 2004).

Negative cognitive and academic outcomes also can vary as a function of injury severity. Findings are consistent with a dose-response relationship, such that more severe injuries result in greater impairments in cognitive abilities (Anderson et al., 2004, 2012). Specifically, studies have shown that children with moderate to severe TBI typically perform more poorly on achievement and neuropsychological tests than children with mild TBI (Ewing-Cobbs et al., 2006). A longitudinal study by Ewing-Cobbs et al. (2006) examining 23 children ages 4 to 71 months who sustained moderate or severe TBI 3 years postinjury, found that acute measures of TBI severity (i.e., GCS score and number of intracranial and extraaxial lesions) were significantly related to cognitive and academic outcomes. Specifically, those who had more severe injuries demonstrated significantly more impaired performance on IQ and academic achievement tests (e.g., Vocabulary and Reading subtests), and demonstrated persistent deficits with no evidence of catch-up growth over the first 3 to 7 years following the injury. Similarly, a study examining preschool aged children over four time points: acutely (0 to 3 months post-injury), 12 months, and 30 months revealed that children who sustained a severe TBI performed significantly worse on both verbal and perceptual-performance IQ measures, as well as on standardized expressive and receptive language measures than children who sustained a mild or moderate injury, despite age-appropriate pre-injury functioning (Anderson et al., 2004).

While it has been well established in the literature that severe TBI in young children is associated with cognitive deficits, similar to the behavioral sequela described previously, cognitive deficits following mild TBI have not been well documented in the literature (Ponsford et al., 1999). The majority of studies report no adverse effects of a mild TBI on long-term cognitive functioning (McKinlay, 2010; Ponsford et al., 1999). However, some early studies suggest that children with minor to moderate head injuries perform more poorly on timed tasks than children without head injuries (Bijur, Haslum, & Golding, 1990; Klonoff, Low, & Clark, 1977). A recent study examining neuropsychological functioning 23 years after sustaining a mild TBI in childhood revealed a significant relationship between injury severity and neuropsychological functioning, suggesting that children who sustain a complicated mild TBI in childhood may be more vulnerable to worse cognitive outcomes than those who sustain an uncomplicated mild TBI (i.e., no intracranial brain pathology; Hessen, Nestvold, & Anderson, 2007). Given the limited scope of the literature on cognitive functioning following mild TBI in early childhood, clear developmental trajectories are not well established for this subset of children.

Family Functioning as a Lever for Change

In addition to the association between injury characteristics and post-injury outcomes, environmental factors, such as family environment, also have been associated with post-injury behavioral and cognitive outcomes. In fact, for young children with TBI, family environment has been found to be one of the strongest predictors of behavioral functioning post-injury (Crowe et al., 2012). Specifically, studies have shown that family environment is an important predictor of behavioral adjustment and social competence across TBI severity groups (Yeates et al., 2010). For instance, permissive parenting (i.e., responsive but lacking rules and discipline) has been shown to predict worse child social competence, whereas authoritative parenting (i.e., responsive with rules and discipline) predicted better child social competence across time, regardless of injury severity (Yeates et al., 2010).

Parenting style also has been shown to influence the trajectory of change in cognitive functioning following TBI. Specifically, high levels of authoritarian parenting (i.e., rules and discipline without responsiveness) have been associated with executive dysfunction following moderate TBI at 12 and 18 months post-injury, but not at 6 months post-injury TBI (Potter et al., 2011). Potter and colleagues (2011) suggest that parenting style might be most influential following the post-acute recovery phase, when rapid neural recovery is occurring and chronic deficits are identified. Of note, authoritarian parenting was unrelated to executive functioning following severe TBI, which suggests children who sustain severe TBIs may be less responsive to environmental influences. However, a recent study by Wade and colleagues (2016) found that TBI can lead to functional impairments across multiple domains relative to orthopedic injuries for young children between the ages of 3 and 7 years. Specifically, those who sustained moderate or severe TBIs were rated as having more functional impairments than those with orthopedic injuries. Additionally, in contrast to existing literature that suggests milder injuries are not associated with residual problems, findings revealed that children with mild TBI also experience long-term functional impairments (e.g., academic decline), particularly in the context of less favorable home environments (e.g., higher levels of permissive or authoritarian parenting, less financial resources; Wade et al., 2016). These findings suggest that improving the quality of the home environment via parenting skills may improve functional recovery following early TBI across injury severity.

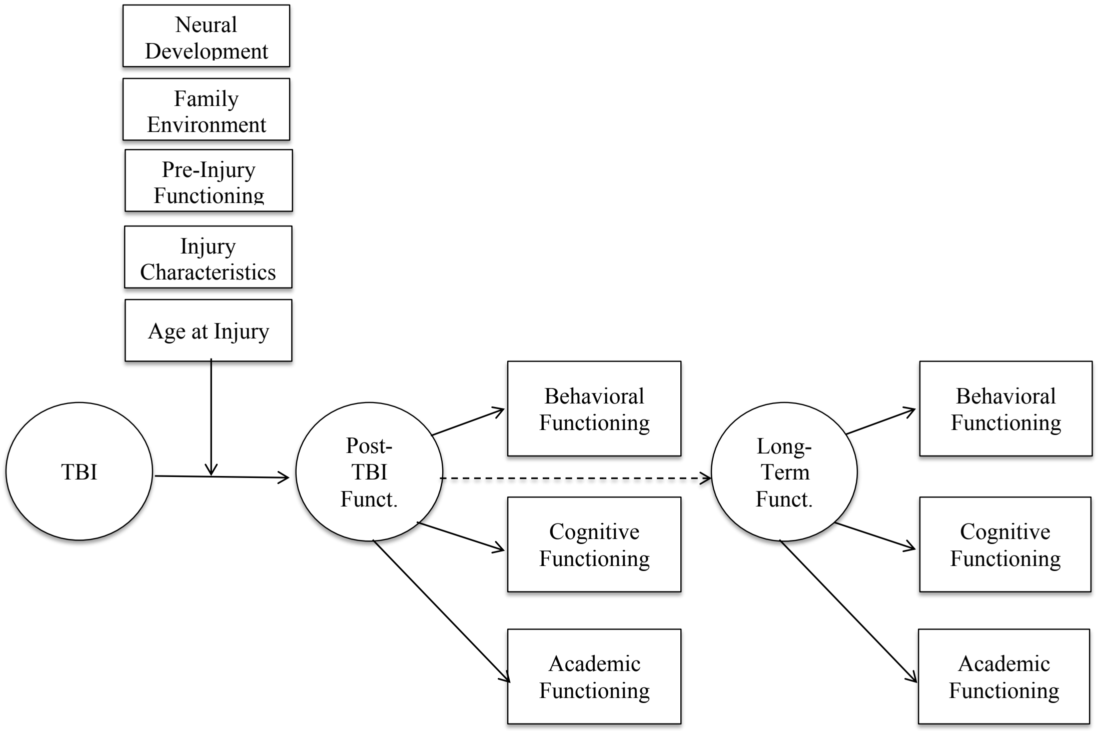
Environmental factors such as family environment may also serve to buffer or exacerbate post-injury behavioral functioning (Anderson et al., 2001). For example, a study by Yeates and colleagues (2010) found that authoritarian and permissive parenting styles were associated with worse child behavioral adjustment at 18 months post-injury. Recent research has highlighted the important role of parental warmth and negativity for young children with TBI. Specifically, parental warmth was associated with lower levels of externalizing behavior problems, whereas parental negativity was associated with higher levels of externalizing behavior problems and ADHD symptoms (Wade et al., 2011).

Research also has focused on the effects of early childhood TBI on caregiver mental health given the important role of family environment and significant family distress associated with TBI in early childhood (Micklewright, King, O'Toole, Henrich, & Floyd, 2012). Notably, studies have documented elevated levels of caregiver psychological distress as early as 24 to 48 hours post-injury, generally associated with objective and perceived child injury severity and social support (Youngblut, Brooten, & Kuluz, 2005). Further, clinically elevated levels of caregiver burden, psychological distress, and poor family functioning have been reported 6 months (Wade et al., 2002) and 12 months post-injury (Taylor et al., 2001). Caregiver psychological functioning and level of social support are important factors to consider as higher caregiver distress has been associated with authoritarian parenting practices and lower child adaptive functioning (Micklewright et al., 2012), whereas lower caregiver distress and better social support have been associated with increased family cohesion (Youngblut & Brooten, 2006).

As highlighted in our conceptual model (see Figure 3), research suggests family functioning may be an ideal lever for change in the treatment of young children with TBI, particularly following the post-acute phase and prior to the development of greater deficits over time. Furthermore, this model is consistent with recommendations suggesting interventions should be family-focused given research noting family environment as an important predictor of young children's post-injury functioning

(Anderson, Catroppa, Haritou, Morse, & Rosenfeld, 2005) and elevated levels of caregiver burden, psychological distress, and poor family functioning (Wade et al., 2002).

Figure 3. Conceptual Model of Post-Injury Functioning



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Family-Focused Interventions for Young Children with TBI

To date, several studies have been conducted with families of older children (i.e., school-age) with TBI. Interventions examining behavioral family-focused (Brown, Koa, Roslyn, & Sofronoff, 2012; Ylvisaker et al., 2007) and cognitive-behavioral problem-solving (Wade et al., 2012; Wade, Carey, & Wolfe, 2006; Wade & Stancin, 2014) approaches have shown significant improvements in child and parent outcomes. However, few interventions have used family-focused approaches to target parent–child interactions and behavior problems in young children with TBI. One parent-based behavioral intervention designed for young children with developmental delay called Signposts for Building Better Behavior was adapted for families of children ages 3 to 12 years with acquired brain injury. The intervention was delivered in either group or telephone-support (consisting of nine information booklets, a DVD, and Workbook) format determined by the families' preference over the course of 5 months. Open trial methodology was used to assess feasibility and consumer satisfaction. Findings revealed evidence for the feasibility and satisfaction of both group and telephone-delivered formats of the Signposts program, but changes in child behavioral function were not described (Woods, Catroppa, Giallo, Matthews, & Anderson, 2012).

Given support for the use of family-focused interventions with school-age children and emerging literature on the negative behavioral and cognitive outcomes following early childhood TBI, two case studies examined the effect of PCIT in improving behavior problems following TBI. Parent-Child Interaction Therapy is an evidence-based parent-training intervention designed to treat externalizing behavior problems in young children (Zisser & Eyberg, 2010) and also has led to improvements in child language among high-risk children (Bagner, Garcia, & Hill, 2016; Garcia, Bagner, Pruden, & Nichols-Lopez, 2014) and parenting stress (Bagner & Eyberg, 2007; Bagner, Sheinkopf, Vohr, & Lester, 2010), which are both common TBI-related difficulties. The intervention is divided into two phases: the Child-Directed Interaction (CDI) and the Parent-Directed Interaction (PDI), which are explained in more detail below. Parent-Child Interaction Therapy uses in-vivo coaching within sessions to reinforce caregivers' use of skills, which also has been shown to be an important component of effective parent training programs (Kaminski, Valle, Filene, & Boyle, 2008). On average, intervention duration for standard PCIT is 12 weeks (Nixon & Sweeney, 2003).

One case study examined PCIT for an 11-year-old Caucasian boy with premorbid ADHD following a severe TBI. Results indicated improvements in behavioral outcomes and parental distress associated with the child's behavior (Cohen, Heaton, Ginn, & Eyberg, 2012). However, post-intervention findings were derived solely from parent report of the frequency of problem behaviors, the extent to which parents found the behaviors problematic, and qualitative observations. Quantitative observational and follow-up data were not collected. Therefore, it is unclear whether intervention gains would have been consistent across other measurement methods (e.g., quantitative observations) and maintained over a longer period of time for this child. In addition, given the case study design, it is unclear whether findings would generalize to other children, especially those younger than 11 years of age. In another case study, PCIT was implemented with a 5-year-old African American girl from an economically disadvantaged family with a moderate TBI and subsequent clinically significant externalizing behavior problems (Garcia, Barroso, Kuluz, & Bagner, 2016). The intervention occurred over the course of 7 months with considerable amount of time in between sessions as a result of work and family stressors. Results demonstrated immediate improvements in the parent–child interaction, child inattentive behaviors, and child oppositional behaviors following the intervention, but gains were not maintained at the 6-month follow-up.

To reduce barriers to participation in family-focused interventions for this population, an online parenting skills intervention called, Internet-based Interacting Together Every-day, Recovery After Childhood Traumatic Brain Injury (I-InTERACT) was developed. Internet-based Interacting Together Every-day, Recovery After Childhood Traumatic Brain Injury is largely based on PCIT and aims to increase positive interactions and contingent responding in children between 3 and 8 years of age. Specifically, I-InTERACT teaches caregivers positive parenting skills, consistent discipline techniques, and training in stress and anger management, and provides parents with information on the cognitive and behavioral sequelae of TBI through tailored online didactics and live coaching. Families participate in 10-14 self-guided web sessions and 10–14 synchronous videoconference/coaching sessions (with the first session in their home), with up to 4 supplementary sessions. Weekly online sessions are comprised of a self-guided web session with videos and exercises pertaining to specific skills and a synchronous videoconference session with the therapist to review progress and provide in-vivo coaching during play through a wireless earpiece.

I-InTERACT has been examined via open trial methodology and has been found to be associated with significant improvements in parenting skills and trends for reductions in the overall number of behavior problems reported (Wade et al., 2009), as well as high satisfaction with the intervention (Antonini, Raj, Oberjohn, & Wade, 2012). A recent randomized clinical trial was conducted by Antonini and colleagues (2014) and compared the efficacy of I-InTERACT with an internet resource comparison group (i.e., access to Internet resources on managing brain injury) in increasing positive parenting behaviors and reducing child behavior problems. Findings revealed improvements in positive parenting skills (i.e., labeled praises and reflective statements) at post-intervention for families in the I-InTERACT group relative to the internet resource comparison group. In terms of child behavior, findings revealed no significant direct effect of group on child behavior problems (as measured by the CBCL Total Problems broadband scale). However, a moderating effect of income on child behavior was found, with lower-income families in the I-InTERACT group reporting the greatest improvements in child behavior. Lastly, significant group effects were not found for undesirable statements (i.e., commands and criticisms), child compliance, and follow-through for noncompliance.

Despite the promising findings for I-InTERACT, existing studies have some limitations. First, clinically elevated levels of behavior problems were not used as an inclusion criterion for any of the aforementioned studies. Further, Antonini and colleagues (2014) noted that the majority of children in the sample did not have clinically elevated behavior problems at baseline, which may partially explain the lack of a significant effect of group on child behavior. Therefore, it is possible that these studies did not target children at highest risk for persistent long-term behavior problems. Second, participants were required to speak English, thus limiting generalizability to non-English speaking families from minority backgrounds despite known disparities in childhood injury morbidity and mortality. For example, Hispanic children are more likely than non-Hispanic white children to be younger at the time of injury and sustain a more severe injury, and are thus more vulnerable to poor outcomes post-injury (Jimenez et al., 2013). Third, maintenance of gains was not assessed following the intervention. Therefore, it is unclear whether the intervention leads to long-lasting changes in parenting skills and child behavior. Lastly, although the use of online content is innovative, parents expressed technological difficulties and findings revealed mediocre session attendance and intervention completion rates (Antonini et al., 2012), suggesting that a web-based program may not be ideal for all families.

Overall, the literature on family-focused interventions for young children with TBI and post-injury behavior problems is limited, but recent studies examining PCIT and an adapted version of PCIT (I-InTERACT) have shown promise with regard to improvements in parenting skills and child behavior. These findings lend preliminary support for the use of PCIT to target behavioral difficulties and foster a positive parent–child relationships following TBI.

The Present Study: Research Overview, Innovation, and Hypotheses

Taken together, the current study aims to build on the growing literature on family-focused interventions to ameliorate post-injury behavior problems in young children with TBI. Intervention outcome studies showing that PCIT is effective in improving child externalizing behavior problems (Zisser & Eyberg, 2010), language skills, (Bagner, Garcia, & Hill, 2016; Garcia et al., 2014), and parenting stress (Bagner, Sheinkopf, Vohr, & Lester, 2010) across diverse families (McCabe, Yeh, & Garland, 2005; McCabe, Lau, Yeh, & Ho, 2012), suggest that it may be an effective method of targeting common behavioral and cognitive outcomes following early childhood TBI. In addition, in-vivo coaching, a key component of PCIT, has been utilized successfully by Wade and colleagues (2011) and has been found to be a partial mediator accounting for changes in parenting behavior among parents of children with behavior problems (Barnett, Niec, & Acevedo-Polakovich, 2014). These findings suggest that in-vivo coaching may help to decrease authoritarian and permissive parenting styles, which are more common among parents of children with TBI and associated with worse child behavioral adjustment and social competence (Yeates et al., 2010).

Consistent with recommendations to examine established interventions with new populations prior to making changes in their structure or content (Eyberg, 2005), the previously described case studies on PCIT revealed mixed findings with regard to long-term behavioral changes. Further, contrary to expectations that an online parenting intervention would be more accessible to families and lead to better completion rates than standard parenting interventions, Antonini et al. (2012) reported high rates of no-shows and cancellations, and completion rates that were consistent with PCIT studies implemented in the clinic (Schuhmann, Foote, Eyberg, Boggs, & Algina, 1998). These challenges to maintaining gains and maximizing intervention adherence suggest an adaptation of PCIT to address the needs of high-risk families of children with TBI may be warranted.

In exploring how to adapt PCIT for children with TBI, it is important to consider research on the length, course, and components of other effective interventions. To date, studies have provided support for the use of brief early intervention programs to improve externalizing behavior problems (Bakermans-Kranenburg, Van Ijzendoorn, &

Juffer, 2003; Shaw & Dishion, 2006). However, careful evaluation of modifications or adaptations to existing programs is recommended given evidence to suggest that certain parent training components are associated with larger effect sizes (e.g., increasing positive parent–child interactions, parenting consistency, in-session practice of parenting skills; Kaminski et al., 2008). Interventions must balance the number of sessions with the inclusion of the necessary intervention components to promote maintenance of gains. As such, recent literature has begun to examine the use of a more intensive format of PCIT, which incorporates the core components in a time-limited manner. Overall, studies have found comparable effects between abbreviated PCIT (i.e., five face-to-face sessions alternated with five 30-min consultations) and standard PCIT (Nixon & Sweeney, 2003) at a 6-month follow-up, as well as equivalent or better outcomes when utilizing time-limited PCIT with families at risk or with a history of maltreatment (Thomas & Zimmer-Gembeck, 2012). Further, Graziano and colleagues (2014) provided evidence for the use of a brief and intensive version of PCIT (ten 90-minute sessions every weekday across 2 weeks) and suggested future research should examine whether intensive interventions can be effective for high-risk families (e.g., low SES and minority group status), who often have more barriers typically resulting in dropout (Graziano et al., 2014; Lavigne et al., 2010). These findings have important implications for children with TBI who are often considered to be at high risk due to the behavior, cognitive, and environmental sequela following TBI (Garcia, Hungerford, & Bagner, 2014) and unique barriers to care (e.g., treatment at centralized rehabilitation centers, lack requisite knowledge and expertise regarding TBI; Wade, Wolfe, Maines Brown, & Pestian, 2005).

In light of recent literature demonstrating success with briefer and more intensive formats of PCIT, and study findings suggesting the need to adapt current models of family-focused interventions for children with TBI, a time-limited and more intensive (e.g., more than once a week) intervention may be effective in treating post-injury behavioral and cognitive difficulties in a brief period of time. Brief and more intensive formats also may be appealing to caregivers who report a sudden worsening in their child's behavioral functioning following the injury (Chapman et al., 2010) and the desire to improve the behavior problems quickly, which may increase engagement in and satisfaction with the intervention. In addition, an intervention delivered more than once per week would be consistent with other rehabilitation therapies commonly implemented for children with TBI, such as speech, occupational, and physical therapy (Bailes, Reder, & Burch, 2008; Dumas, Haley, Carey, & Ni, 2004; Jones, Drummond, & Vella, 2007).

In addition to the length and frequency of the intervention, the timing of the intervention is an important consideration for children with TBI. It has been well established that behavioral and cognitive problems can persist beyond the post-acute recovery phase, which poses treatment challenges for other healthcare providers (e.g., physicians, physical therapists, occupational therapists, and speech therapists). Intervening soon after a TBI, but following the post-acute recovery phase to ensure stability, may address post-injury problems before they become ingrained and more resistant to intervention.

Given evidence to suggest that families of young children with TBI may benefit from more intensive interventions that are delivered following the post-acute recovery phase, the primary purpose of the current study was to examine the initial outcome, feasibility, acceptability, and satisfaction of a time-limited and intensive format of PCIT for 2- to 5-year-olds with TBI and elevated externalizing behavior problems. The intervention protocol consisted of 1 to 1 ½ hour sessions delivered twice per week for 5 weeks for a total of 10 sessions, consistent with intensive PCIT in Graziano et al. (2014).

The first aim of the study was to examine the effect of PCIT on child externalizing and internalizing behavior problems, self-regulation, and compliance. I hypothesized that following intervention completion and at a 2-month follow-up assessment, children will display lower levels of caregiver-reported externalizing and internalizing behaviors (as measured by broadband scales and syndrome subscales), increased levels of observed self-regulation, and observed child compliance to caregiver commands during a caregiver-led play and cleanup situation. The second aim of the study was to examine the effect of the intervention on child cognitive functioning, as measured by child performance on working memory and receptive language tasks, as well as caregiver report of child overall executive functioning. I hypothesized that following intervention completion and at a 2-month follow-up assessment, children will display improved scores on working memory and receptive language tasks, as well as lower levels of caregiver-reported executive dysfunction. The third aim of the study was to examine the effect of PCIT on parenting practices (as measured by positive and negative parenting skills), family functioning (as measured by level of cohesion and adaptability), and caregiver stress. I hypothesized that following intervention completion and at a 2-month follow-up assessment, caregivers will display a higher proportion of positive parenting skills and a lower proportion of negative parenting skills, as well as higher levels of caregiver-reported positive family functioning and lower levels of caregiver-reported stress. The fourth aim of the study was to examine the feasibility, acceptability, and satisfaction of the intervention. I hypothesized (a) high rates of intervention attendance, homework compliance, and intervention completion, (b) high rates of baseline, post-intervention, and follow-up assessment completion, and (c) high levels of caregiver-reported intervention acceptability and satisfaction.

II. INTENSIVE PCIT FOR EARLY TBI: AN OPEN TRIAL

The current study was an open trial (i.e., one group pre-post and follow-up design) of a brief and intensive format of PCIT to treat behavior and cognitive problems following TBI in early childhood. The protocol was approved by the Institutional Review boards at the research site and at the pediatric hospital where participants were recruited.

Participants and Recruitment

Participants were 15 families and their 2- to 5-year-old child who sustained a mild (13 cases) or moderate to severe (2 cases) TBI within the last 3 to 6 months and displayed clinically elevated levels of externalizing behavior problems. Families were actively recruited over the course of six months from Emergency Department reports at a large pediatric hospital. Given the large percentage of Hispanic families seen at this hospital and living in the surrounding areas, families were required to speak and understand either English or Spanish. For bilingual families, the primary caregiver was given the option to complete the assessments and intervention in English or Spanish.

For initial inclusion, all child participants in the current study were required to be between 2- and 5-years of age at the time of the phone screening, and have documented evidence of a head injury within the past 3 to 6 months, with at least one physical finding consistent with head trauma, including loss of consciousness (no matter how brief), a remarkable CT scan or MRI, or symptoms consistent with head injury in children (e.g., vomiting, drowsiness, seizures, neurologic deficits, cerebrospinal fluid or bloody discharge from the ears or nose). Injury characteristics and post-injury symptoms were obtained from the primary caregiver and provided a broader sense of the injuries sustained by the participants. For children for whom GCS scores were not available, a moderate or severe TBI was defined if there was documented pathology on a CT scan or MRI, whereas a mild TBI was defined if there was no documented pathology on a CT scan or MRI but physical symptoms were consistent with a head injury (Woods et al., 2012).

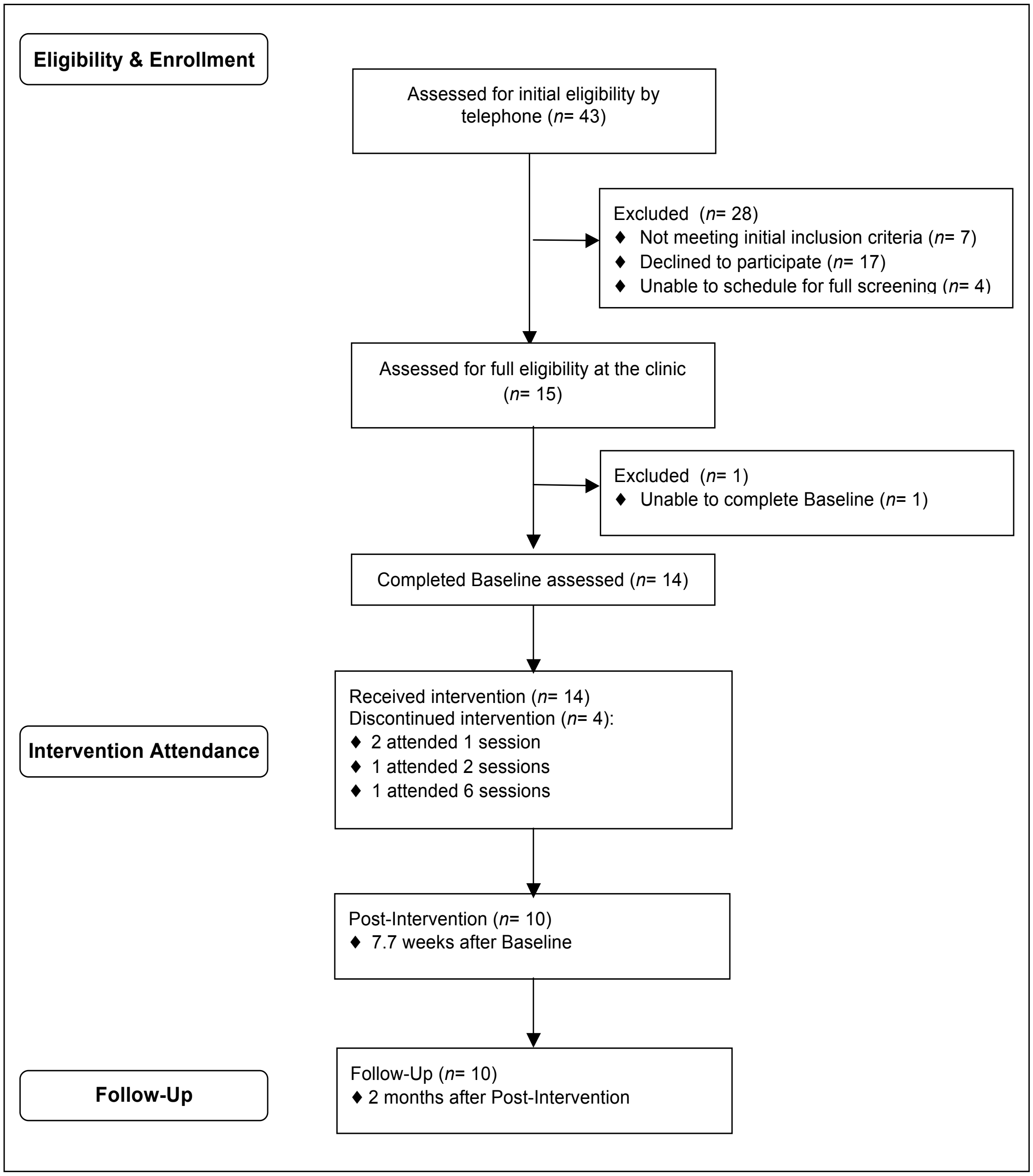
Eligible families were contacted via telephone and provided a brief description about the study by a research staff member. Primary caregivers who expressed interest and provided verbal consent participated in a brief screening assessment over the telephone, which consisted of the 19-item Aggressive Behavior and 5-item Attention Problems subscales of the CBCL. If the primary caregiver rated the child's behavior as clinically elevated (T-score ≥ 60) on either subscale, they were scheduled to complete the screening and a baseline assessment (if eligible) at the psychology clinic housed within a large public university. The second part of the screening involved the primary caregiver completing a two-subtest cognitive screening measure. Consistent with previous PCIT research (Bagner, Rodríguez, Blake, & Rosa-Olivares, 2013) and to ensure the ability of the parent to learn the skills, the primary caregiver had to receive an estimated IQ score ≥ 70 on the two-subtest (Vocabulary and Matrix Reasoning) Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1997) for mothers speaking English or an average standard score ≥ 4 (two standard deviations below the mean) on the Vocabulary and Matrix Reasoning subtests of the Escala de Inteligencia Wechsler Para Adultos– Third Edition (EIWA-III; Pons et al., 2008), the Spanish version of the WAIS (Wechsler, 1997), for mothers speaking Spanish.

During the recruitment period, 43 families were contacted by the research team to assess interest and determine initial eligibility for the study. Twenty-six families (60%)

agreed to participate in the brief telephone screening. All 17 families that did not participate in the telephone screening were not interested because the primary caregiver had no concern about post-injury behavioral changes in the child. Of the 26 families that participated in the initial telephone screening, 19 families (73%) reported clinically elevated behavior problems on the Aggressive Behavior or Attention Problems subscales on the CBCL. Of the 19 families that participated in the brief telephone screening, 15 families (78%) completed the full screening at the clinic, and all met inclusion criteria on the WASI or EIWA-III. The four families that did not complete the full screening could not be reached by telephone to schedule the clinic visit after the initial telephone screening. The only exclusion criterion was child cognitive or physical deficits significantly affecting mobility. No families were excluded on the basis of this criterion. As a result of the preliminary nature of the study, recruitment ended once 15 families completed the full screening.

Of the 15 families that completed the full screening, 14 (93%) completed the baseline assessment. The one family that did not complete the baseline assessment dropped out of the study because of a high-risk pregnancy and did not start the intervention. Of the 14 families that completed the baseline assessment and started the intervention, 10 families (71%) completed the intervention. Of the 4 families that dropped out, 1 family completed more that half of the intervention. Specifically, 2 families dropped out following the CDI teach session, one family dropped out following the first CDI coach session, and one family dropped out following the PDI teach session. Reasons for dropout included medical emergencies, scheduling conflicts, and custody changes limiting the families' ability to complete the intervention. All the families that completed the intervention also completed the post-intervention and 2-month follow-up assessments. Of note, one of the families completed questionnaires over the telephone for the 2-month follow-up assessment due to relocation. Therefore, results of child performance on working memory, receptive language, and self-regulation tasks, as well as parenting skills during a behavioral observation task with the child were not obtained for this family at the 2-month follow-up assessment. In addition, one of the child participants had significant cognitive impairments, so the working memory, receptive language, and self-regulation tasks were not administered across assessments with this child. For this case, deficits preceded the injury based on caregiver report. Figure 4 provides an overview of the participant flow and study procedures.

Figure 4. Open Trial Participant Flow



Child participants who completed the intervention (*n* = 10) had a mean age of 50.8 months (*SD* = 16.1 months) and 6 (60%) were male. Ninety percent of caregivers reported their child's ethnicity as Hispanic and 1 (10%) caregiver reported their child's race as African American. Fifty percent of the families were two-parent families. Socioeconomic status (SES) and education level varied across the participants with an average yearly income of $30,420 and a range from $1,200 to $93,000. Education level for the primary caregiver ranged from some high school to college graduate, with most primary caregivers (30%) reporting some college or technical school. Sixty-four percent (*n* = 9) of caregivers reported being employed either full-time or part-time at the time of the baseline assessment. Primary caregivers reported a mean level of support of 61.1 (*SD* = 9.7) out of a maximum score of 74 on the Multidimensional Scale of Perceived Social Support (Zimet, Powell, Farley, Werkman, & Berkoff, 1990), suggesting high levels of perceived social support. All demographic characteristics for study participants are presented in Table 1.

Table 1. Demographic Characteristics

Characteristics	Treatment Completers ($n = 10$)	Treatment Non-Completers ($n = 5$)
	M (SD) or n (%)	M (SD) or n (%)
Child Age (months)	50.8 (16.1)	43.8 (13.6)
Child Sex (% male)	6 (60%)	3 (60%)
Child Race/Ethnicity (% Minority)	10 (100%)	5 (100%)
Child IQ[a]	86.70 (18.8)	94.60 (15.1)
Two-Parent Household[b]	5 (50%)	3 (60%)
Mother IQ		
WASI	91.3 (7.43); $n = 7$	93 (10.6); $n = 5$
EIWA	10.2 (1.89); $n = 3$	---
Mother Age	29.6 (6.3)	29.2 (3.3)
Mother Ethnicity (% Minority)	9 (90%)	5 (100%)
Father Age[c]	32.8 (6.5)	29.2 (3.3)
Father Ethnicity (% Minority)	10 (100%)	5 (100%)
Annual Family Income	30,420 (24,191)	49,500 (32,423)

Note. WASI = Wechsler Abbreviated Scale of Intelligence; EIWA = Escala de Inteligencia Wechsler Para Adultos.

[a] One of the participants had significant cognitive impairments and was administered the Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III; Bayley, 2006). The Cognitive scale was used to provide an estimate of the child's cognitive functioning as scores are comparable to the WPPSI-IV.

[b] Of the 5 two-parent households for the treatment completes, 2 (20%) fathers attended 5 or more sessions.

[c] Only one father had the role of primary caregiver.

On average, participants were injured 3.9 months prior to recruitment (*SD* = 0.7). No injury was reported to have resulted from abuse. The most common mechanism of the head injury was falls (*n* = 6), followed by struck by/against another child or object (*n* = 3), and motor vehicle crash (*n* = 1). Forty percent of the participants (*n* = 4) received a CT scan or MRI, and 1 (10%) was remarkable for cranial fractures and intracranial hematomas. Other injuries sustained by the participant involved in the motor vehicle crash included facial fractures and injuries to the lung, abdomen, and optic nerve. One participant was reported to have experienced a loss of consciousness, ranging between 5 and 10 minutes. Only one participant underwent surgical intervention (i.e., craniofacial repair, including repair of skull fracture, dural tear, and multiple facial fractures) and was subsequently hospitalized. None of the participants were receiving medication or other services for attention or behavioral problems at the time of the study. However two participants were receiving anticonvulsant medication for seizure management (seizures preceded the injury).

Forty percent of child participants were receiving other therapies (i.e., physical, occupational, and/or speech therapy) at the time of the baseline assessment, and all of the participants continued these therapies while completing the current intervention. To provide an estimate of pre-injury behavioral functioning, caregivers were asked to rate their child’s behavior pre and post-injury on a 7-point scale from 0, “not a problem” to 7, “a severe problem.” On average, caregivers rated pre-injury behavior problems as a 2.9 (*SD* = 2.3) and post-injury behavior problems as a 4.9 (*SD* = 1.2). Research suggests brain location of the injury is less predictive and harder to quantify in closed head injuries commonly seen in young children (Moses & Stiles, 2002), and therefore brain location of the injury was not reported. Injury characteristics are described in detail in Table 2.

Table 2. Injury Characteristics

Characteristics	Treatment Completers (*n* = 10)	Treatment Non-Completers (*n* = 5)
	M (SD) or *n* (%)	*M* (SD) or *n* (%)
Injury Type		
Falls	6 (60%)	5 (100%)
Struck by/Against	3 (30%)	---
MVC	1 (10%)	---
Age at Injury (months)	47.1 (16.4)	39.1 (13.7)
Time since Injury (months)	3.9 (0.7)	4.4 (0.5)
Injury Severity (% mild)	9 (90%)	4 (80%)
Received CT/MRI	4 (40%)	3 (60%)
CT/MRI (% remarkable)	1 (10%)	1 (20%)
LOC (% Yes)	1 (10%)	2 (40%)

Note. MVC = Motor Vehicle Crash; LOC = Loss of Consciousness.

Procedure

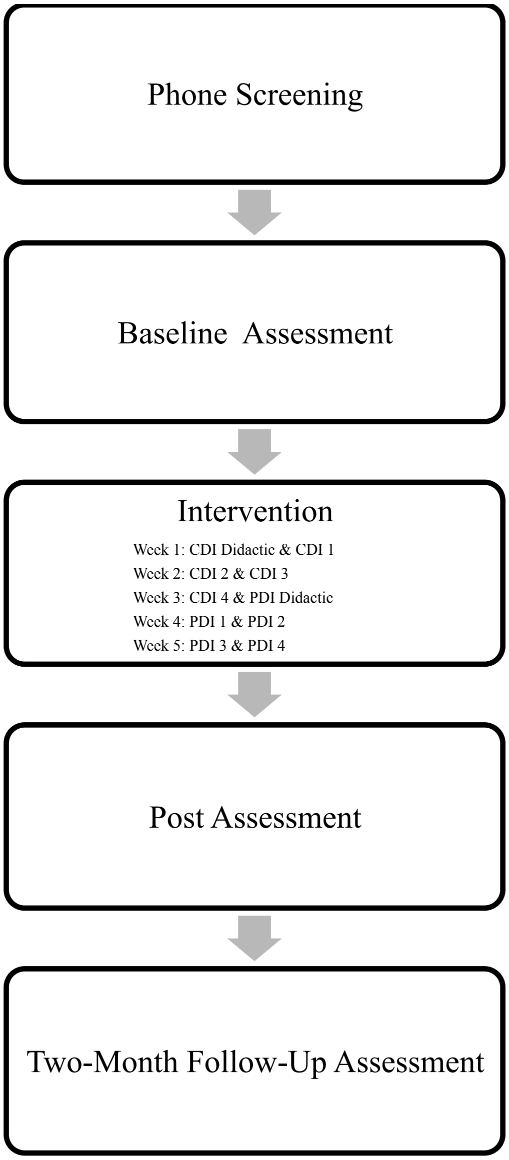
Assessments. Following the initial telephone screening, eligible families were scheduled to complete the screening at the psychology clinic with an advanced doctoral student in clinical psychology. At the visit, the primary caregiver provided written consent. If inclusion criteria were met after completing the screening (described above in the Participants and Recruitment section), families completed the baseline assessment during their visit. During the baseline assessment, questionnaire data were collected from the child's primary caregiver, which was the mother for most cases (93%; $n = 13$). The child's father was the primary caregiver for one case. The primary caregiver also participated in a 20-min behavioral observation with the child (described in detail below). Following the intervention and on average 7.7 weeks ($SD = 3.1$) after the baseline assessment, families completed the post-intervention assessment, which included an additional measure of intervention satisfaction. For two cases, the post-intervention assessment was conducted in the family's home due to difficulty obtaining transportation to the clinic. Families were also contacted to participate in a follow-up assessment that occurred approximately 2 months after the post-intervention assessment. The follow-up assessment was conducted in the family's home for two cases because of difficulty obtaining transportation to the clinic, and over the telephone for one case as a result of relocation out the area. Forty-seven percent of families completed the assessments in English.

Intervention. Intervention was provided by advanced doctoral students in clinical psychology, under the supervision of a licensed clinical psychologist. Therapy consisted of ten 1 to 1 ½ hour sessions conducted twice per week at the clinic and in the family's home for two cases. Parent-Child Interaction Therapy skills were taught via two didactic presentations (i.e., CDI and PDI), during which the child was not present, followed by 4 CDI and 4 PDI coach sessions, where caregivers were coached in-vivo while they were interacting with their child. Sessions were typically conducted with one caregiver and the child in a play therapy room and the therapist behind a one-way mirror coaching the caregiver through a wireless headset that allows for immediate feedback. Of note, for the two participants who completed the post and follow-up assessments in the home because of difficulties with transportation to the clinic, the therapist conducted the majority of the intervention sessions in the family's home. In order to optimize in-home coaching, an appropriate location for the session was discussed that minimized distractions (e.g., television), and the therapist generally sat near the caregiver and coached him/her using a low voice. Following research demonstrating that father involvement enhances intervention outcome (Bagner & Eyberg, 2003; Bagner, 2013), all caregivers were encouraged to participate in the sessions, and the therapist divided the session time to coach other caregivers with the child (e.g., 15 minutes coaching each caregiver).

During CDI, caregivers were taught to follow their child's lead by using PRIDE skills (i.e., *P*raising, *R*eflecting, *I*mitating, *D*escribing, *E*njoyment) and avoiding questions, commands, and critical statements. Parent-Directed Interaction focused on helping the caregivers set limits and consistently use discipline to improve child compliance. Given the intensive and time-limited nature of the current study, caregivers were not required to meet mastery criteria (i.e., 10 behavioral descriptions, 10 reflections, 10 labeled praises, and less than 3 questions, commands, and negative statements during a 5-min child-led play observation) in order to proceed from CDI to PDI or to complete the intervention. The families were also asked to practice the PRIDE skills at home during daily 5-minute play sessions and received handouts describing specific PCIT skills taught during the sessions.

In accordance with PCIT international guidelines, advanced doctoral students were trained in PCIT by a licensed clinical psychologist and PCIT Master Trainer. The advanced doctoral students participated in weekly group supervision to discuss each case. In addition, there were several practical and ethical considerations to implementing the intervention in the home that were carefully addressed for these families (e.g., therapists traveled to families' homes in pairs). All sessions were audiotaped, and 20% were randomly selected coded for integrity by an undergraduate research assistant uninvolved in providing the intervention. Integrity, defined as the percent with which the therapist adhered to key elements of each session detailed in the manual, was 99%. Figure 5 provides an overview of the study design.

Figure 5. Overview of Study Design



Measures

Figure 6 provides an overview of the measures administered across time points.

Screening measures. The *Child Behavior Checklist for 1½ to 5 Year Olds* (*CBCL*; Achenbach & Rescorla, 2000) is a 99-item parent-rating scale designed to measure the frequency of children's behavioral and emotional problems. Prior research supports the validity of the CBCL in identifying behavior problems (Biederman & Faraone, 1993; Jensen & Watanabe, 1996). The CBCL is also sensitive to behavior problems after TBI (Schwartz et al., 2002; Taylor et al., 2002). The Aggressive and Attention syndrome subscales of the CBCL were used as a screening measure (i.e., T-score ≥ 60 on either subscale).

The *Wechsler Abbreviated Scale of Intelligence* (*WASI*; Wechsler, 1999) and the *Escala de Intelligencia Wechsler Para Adultos –Third Edition* (*EIWA-III*; Pons et al., 2008) are reliable English and Spanish measures of intelligence, designed for use with individuals aged 6 to 89 years. The WASI two-subtest form consists of the Vocabulary and Matrix Reasoning subtests and yields a Full Scale Intelligence Quotient (FSIQ-2), which has a mean score of 100 with a standard deviation of 15. An FSIQ-2 score ≥ 70 was used as a cutoff for the current study. The WASI FSIQ-2 correlated .87 with the FSIQ of the Wechsler Adult Intelligence Scale – Third Edition (WAIS-III; Wechsler, 1997) and has high test-retest reliability, ranging from .83 to .90 in previous studies (Wechsler, 1999). The WASI also has high test-retest reliability and good concurrent validity (Wechsler, 1999). The Spanish version of the WAIS (i.e., EIWA-III) was used as a cognitive screening measure for Spanish-speaking caregivers. The same EIWA subtests as in the WASI (Vocabulary and Matrix Reasoning) were administered, and an average standard score ≥ 4 (two standard deviations below the mean) was used as a cutoff for the current study. Reliability coefficients range from .65 to .96 for subtest scores and from .95 to .97 for performance and verbal scores. The reliability coefficient associated with the full-scale score is .98 (Pons et al., 2008; Pons & Matías-Carrelo, 2008).

Measures of child behavioral outcomes. The *Child Behavior Checklist* (*CBCL*; Achenbach & Rescorla, 2000, 2001) is a widely used parent-rating scale designed to measure the frequency of children's behavioral and emotional problems. Caregivers with children younger than the age of 6 years received the CBCL 1 ½–5 version (99 total items; Achenbach & Rescorla, 2000) and those with children 6 years or older received the CBCL 6–18 version (112 total items; Achenbach & Rescorla, 2001). Each item on the CBCL is rated on a 3-point scale with respect to the frequency of occurrence (not true, somewhat or sometimes true, and very true or often). The measure yields scores on broadband scales, as well as empirically-based syndrome subscales. For the purpose of the current study, the following broadband scales: Total Behavior, Internalizing, and Externalizing, and syndrome subscales: Anxious/Depressed, Withdrawn, Attention Problems, and Aggressive Behavior were used as measures of child internalizing and externalizing symptoms. Test-retest reliability coefficients range from .87 to .94 for the broadband scales and from .68 to .92 for empirically-based syndrome subscales noted above (Achenbach & Rescorla, 2000, 2001). Broadband scales and empirically-based syndrome subscales were used as outcome measures of child behavior across time points.

The *Eyberg Child Behavior Inventory* (*ECBI*; Eyberg & Pincus, 1999) is a 36-item parent-rating scale assessing disruptive behavior problems in children ages 2 through 16 years. Each item on the ECBI is rated on a 7-point intensity scale that indicates how often the behaviors currently occur. It includes an Intensity scale, which measures the frequency of each problem behavior and a Problem scale, which measures the extent to which parents find the behaviors problematic. The ECBI has been found to have good test-retest reliability (Funderburk & Eyberg, 2003), and has been shown to be sensitive to intervention effects of PCIT (Schuhmann et al., 1998). The ECBI was used to assess weekly progress and as an outcome measure of child disruptive behaviors.

The *Head-Toes-Knees-Shoulders Task (HTKS*; Cameron Ponitz et al., 2008) is conceptualized as behavioral measure of self-regulation, which requires inhibitory control, working memory, and sustained attention skills (Ponitz et al., 2008). The HTKS task includes three sections with each containing practice items and 10 test items. Each section involves administering four commands to the child: “touch your head,” “touch your toes,” “touch your knees,” and “touch your shoulders,” which are then switched in the second (e.g., touch your head when told to touch your toes) and third sections (e.g., head goes with knees and shoulders go with toes). Children are assigned 0 (incorrect), 1 (self-correct), or 2 (correct) points for each item, with higher scores indicating higher behavioral regulation skills. A self-correct is defined as any discernable motion toward the incorrect response followed by the child stopping and correcting himself or herself. The scores were summed at each time point, and possible scores ranged from 0–20 points. Research with different samples of children has found that the task significantly correlated to parent and teacher ratings of behavioral regulation (Ponitz et al., 2008). Additionally, a recent study provided support for the validity and utility of the HTKS task with a predominately Hispanic sample of children with externalizing behavior problems

(Graziano et al., 2016). The HTKS task was used to assess changes in children's self-regulation skills across time points.

Measures of child cognitive outcomes. The *Peabody Picture Vocabulary Test-Fourth Edition* (*PPVT-4*; Dunn & Dunn, 2007) is a measure of single word listening vocabulary and a screening test of verbal ability, as well as an estimate of intellectual functioning designed for use with individuals aged 2.5 to 90 years. The child is presented four pictures at a time and asked to point to a picture that represents a particular word. The PPVT-4 has been found to have good internal consistency and test-retest reliability (both $r > .90$), and validity (Kush & Shaw, 2010). The PPVT-4 was used to assess child receptive vocabulary across time points. Form A was administered at the baseline and 2-month follow-up assessments, and form B was administered at the post-intervention assessment.

The *Wechsler Preschool and Primary Scale of Intelligence-Fourth Edition* (*WPPSI-IV;* Wechsler, 2012) was used to assess the child's cognitive ability. Internal consistency across age groups range from .85 to .96 for index scores and from .71 to .95 for subtest scores. Children were administered the core subtests at the baseline assessment to assess their general intellectual ability (Full Scale IQ) for descriptive purposes. At the post-intervention and 2-month follow-up assessments, only two subtests of working memory (Picture Memory and Zoo Locations) were administered to assess changes in working memory over time.

The *Behavior Rating Inventory of Executive Functioning* (*BRIEF*; Gioia, Espy, & Isquith, 2003; Gioia, 2000) is a parent-report rating scale that assesses child executive functioning behaviors in the home. Caregivers with children younger than the age of 6 years received the preschool version (63 total items; Gioia et al., 2003) and those with children 6 years or older received the school-age version (86 total items; Gioia, 2000). Each item on the BRIEF is rated on a 3-point Likert scale (never, sometimes, and often), which yields five nonoverlapping but correlated clinical subscales (Inhibit, Shift, Emotional Control, Working Memory, Plan/Organize) as well as two validity scales. Scores on these clinical scales are also summed to create composite indices and an overall Global Executive Composite (GEC). The BRIEF preschool and school-age versions have demonstrated high levels of internal consistency and stability and acceptable levels of both interrater and test–retest reliability (Gioia et al., 2003; Gioia, 2000; Sherman & Brooks, 2010). The BRIEF is also highly sensitive to behavioral deficits observed in a variety of clinical groups, including ADHD (Mahone & Hoffman, 2007), TBI (Mangeot, Armstrong, Colvin, Yeates, & Taylor, 2002), and frontal lobe lesions (Anderson, Anderson, Northam, Jacobs, & Mikiewicz, 2002). For the purpose of the current study, the GEC, or total score, was used as a broad measure of caregiver-reported executive ability across time points, as has been done in previous research (Karver et al., 2012).

Measures of parent outcomes. Observations of parent-child interactions were incorporated within each assessment using the *Dyadic Parent-Child Interaction Coding System, Third Edition* (*DPICS-III*; Eyberg, Nelson, Duke, & Boggs, 2005) to evaluate parenting practices. The DPICS is a behavioral coding system that measures the quality of parent-child interactions. The primary caregiver was videotaped in four 5-minute standard parent-child interaction situations (warm-up, child-led play, caregiver-led play, cleanup), lasting a total of 20 minutes. For the current study, parent and child behaviors were coded to examine changes in the parent-child interaction. Cohen’s Kappa has been shown to be adequate for parent verbalizations that were used in the current study and ranged from .62 to .89 (Bagner & Eyberg, 2007). To examine changes in parenting practices, we created two composite categories of “do skills” (behavior descriptions, reflections, and praises) and “don’t skills” (questions, commands, and negative talk) reflecting behaviors parents are taught to use and not use during play. The proportion of do skills and don’t skills was calculated by dividing the number of do skills and don’t skills by the total number of parent verbalizations (including neutral statements) during combined warmup and child-led play. Child responses to parental commands (e.g., compliance, noncompliance, and no opportunity for compliance) were coded to measure changes in child compliance during combined caregiver-led play and cleanup observations. As a result of the child participants requiring multiple breaks, parent-child interaction situations were combined for the current study. Child Alpha compliance was calculated and defined as the ratio of compliance to total caregiver commands that provided an opportunity for compliance. Undergraduate research assistants were trained to 80% agreement with a criterion tape. For purposes of reliability coding, 20% of the baseline observations were coded a second time, and inter-rater reliability was adequate and ranged from 81% to 85%.

The *Family Adaptability and Cohesion Evaluation Scale* (*FACES-II*; (Olson, D. H., Portner, J., & Bell, 1983) is a measure of functioning of the family unit using two subscales: family cohesion (16 items) and family adaptability (14 items). Family cohesion is defined as the degree to which there is emotional bonding between and among family members, while family adaptability is the extent to which the family system is flexible and able to change its roles and relationships in response to stress. Parents rate each of the 30 items on a 5-point scale from 1, “almost never” to 5, “almost always.” Validity is supported by significant correlations with other measures of family functioning (Thomas & Barnard, 1986). Higher summative scores indicate greater cohesion and adaptability. The FACES-II subscales were used to assess family cohesion and adaptability across time points.

The *Parenting Stress Index-Short Form* (*PSI-SF*; Abidin, 1990) is a 36-item self-report instrument of parenting stress for parents of children ages 1 month to 12 years. The PSI-SF contains a Total scale and three subscales (Parental Distress, Parent-Child Dysfunctional Interaction, and Difficult Child) with Cronbach’s alphas of .87, .80, and .85, respectively, and 6-month test-retest reliabilities of .85, .68, and .78, respectively (Abidin, 1990). More specifically, parents of children with traumatic brain injuries have been found to have higher PSI-SF scores than did parents of uninjured children (Hawley, Ward, Magnay, & Long, 2003). All scales on the PSI-SF were used to assess caregiver stress across time points.

Measures of caregiver acceptability and intervention satisfaction. The *Treatment Acceptability Rating Form-Revised (TARF-R;* Reimers, Wacker, & Cooper, 1991) is a 20-item instrument that measures intervention acceptability. Parents rate each of the items on a 7-point Likert scale with varying anchor point descriptors for each item. Total scores are obtained by summing all items with higher summed scores representing greater levels of acceptability. The internal consistency of this instrument was reported to be .92 (Reimers et al., 1991). The TARF-R was used to measure families’ acceptability at the baseline assessment, prior to receiving the intervention (based on the overview of the intervention provided to families) and at the post-intervention assessment. A modified version of the TARF-R (items presented in past tense) was administered at post-intervention.

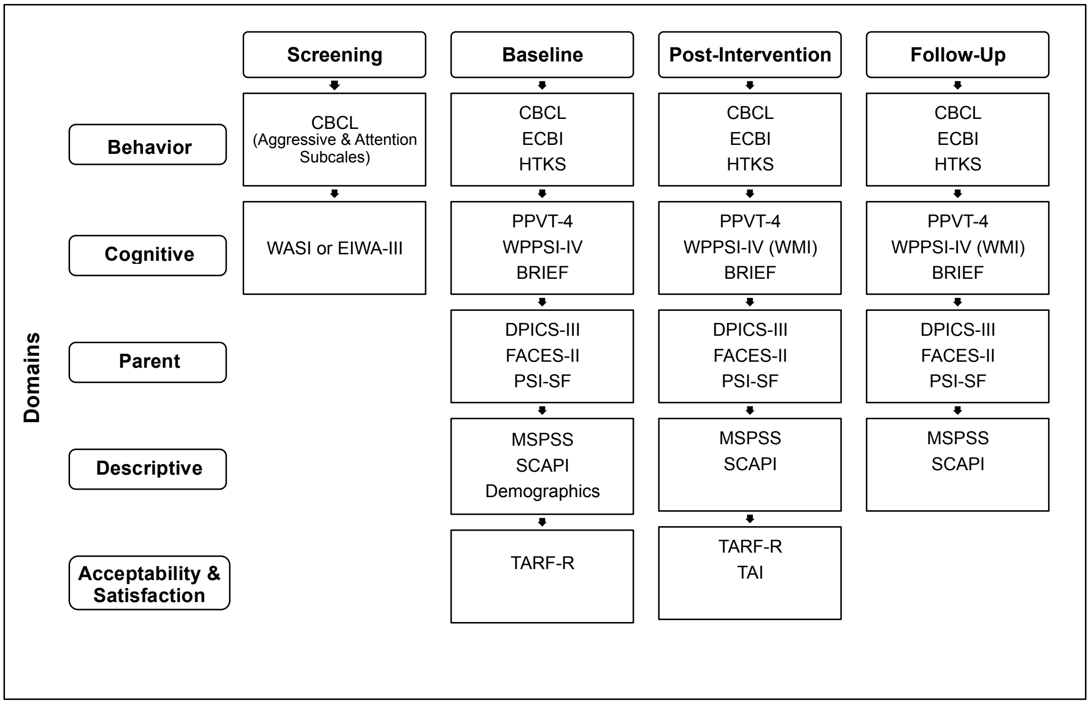
The *Therapy Attitude Inventory* (*TAI*; Eyberg & VandeCreek, 1993) is a 10-item parent-report measure that assesses parental satisfaction with the process and outcome of therapy. Eisenstadt and colleagues (1993) reported an internal consistency coefficient of .88, and discriminant validity has been shown between outcomes of alternative interventions (Eisenstadt et al., 1993; Eyberg & Matarazzo, 1980). Test-retest reliability over a four-month period and correlations between the TAI and both parent-rating scales and observational measures of treatment change have been demonstrated (Brestan et al. 1999). The TAI total score was used to assess parent satisfaction with the intervention at the post-intervention assessment.

Descriptive measures. The *Demographic and Background Questionnaire* is a parent questionnaire that was used to provide descriptive information about the child and family (e.g., sex, age, race/ethnicity, and medical/psychosocial history) at the baseline assessment.

Multidimensional Scale of Perceived Social Support (*MSPSS*; Zimet, Powell, Farley, Werkman, & Berkoff, 1990) is a 12-item measure of support received from friends, family, and significant others. Caregivers rate each of the items on a 7-point Likert scale from 1, “very strongly disagree” to 7, “very strongly agree.” Construct validity is supported by a moderate correlation ($r = –.35$) between MSPSS scores and depression scores for participants reporting high life stress but no correlation ($r = .02$) for participants reporting low life stress (Zimet et al., 1990). Higher summative scores on the MSPSS represent greater levels of support from friends, family, and significant others. The MSPSS was used for descriptive purpose across time points to asses caregiver level of support from family, friends, and significant others.

The *Services for Children and Adolescents-Parent Interview* (*SCAPI*; Jensen et al., 2004) is a structured parent interview of health service utilization that has demonstrated descriptive validity as part of the National Institute of Mental Health Multimodal Treatment Study of Children with ADHD. The SCAPI provides information on the type, number, duration, and intensity of physical and mental health services provided for the child within the past 6 months or since the last time it was administered. The SCAPI was used for descriptive purposes at the post-intervention and 2-month follow-up assessments to assess the use of other services.

Figure 6. Flow of Measures Across Study Time Points



Domains	Screening	Baseline	Post-Intervention	Follow-Up
Behavior	CBCL (Aggressive & Attention Subcales)	CBCL ECBI HTKS	CBCL ECBI HTKS	CBCL ECBI HTKS
Cognitive	WASI or EIWA-III	PPVT-4 WPPSI-IV BRIEF	PPVT-4 WPPSI-IV (WMI) BRIEF	PPVT-4 WPPSI-IV (WMI) BRIEF
Parent		DPICS-III FACES-II PSI-SF	DPICS-III FACES-II PSI-SF	DPICS-III FACES-II PSI-SF
Descriptive		MSPSS SCAPI Demographics	MSPSS SCAPI	MSPSS SCAPI
Acceptability & Satisfaction		TARF-R	TARF-R TAI	

III. DATA ANALYSIS

As a result of the preliminary nature of an open trial and small sample size, the primary aim of the data analytic strategy was to collect data to inform future intervention testing. Data from the clinical measures described above were analyzed with caution to assess preliminary intervention response. Coefficient alpha was calculated for each of the scales and subscales (Table 3). Paired samples *t*-tests were used to assess for any changes in behavior problems during the baseline period (i.e., screening to baseline assessment) on the Aggressive Behavior and Attention Problems syndrome subscales, which was on average 17.9 days (*SD* = 20.4). Additionally, paired samples *t*-tests were used to assess the immediate effect of the intervention on child externalizing and internalizing behaviors, child compliance (as measured using combined caregiver-led play and cleanup observations), cognitive functioning, as well as family factors (i.e., parenting practices, family functioning, and caregiver stress) by comparing scores at baseline with scores at the post-intervention assessment. To assess maintenance of gains, paired samples *t*-tests were conducted comparing scores at baseline with scores at the 2-month follow-up assessment. Given the small sample size, we also used the reliable change index (RCI; Jacobson, Follette, & Revenstorf, 1984) to examine the extent to which changes were clinically significant on measures with a clinical cutoff score, including measures of child externalizing and internalizing behavior problems, as well as child executive functioning and caregiver stress, as has been done in previous pilot work with small samples (e.g., Bagner, Rodríguez, Blake, & Rosa-Olivares, 2013; Chu, Colognori, Weissman, & Bannon, 2009).

Paired samples *t*-tests presented below were conducted utilizing data from intervention completers (*n* = 10). Consideration was given to analyses utilizing the available data from all 15 families by imputing data for intervention dropouts. However, these analyses were not conducted because of the small sample size and large quantity of missing data.

Table 3. Coefficient Alphas for Study Measures

Measure/Scale	Baseline (*n* = 10)	Post-Intervention (*n* = 10)	Follow-up (*n* = 10)
CBCL (P)			
Total Behavior	.87	.94	.92
Externalizing	.84	.88	.81
Attention Problems	.12	.69	.71
Aggressive Behavior	.86	.85	.75
Internalizing	.76	.86	.67
Withdrawn	.80	.72	.73
Anxious/Depressed	.32	.68	.86
ECBI (P)			
Intensity	.93	.96	.89
Problem	.86	.80	.90
WPPSI-IV[a] (O)	.78	.86	.88
BRIEF (P)			
GEC	.93	.96	.95
FACES-II (P)			
Cohesion	.70	.89	.83
Adaptability	.83	.90	.86
PSI-SF (P)			
Total Stress	.78	.89	.92
Parental Distress	.38	.82	.92
Parent-Child Dysf.	.90	.89	.93
Difficult Child	.71	.80	.79

Note. CBCL = Child Behavior Checklist; ECBI = Eyberg Child Behavior Inventory; WPPSI-IV = Wechsler Preschool and Primary Scale of Intelligence, Fourth Edition; BRIEF = Behavior Rating Inventory of Executive Functioning; GEC = Global Executive Composite; FACES-II = Family Adaptability and Cohesion Evaluation Scale; PSI-SF = Parenting Stress Index-Short Form; Parent-Child Dysf. = Parent-Child Dysfunctional Interaction; O observational measure, P Parent report measure.

[a] Only the Working Memory Index WPPSI-IV was administered across time points. Due to cognitive impairments that preceded the injury, one of the participants did not complete the WPPSI-IV. Therefore, the WPPSI-IV was administered to 9 participants. At 2-month follow-up, an additional participant did not complete the WPPSI-IV due to relocation. Therefore, the WPPSI-IV was administered to 8 participants.

IV. RESULTS

Outliers and Missing Data

Prior to analysis, the data were evaluated for univariate outliers by converting study variables to standard scores for each participant. An outlier was defined as any participant having a standard score greater than the absolute value of 2.5 as recommended by Selst and Jolicoeur (1994). No outliers were evident using this criterion.

Behavior Problems, Self-Regulation, and Compliance

Table 4 presents the means, standard deviations, and effect sizes for child behavioral outcomes at the baseline, post-intervention, and 2-month follow-up assessments for the 10 families that completed the intervention and all assessments.

Change in behavior problems prior to the intervention. Paired samples *t*-tests revealed no statistically significant changes in child behavior on the Aggressive Behavior, $t(9) = 1.05$ $p = .32$, or Attention Problems, $t(9) = 1.06$, $p = .32$ syndrome subscales from screening to baseline.

Post-intervention versus baseline. Paired sample *t*-tests revealed statistically significant decreases on the CBCL Total Problems scale, $t(9) = 8.46$, $p = < .001$. Decreases from baseline to post-intervention were also statistically significantly on the CBCL Externalizing scale, $t(9) = 5.21$, $p = .001$, especially the Aggressive Behavior, $t(9) = 5.58$, $p < .001$, and Attention Problems, $t(9) = 3.05$, $p = .01$, syndrome subscales. In addition, paired samples *t*-tests revealed statistically significant decreases on the CBCL Internalizing scale, $t(9) = 6.43$, $p < .001$, especially on the Anxious/Depressed, $t(9) = 4.04$, $p =.003$, and Withdrawn, $t(9) = 4.33$, $p = .002$, syndrome subscales.

On the ECBI Intensity and Problem scales, paired sample *t*-tests revealed decreases in the frequency of disruptive behaviors, *t*(9) = 6.15, *p* < .001, and the extent to which parents find the disruptive behaviors problematic, *t*(9) = 5.98, *p* < .001. However, comparisons of a child measure of self-regulation skills (i.e., HTKS) at baseline to post-intervention was not statistically significant, *t(*8) = 1.44, *p* = .19. In terms of child compliance to caregiver commands during combined caregiver-led play and cleanup observations, scores from baseline to post-intervention revealed a significant increase in Alpha compliance, *t*(9) = 6.12, *p* < .001.

Two-month follow-up versus baseline. On the CBCL, paired samples *t*-tests revealed statistically significant decreases on the CBCL Total Problems broadband scale, *t*(9) = 8.34, *p* < .001. In addition, paired samples *t*-tests revealed statistically significant decreases on the Externalizing scale, *t*(9) = 7.91, *p* < .001, especially on the Aggressive Behavior syndrome subscale, *t*(9) = 8.23, *p* < .001, but not for the Attention Problems syndrome subscale, *t*(9) = 1.43, *p* = .19. Statistically significant decreases were also evident on the Internalizing scale, *t*(9) = 5.44, *p* < .001, especially on the Anxious/Depressed, *t*(9) = 3.80, *p* = .004, and Withdrawn, *t*(9) = 4.21, *p* = .002, syndrome subscales.

Paired samples *t*-tests also revealed statistically significant decreases on the ECBI Intensity, *t*(9) = 5.69, *p* < .001 and Problem, *t*(9) = 5.90, *p* < .001 scales. However, statistically significant changes were not evident on the HTKS task at the 2-month follow-up, *t*(7) = 2.26, *p* = .06. For child compliance to caregiver commands during combined caregiver-led play and cleanup observations, paired samples *t*-tests revealed a significant increase in Alpha compliance, *t*(8) = 5.00, *p* = .001.

Table 4. Child Behavioral Outcomes Between Assessment Time Points

	Baseline (*n* = 10)	Post-Intervention vs. Baseline (*n* = 10)	*d*	Follow-up vs. Baseline (*n* = 10)	*d*
Measure/Scale	*M (SD)*	*M (SD)*		*M (SD)*	
CBCL (P)					
Total Behavior	65.0 (14.74)	27.2 (19.79)***	2.2	26.0 (14.56)***	2.7
Externalizing	25.2 (6.14)	10.7 (7.33)**	2.1	8.2 (5.01)***	3.0
Aggressive Behavior	20.0 (5.25)	8.0 (5.66)***	2.2	6.1 (3.60)***	3.1
Attention Problems	5.2 (1.75)	3.3 (1.95)*	1.0	3.9 (3.18)	0.5
Internalizing	17.2 (7.67)	6.4 (7.01)***	1.5	6.5 (4.55)***	1.7
Anxious/ Depressed	4.6 (1.96)	1.5 (2.07)**	1.5	1.6 (.97)**	1.9
Withdrawn	4.0 (3.09)	1.2 (2.20)**	1.0	1.4 (1.96)**	1.0
ECBI (P)					
Intensity	122.9 (36.86)	58.8 (23.02)***	2.1	62.3 (22.13)***	2.0
Problem	16.6 (7.99)	2.1 (2.38)***	2.5	1.2 (2.39)***	2.6
HTKS[a] (O)	15.2 (15.20)	21.6 (24.15)	0.3	25.1 (26.07)	0.5
Alpha Compliance[b] (O)	.42 (.15)	.65 (.18)***	1.4	.69 (.19)**	1.6

Note. **p* < .05; ***p* < .01; ****p* < .001; *d* = Cohen's effect size; CBCL = Child Behavior Checklist; ECBI = Eyberg Child Behavior Inventory; O observational measure, P Parent report measure

[a] Due to cognitive impairments that preceded the injury, one of the participants did not complete the HTKS task. Therefore, the HTKS task was administered to 9 participants at baseline and post-intervention. At 2-month follow-up, an additional participant did not complete the HTKS task due to relocation. Therefore, the HTKS task was administered to 8 participants.

[b] At 2-month follow-up, one family did not complete the DPICS due to relocation. Therefore, Alpha Compliance was reported for 9 participants.

Child Cognitive Functioning

Table 5 presents the means, standard deviations, and effect sizes for child cognitive outcomes at the baseline, post-intervention, and 2-month follow-up assessments for the 10 families that completed the intervention and all assessments.

Post-intervention versus baseline. Paired samples *t*-tests revealed statistically significant increases between baseline and post-intervention assessments on the WPPSI-IV working memory index, $t(8) = 4.97, p = .001$. Similarly, comparison of receptive language on the PPVT-4 between baseline to post-intervention revealed a statistically significant increase in scores, $t(8) = 4.46, p = .002$. Caregiver-report of executive function on the BRIEF also revealed statistically significant increases following the intervention on the GEC, $t(9) = 6.16$ $p < .001$.

Two-month follow-up versus baseline. Paired samples *t*-tests revealed statistically significant increases in working memory, as measured by the WPPSI-IV working memory index, $t(7) = 3.92, p = .006$. Comparison of receptive language on the PPVT-4 at baseline to 2-month follow-up revealed a statistically significant increase in scores over time, $t(7) = 3.46, p = .01$. Paired samples *t*-tests also revealed statistically significant increases at the 2-month follow-up assessment on the Global Executive Functioning scale, $t(9) = 3.69$ $p = .005$.

Table 5. Child Cognitive Outcomes Between Assessment Time Points

	Baseline (*n* = 10)	Post-Intervention vs. Baseline (*n* = 10)	*d*	Follow-up vs. Baseline (*n* = 10)	*d*
Measure/Scale	*M (SD)*	*M (SD)*		*M (SD)*	
WPPSI-IV [a] (O)	96.56 (17.05)	111.33 (18.57)**	0.8	112.38 (16.37)**	0.9
PPVT-IV[a] (O)	55.11 (32.05)	71.00 (35.55)**	0.5	73.50 (39.39)*	0.5
BRIEF (P)					
GEC	117.90 (20.55)	87.80 (17.27)***	1.6	83.64 (28.06)**	1.4

Note. **p* < .05; ***p* < .01; ****p* < .001; *d* = Cohen's effect size; WPPSI-IV = Wechsler Preschool and Primary Scale of Intelligence, Fourth Edition; PPVT-4 = Peabody Picture Vocabulary Test, Fourth Edition; HTKS = Head-Toes-Knees-Shoulders Task; BRIEF = Behavior Rating Inventory of Executive Functioning; GEC = Global Executive Composite; O observational measure, P Parent report measure.

[a] Only the Working Memory Index WPPSI-IV was administered across time points. Due to cognitive impairments that preceded the injury, one of the participants did not complete the WPPSI-IV and PPVT-4. Therefore, the WPPSI-IV and PPVT-4 were administered to 9 participants. At 2-month follow-up, an additional participant did not complete the WPPSI-IV and PPVT-4 due to relocation. Therefore, the WPPSI-IV and PPVT-4 were administered to 8 participants

Family Functioning

Table 6 presents the means, standard deviations, and effect sizes for family outcomes at the baseline, post-intervention, and 2-month follow-up assessments for the families that completed the intervention and all assessments.

Post-intervention versus baseline. Paired samples *t*-tests revealed a significant increase in the proportion of do skills, $t(9) = 3.10$, $p = .01$, and a significant decrease in don’t skills , $t(9) = 5.35$ $p < .001$, following the intervention. Comparisons on a measure of family functioning (i.e., FACES-II) at baseline to post-intervention was not statistically significant for family cohesion, $t(9) = 1.05$, $p = .32$, or family adaptability, $t(9) = 1.03$, $p = .33$. However, caregiver reported stress, as measured on the PSI-SF, revealed significant decreases from baseline to post-intervention on the Total Stress, $t(9) = 3.18$, $p = .01$ scale, especially on the Parent-Child Dysfunctional Interaction, $t(9) = 2.64$, $p = .03$ and Difficult Child, $t(9) = 3.38$, $p = .008$ subscales. However, changes from baseline to post-intervention on the PSI-SF Parental Distress subscale were not statistically significant, $t(9) = 1.79$, $p = .11$.

Two-month follow-up versus baseline. Paired samples *t*-tests revealed a significant increase in do skills, $t(8) = 2.26$, $p = .05$, and a significant decrease in don’t skills, $t(8) = 3.24$ $p = .01$, from baseline to the 2-month follow-up. Changes on a measure of family functioning (i.e., FACES-II) at baseline to 2-month follow-up was not statistically significant for family adaptability, $t(9) = 1.03$, $p = .33$, or family cohesion, $t(9) = 1.99$, $p = .08$. In addition, caregiver stress scores significantly decreased from baseline to the 2-month follow-up on the Total Stress, $t(9) = 2.92$, $p = .02$, scale, especially on the Difficult Child, $t(9) = 3.81$, $p = .004$, subscale. However, statistically significant changes from baseline to 2-month follow-up were not found on the Parental Distress, $t(9) = 0.99$, $p = .35$, and the Parent-Child Dysfunctional Interaction, $t(9) = 1.98$, $p = .08$, subscales.

Table 6. Family Outcomes Between Assessment Time Points

	Baseline (*n* = 10)	Post-Intervention vs. Baseline (*n* = 10)	*d*	Follow-up vs. Baseline (*n* = 10)	*d*
Measure/Scale	*M (SD)*	*M (SD)*		*M (SD)*	
Proportion of Do Skills (O)	.10 (.09)	.29 (.16)*	1.5	.20 (.11)*	1.0
Proportion of Don't Skills (O)	.66 (.12)	.42 (.20)***	1.5	.45 (.13)*	1.7
FACES-II (P)					
Cohesion	46.70 (7.53)	50.40 (13.55)	0.3	50.33 (10.47)	0.4
Adaptability	39.40 (9.78)	42.30 (13.41)	0.2	41.67 (10.09)	0.2
PSI-SF (P)					
Total Stress	85.10 (13.98)	64.30 (13.95)*	1.5	66 (17.33)*	1.2
Parental Distress	28.40 (4.95)	23.20 (6.94)	0.9	25.10 (9)	0.5
Parent-Child Dysf.	21.70 (8.51)	16.40 (4.33)*	0.8	18.70 (6.72)	0.4
Difficult Child	35 (6.11)	24.70 (7.15)**	1.5	22.20 (6.63)**	2.0

Note. *p<.05; **p<.01; ***p<.001; *d* = Cohen's effect size; FACES-II = Family Adaptability and Cohesion Evaluation Scale; PSI-SF = Parenting Stress Index-Short Form; Parent-Child Dysf. = Parent-Child Dysfunctional Interaction; O observational measure, P Parent report measure.

[b] At 2-month follow-up, one family did not complete the DPICS due to relocation. Therefore, the proportions of Do Skills and Don't Skills were reported for 9 participants.

Intervention Feasibility

Ten of the 14 families that completed the baseline assessment (71%) completed the intervention in an average of 6 weeks (*SD* = 1.8). Parents were moderately compliant with practicing the parenting skills daily during a child-led and caregiver-led play for homework (completed on average 52% of homework weekly). Of note, families rescheduled or cancelled an average of two sessions over the course of the intervention, and no family ever no-showed for an appointment (i.e., did not come to an appointment without cancelling in advance).

Intervention Satisfaction and Acceptability

Intervention families (n = 10) reported high levels of satisfaction with the intervention on the TAI with a mean score of 48 (*SD* = 2.85) out of a possible 50 (range from 42 to 50). To assess change in intervention acceptability, a paired samples *t*-test was conducted comparing TARF-R scores at baseline with scores at post-intervention and revealed a significantly higher score at post-intervention than at baseline, $t(9) = 3.63$ $p = .009$. Families were also informally asked to provide feedback regarding their experiences with the intervention during the post-assessment. Families provided some of the following statements: “We don’t know how to show our gratitude for all that you have done for our family;” “We love spending special time together [with my child];” “I love that he actually listens to me;” “I thought medication was our only option, but we didn’t feel ready - this program changed our lives;” “I never thought I could do this on my own and now I feel so confident as a mom;” “We are so thankful for this program - it changed our family;” “[child’s name] loved the program and I love how well she behaves now;” “…even his teacher has made comments about how great his behavior is now;”

and "I would recommend this program to every family who feels like they don't know what to do or how to handle such a scary experience, and how to help your kid get through it." No families reported any negative experiences with the intervention.

Clinical Significance

The RCI was used to assess individual clinically significant changes in individual child and caregiver measures with established cutoff scores (i.e., CBCL, ECBI, BRIEF, and PSI-SF). We applied the Jacobson, Roberts, Berns, and McGlinchey (1999) criteria, which required that (a) the magnitude of change from baseline to post-intervention and from baseline to follow-up be statistically reliable and (b) the post-intervention and follow-up scores fall within the normal range. For criteria a, the RCI was calculated by dividing the magnitude of change between baseline and post-intervention (and baseline and follow-up) scores by the standard error of the difference score. Specifically, the RCI= $\frac{\mathrm{x1-x2}}{\mathrm{Sdiff}}$, where x1 is the baseline score, x2 is the post-intervention score, and Sdiff is the standard error (SE) of difference between the two scores (i.e., $\sqrt{2(SE)^2}$, where SE = $s1\sqrt{1-r_{XX}}$ and s1 is the standard deviation of the normal population and $r_{xx}$is the reliability of the measure. RCIs greater than 1.96 represent a reliable change at α = .05 (Jacobson et al., 1999). For criteria b, scores needed to be at or above a T-score of 60 at the baseline assessment and below 60 at the post-intervention and 2-month follow-up assessments on the CBCL, ECBI, and BRIEF. A T-score of 60 is consistent with our screening criteria and also considered the cutoff for the borderline clinical range on most measures used, with the exception of the syndrome subscales on the CBCL (i.e., Anxious/Depressed, Withdrawn, Attention Problems, and Aggressive Behavior), where a

T-score of 65 is considered in the borderline clinical range. However, research supports the use of a T-score cutoff of 60 to represent elevated behavior problems given data to suggest that a higher cutoff may be too stringent (Petty et al., 2008). A T-score of 85 was used as the cutoff for the PSI-SF. Normative and reliability data for criteria a were from the standardization samples for the CBCL (Achenbach & Rescorla, 2000), BRIEF (Gioia et al., 2003), and ECBI (Eyberg & Pincus, 1999).

On the CBCL, as shown in Table 7, 8 children (80%) made clinically significant changes on the broadband Total Problems scale. Seven children (70%) demonstrated clinically significant changes from baseline to post-intervention on the broadband Externalizing scale and the Aggressive Behavior subscale, and 50% of children demonstrated clinically significant changes on the Attention Problems subscale. Five children (50%) made clinically significant changes from baseline to post-intervention on the CBCL broadband Internalizing scale, and the following percentage of children made clinically significant changes on the associated syndrome subscales: 60% on the Withdrawn and 20% on the Anxious/Depressed. Using the same criteria for the families that completed the 2-month follow-up assessment, 8 children (80%) made clinically significant changes on the broad Total Problems scale, Externalizing scale, and Aggressive Behavior subscale, and 50% on the Attention Problems subscale. Six children (60%) made clinically significant changes from baseline to follow-up on the CBCL broadband Internalizing scale, and the following percentage of children made clinically significant changes on the associated syndrome subscales: 50% on the Withdrawn and 20% on the Anxious/Depressed.

On the ECBI, 4 children (40%) made clinically significant changes from baseline to post-intervention on the Intensity scale and 60% on the Problem scale. On the BRIEF, 5 children (50%) demonstrated clinically significant changes from baseline to post-intervention on the GEC. At 2-month follow-up, 4 children (40%) made clinically significant changes from baseline to follow-up on the ECBI Intensity scale and 60% on the Problem scale. On the BRIEF, 6 children (60%) made clinically significant changes from baseline to follow-up on the GEC.

On the PSI-SF, 4 caregivers (40%) demonstrated clinically significant changes from baseline to post-intervention on the PSI-SF Total Stress scale, and the following percentage of caregivers demonstrated clinically significant changes on the associated subscales: 50% on the Difficult Child, 40% on the Parental Distress, and 20% on the Parent-Child Dysfunctional Interaction. At 2-month follow-up, 4 caregivers (40%) made clinically significant changes from baseline to follow-up on the PSI-SF Total Stress scale, and the following percentage of caregivers made clinically significant changes on the associated subscales: 60% on the Difficult Child, 40% on the Parental Distress, and 10% on the Parent-Child Dysfunctional Interaction.

When examining the trend in clinically significant change across families, most children whose caregivers reported clinically significant improvements at the post-intervention assessment also indicated clinically significant improvements at the 2-month follow-up, with the exception of the CBCL Withdrawn subscale and the PSI subscales. Notably, a greater number of families demonstrated significant change from baseline to post-intervention and 2-month follow-up across measures using reliable change (criteria a), as opposed to clinically significant change (criteria b). Rates using criteria b were likely lower than rates using criteria a because of the use of a lower cutoff value (at or above a T-score of 60). This was the case for a subset of the sample (ranging from 1 to 2 cases), where clinically significant change was not seen at post-intervention. However, at 2-month follow-up most of these families demonstrated clinically significant improvements with scores below the cutoff, with the exception of one case (although not the same case across measures) with scores above the cutoff on the CBCL (i.e., Total Behavior, Internalizing, Withdrawn, and Attention Problems scales/subscale), BRIEF GEC, and PSI Parental Distress subscale.

Table 7. Number of Families showing Clinically Significant Change

	Reliable Change Post[a]		Clinically Significant Change Post[b]		Reliable Change F/U[a]		Clinically Significant Change F/U[b]	
Measure	No.	%	No.	%	No.	%	No.	%
CBCL (P)								
Total Behavior	10	100	8	80	10	100	8	80
Externalizing	9	90	7	70	10	100	8	80
Aggressive Behavior	9	90	7	70	10	100	8	80
Attention Problems	3	30	5	50	4	40	5	50
Internalizing	8	80	5	50	8	80	6	60
Anxious/Depressed	5	50	2	20	6	60	2	20
Withdrawn	8	80	6	60	8	80	5	50
ECBI Intensity (P)								
Intensity	9	90	4	40	9	90	4	40
Problem	10	100	6	60	10	100	6	60
BRIEF (P)								
GEF	10	100	5	50	8	80	6	60
PSI-SF (P)								
Total Stress	7	70	4	40	5	50	4	40
Parental Distress	4	40	4	40	3	30	4	40
Parent-Child Dysf.	4	40	2	20	4	40	1	10
Difficult Child	6	60	5	50	8	80	6	60

Note. F/U = Follow-Up; No. = Number; CBCL = Child Behavior Checklist; ECBI = Eyberg Child Behavior Inventory; WPPSI-IV = Wechsler Preschool and Primary Scale of Intelligence, Fourth Edition; PPVT-4 = Peabody Picture Vocabulary Test, Fourth Edition; BRIEF = Behavior Rating Inventory of Executive Functioning; GEC = Global Executive Composite; PSI-SF = Parenting Stress Index-Short Form; Parent-Child Dysf. = Parent-Child Dysfunctional Interaction; O observational measure, P Parent report measure.

[a] The reliable change index (RCI) was used to determine whether the magnitude of change exceeded the margin of measurement error. RCIs greater than 1.96 were considered sufficient in magnitude.

[b] A child was determined to have made a clinically significant change if the child's score was in the borderline clinically significant range at pretreatment and the normal range at posttreatment and follow-up, and the change in the child's score was statistically reliable as defined using the RCI.

V. DISCUSSION

Summary of the Current Work

The current study examined the initial outcome, feasibility, acceptability, and satisfaction of a time-limited and intensive format of PCIT in improving externalizing and internalizing behavior problems, working memory, receptive language skills, and executive functioning in young children with TBI and clinically elevated levels of externalizing behavior problems. The current study also included an examination of the effects of the intervention on parenting skills, caregiver stress, and family functioning. Overall, findings suggest that families of young children with TBI may benefit from a brief and intensive format of PCIT designed to improve common deficits following TBI.

Recruitment findings suggest moderate response rates to telephone recruitment strategies for identifying families at highest risk for negative post-injury outcomes, highlighting a time-efficient and potentially cost-effective strategy for identification of young children with clinically elevated behavior problems post-injury. Consistent with studies documenting high rates of behavioral difficulties in young children with TBI (Chapman et al., 2010), recruitment efforts for the current study suggested high rates of behavior problems (73% reported clinically elevated behavior problems) and moderate to high interest (60% participate in screening) in participating in the current study to address these difficulties. Notably, scores at baseline were generally in the borderline clinically significant range for measures assessing behavioral and cognitive functioning, and as expected for this young age range, parents reported more problems in externalizing domains than internalizing domains.

Contrary to expectations, families demonstrated mediocre homework completion (52%). However, they demonstrated high intervention completion rates (71%) consistent with, and in some cases higher than, other PCIT studies (e.g., Antonini et al., 2012; Boggs et al., 2005; Schuhmann et al., 1998; Werba & Eyberg, 2006). Moreover, completion rates for the current study fare well relative to other evidenced-based parent training programs with attrition rates approaching 50% (Reyno & McGrath, 2006), and family-focused TBI interventions with attrition rates between 56% and 76% (Antonini et al., 2014, 2012). Notably, caregivers who dropped out of the intervention endorsed multiple psychosocial stressors during the time they were enrolled in the study, which may have contributed to their inability to complete the intervention. Nonetheless, the fact that the retention rate for the current intervention, which was delivered twice per week, was similar and in some cases better than previously documented rates for weekly in-person and web-based interventions (Antonini et al., 2012; Boggs et al., 2005; Schuhmann et al., 1998; Werba et al., 2006), provides preliminary evidence regarding the feasibility of this time-limited and intensive approach to intervention. Notably, two families relied primarily on public and medical transportation during the study and still completed the intervention in spite of significant transportation barriers. However, accommodations were made for these families by providing in-home services when transportation was not available. Further, documented evidence of the low number of cancellations and no-shows, as well as no loss to follow-up, further highlights the feasibility and acceptability of the intervention.

Consistent with hypotheses, post-intervention scores on measures of intervention satisfaction and acceptability, as well as information obtained through informal feedback with caregivers, suggested that caregivers were highly satisfied with the intervention. Similarity, caregivers reported significantly higher intervention acceptability scores following the intervention. In other words, the increase in caregivers' acceptability from baseline to post-intervention suggests the intervention exceeded their initial perceptions.

The current study replicated and extended previous TBI intervention work by examining changes in child behavior problems following intervention for children identified as having clinically elevated levels of externalizing behavior problems. Study results revealed no statistically significant differences between the screening and the baseline assessment, which suggest that aggressive and inattentive symptoms were stable for approximately 2.5 weeks prior to the intervention. Significant changes were observed from baseline to post-intervention on most behavioral measures. Findings were consistent with the hypothesis, showing lower rates of overall externalizing and internalizing behavior problems. Consistent with caregiver-reported changes in child behavior following the intervention, children were also observed to be significantly more compliant from baseline to post-intervention. Moreover, significant improvements across most areas of child behavioral functioning were maintained at the 2-month follow-up assessment, with the exception of the Attention Problems syndrome subscale on the CBCL. On average attention problems remained relatively stable at 2-month follow-up compared to post-intervention. Given the low levels of attention problems reported by caregivers at baseline and the study's open trial methodology, it is possible that the study's small size limited power to detect effects. Future studies should examine multiple domains of attention (e.g., sustained, divided, auditory, visual) with an increased sample size, as it may yield results that the current study may have been unable to detect, such as the direct effect of the intervention on attention problems.

In addition to statistically significant changes, most of the children demonstrated clinically significant and reliable changes on the externalizing scales on the CBCL. However, about half of the children demonstrated clinically significant change on the ECBI and internalizing scales on the CBCL. These rates of clinically significant change were somewhat lower than anticipated, but may be attributable to the use of a lower cutoff score. This finding also is consistent with literature that suggests low sensitivity to the behavioral sequelae of pediatric TBI (Kinsella et al., 1995; Knights et al., 1991). In fact, two studies found that structured interviews identified more post-TBI behavior problems than parent ratings (Bloom et al., 2001; Green, Foster, Morris, Muir, & Morris, 1998). More importantly, most scales showing less clinically significant change were not scales targeted specifically in PCIT, including internalizing scales (with the exception of the ECBI).

While gains on most behavioral measures were demonstrated following the intervention and maintained at the 2-month follow-up, improvements were not found for child self-regulation skills following the intervention. It is possible that the lack of significant effects immediately following the intervention and at the 2-month follow-up may be related to a delayed effect of the intervention on child self-regulation skills. Given that the primary target of the intervention was to improve child behavior, it is possible that changes in child self-regulation occurred following more immediate changes in behavior. A study by Lewis and colleagues (2008) produced similar findings by examining changes in cortical activation in regions thought to underlie self-regulation skills (i.e., ventral regions of the prefrontal cortex and dorsal anterior cingulate cortex) following a behavioral intervention. Findings revealed that children who improved clinically in terms of externalizing behaviors demonstrated less ventral (but not dorsal) activation during an inhibitory control task administered at the post-intervention assessment (approximately 14 weeks following the baseline assessment) than those that did not improve following the intervention. It is also possible that the small sample size limited power to detect a significant effect on the measure used to assess child self-regulation. Taken together, research suggests behavioral interventions may lead to positive changes in regulatory processes. The current study was an important first step in examining the effect of a behavioral parenting intervention on child self-regulation skills following TBI in early childhood and warrants further examination.

In terms of child cognitive functioning, post-intervention results suggested improvements in working memory on the WPPSI-IV and receptive language skills on the PPVT-4. Caregiver-report of executive function also revealed improvements in executive ability on the BRIEF. However, about half of the children demonstrated clinically significant change on the BRIEF, although most demonstrated reliable change. Furthermore, improvements across all areas of child cognitive functioning were maintained at the 2-month follow-up assessment. To our knowledge, the current study is the first to explore the effects of a family-focused intervention targeting child behavior problems on child working memory and receptive language skills with children with TBI. In terms of language skills, TBI can have negative effects on child language development and functioning (Catroppa & Anderson, 2004). However, behavioral difficulties among children with TBI may also exacerbate difficulties with language, in turn impeding interventions targeting language deficits. Findings suggest that an intensive format of PCIT may be effective at improving receptive language skills. Specifically, the use of positive child-directed parenting skills, which have been noted to be similar to procedures used in speech-language interventions, are thought to have a positive impact and represent a mechanism of change for child language outcomes (Garcia, Bagner, et al., 2014). Although child expressive language skills were not formally assessed in the current study, previous studies examining the effect of PCIT on child and infant language production suggest promising findings (Bagner et al., 2016; Garcia & Bagner, 2014).

Lastly, findings indicated that participation in a time-limited and intensive format of PCIT may also lead to improvements in observed parenting practices and caregiver-reported stress. As expected, following the intervention and at the 2-month follow-up, caregivers utilized higher percentages of positive parenting strategies (i.e., do skills) and decreased negative and directive parenting practices (i.e., don't skills) during combined warmup and child-led play. These findings suggest that the intervention was effective at producing lasting change in parenting skills. However, contrary to hypotheses, caregiver stress did not improve across all of the domains assessed on the PSI-SF. Specifically, lower rates of caregiver-reported stress were found for the Parent-Child Dysfunctional Interaction, Difficult Child, and Total Stress scales immediately following the intervention, and for the Difficult Child and Total Stress scales at 2-month follow-up. Significant improvements on the Difficult Child subscale across time points strengthens the above-mentioned behavioral findings, and suggests that the intervention may be effective at reducing both child behavior problems and caregiver stress associated with difficult child behavior over time. While it is possible that changes in caregiver-reported stress associated with difficult child behavior were related to changes in caregiver perceptions of child behavior (as opposed to actual improvements in behavior), objective measures of child behavior (e.g., DPICS-III) also correspond with caregiver-report and strengthen study findings. However, improvements were not found on the Parental Distress subscale across time points, which suggest that the intervention may not be effective at decreasing general stress unrelated to the child. Further, changes in stress associated with the caregiver-child interaction (i.e., Parent-Child Dysfunctional Interaction subscale) were no longer significant at the 2-month follow-up. One possible explanation is the relatively low level of stress reported on this subscale at baseline, with less than half of the caregivers reporting scores above the clinical cut-off. It is also possible that other psychological factors, such as depressive symptoms and negative affectivity, which were not assessed in the current study, played a role in the caregivers' perceptions of the caregiver-child relationship. Nonetheless, findings suggest that participation in the intervention may contribute to reductions in overall caregiver stress, and particularly stress associated with difficult child behavior. These findings are noteworthy given the elevated levels of caregiver stress and burden following TBI in young children (Wade et al., 2002), and highlight the importance of examining other domains of caregiver distress in future research.

Similar non-significant findings were found with respect to the level of family cohesion and adaptability at post-intervention and 2-month follow-up. As noted above, it is possible that stress unrelated to child behavior may have affected caregivers' perceptions of family cohesion and adaptability. Research also has shown that lower caregiver distress and better social support have been associated with increased family cohesion (Youngblut & Brooten, 2006). Given that the level of caregiver-reported social support was within normal limits across time points, it is possible that caregiver psychological functioning may have contributed to non-significant findings for the level of family cohesion and adaptability.

To date, few studies have examined family-focused interventions for young children with TBI. Case studies and studies conducted by Wade and colleagues have provided a framework by which to target some of the common negative outcomes seen following TBI in young children. They also have highlighted some of the challenges (e.g., lack of long-term behavioral change, poor intervention adherence) to implementation and concerns about whether standard PCIT and/or PCIT-based programs (e.g., I-InTERACT) are sufficient to meet the needs of this population and lead to long-term changes in behavior, particularly for high-risk children, such as those with clinically elevated behavior problems and those from ethnic and racial minority backgrounds.

Given the current state of the TBI intervention literature, the current study aimed to expand on existing intervention work targeting TBI sequela in young children. To our knowledge, this is the first study to examine the use of a brief and intensive format of PCIT to address the behavioral, cognitive, and family changes secondary to a TBI in early childhood. Significant improvements in child behavioral and cognitive functioning, as well as in observed parenting practices and caregiver-reported total stress in this sample add to the existing literature by providing preliminary evidence that a brief and more intensive format of PCIT may be an effective approach to target deficits known to persist among children with TBI. Further, study findings supported the notion that family factors (e.g., parenting) play an important role in child post-injury functioning, highlighting the need not only to treat behavioral and cognitive problems arising after TBI, but also to target key moderating factors, such as parenting practices and stress.

Study Limitations

The current study has some limitations, and it is important to interpret the results in light of these limitations. First, the sample size was relatively small ($n = 10$), which in turn limits power to detect effects. Despite limited power, significant effects were found across multiple domains of functioning, providing preliminary evidence that a brief and intensive format of PCIT can be effective at improving child behavioral and cognitive functioning, as well as parenting skills and caregiver stress. Additionally, the small sample size limits the extent to which other questions could be tested to elaborate on intervention effects (e.g., mediating and moderating effects) and decreases generalizability of the findings. Second, the lack of a control group limits the ability to make inferences about changes in functioning beyond what is expected following a TBI and changes may represent a regression to the mean. It is possible that changes in child and family variables may be attributable to post-injury recovery rather than intervention effects. However, given research to support higher levels of persistent symptoms among children who are younger at the time of injury and across extended follow-up assessments (Karver et al., 2012), it is unlikely that symptoms would have resolved naturally for participants in the current study given clinically elevated symptoms following the post-acute recovery phase. A randomized controlled trial comparing this brief and intensive format of PCIT to a control group and standard PCIT would provide further confidence in these findings and would allow for adaptations in intervention length based on the needs of the family and/or service provider.

Third, injury severity scores were not obtained for the entire sample (for descriptive purposes), as study inclusion criteria only required documented evidence of a TBI. As such, criteria were created on the basis of previous studies to support the classification of mild to severe injuries based on post-injury symptoms and imaging findings. The sample in the current study consisted of children with primarily mild injuries. Although this limits generalizability to children with more severe injuries, mild TBI is a relatively unexplored area, particularly in intervention research. This study is an important first step in examining changes in behavioral and cognitive outcomes for children with mild TBI following intensive intervention. Further research is needed to replicate and expand these findings to examine generalizability to children with diverse patterns of cognitive and behavioral functioning. Fourth, the sample was predominantly Hispanic, although it was diverse with regard to family income and caregiver education. Despite limitations with regard to generalizability, findings contribute to the existing literature as Hispanic children are often understudied in TBI research (Jimenez et al., 2013), as well as child intervention research (La Greca, Silverman, & Lochman, 2009).

Fifth, data were only collected from the primary caregiver, which differed for some cases. Thus, future research should examine the difference across multiple informants, including secondary caregivers and teachers. Sixth, as noted previously, only receptive language skills were formally assessed. Although expressive language skills were not examined, current results provide preliminary support for the use of PCIT to help foster language skills for young children with TBI. Future studies should examine both expressive and receptive language in order to thoroughly evaluate intervention effects on language outcomes. Seventh, the sample was homogeneous with regard to type of injury (non-abusive TBI) and time since injury (3 to 6 months). As such, generalizability to children with varying injury characteristics and/or time since injury may be limited. Eighth, follow-up assessments were only completed 2-months following the intervention (twice as long as the intervention). Thus, it is unclear whether intervention effects will continue to maintain over time. However, relative to other intervention studies for children with TBI that only reported post-intervention data (Antonini et al., 2014, 2012; Cohen et al., 2012), the current study provides preliminary support for maintenance of intervention gains. Lastly, the current study was primarily conducted in a university-based clinic setting, with home-based intervention delivery for two families. Although a recent study provided support for the use of home-based parent-training for families of infants with elevated behavior problems (Bagner et al., 2015), it is possible that there are differences related to the method of intervention delivery. In addition, future research should examine the feasibility of disseminating such services in specialized clinics and centralized rehabilitation centers.

Despite these limitations, the current study addressed a relatively unexplored research question and provided preliminary findings that have important clinical implications. Findings build on the current intervention literature for early childhood TBI and highlight the importance of taking a family-focused approach that intervenes early prior to the development of more severe and persistent behavior problems. Importantly, improvements over time and in the context of the time-limited nature of the intervention contribute to the literature by demonstrating that positive changes can be made in domains commonly affected by TBI within a brief period of time.

Future Directions

The current work yielded important information on outcome, intervention feasibility, acceptability, and satisfaction. The use of a brief and intensive format of PCIT with families of young children with TBI appears to be a promising approach for reducing post-injury behavior problems and improving working memory skills, receptive language, parenting practices, and caregiver stress, but warrants further examination to document intervention efficacy and sustainability in clinical practice. Additionally, it will be important for future research to examine the ideal dose or level of intensity that would be both therapeutic and feasible for families and service providers, as well as the underlying mechanism(s) of therapeutic change. Shorter and more intensive interventions may be particularly useful for community-based clinicians and providers housed within interdisciplinary teams, who typically provide services for children with TBI on a more frequent and time-limited basis. PCIT can potentially serve as a brief component of pediatric TBI rehabilitation to target common negative consequences following TBI in early childhood.

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APPENDICES

Topical Review: A Review of Negative Behavioral and Cognitive Outcomes Following Traumatic Brain Injury in Early Childhood.

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Topical Review: A Review of Negative Behavioral and Cognitive Outcomes Following Traumatic Brain Injury in Early Childhood

Dainelys Garcia, BA, Gabriela M. Hungerford, BS, and Daniel M. Bagner, PhD

Department of Psychology, Florida International University

All correspondence concerning this article should be addressed to Daniel M. Bagner, PhD, Department of Psychology, Florida International University, 11200 SW 8th Street, AHC I Room 241, Miami, FL 33174, USA. E-mail: dbagner@fiu.edu

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Objective To summarize recent research on negative behavioral and cognitive outcomes following early childhood traumatic brain injury (TBI). **Methods** Topical review of the literature published since the year 2000 examining behavioral and cognitive difficulties following TBI in early childhood. **Results** Research findings from the reviewed studies demonstrate a variety of negative behavioral and cognitive outcomes following TBI in childhood, particularly for children <5 years of age. Negative outcomes include problems with externalizing behaviors, attention, language, and cognitive functioning (e.g., IQ, executive functioning). Furthermore, negative outcomes have been shown to persist up to 16 years following the injury. **Conclusions** The empirical studies reviewed demonstrate the increased risk for negative behavioral and cognitive outcomes following early childhood TBI. Furthermore, the review highlights current strengths and limitations of TBI research with young children and the need for multidisciplinary work examining outcomes for this vulnerable pediatric population.

Key words child behavioral outcomes; child cognitive outcomes; early childhood; traumatic brain injury.

Traumatic brain injury (TBI) is the leading cause of death and disability in children, affecting approximately 2 of every 100 children aged <5 years each year (McKinlay et al., 2008). Recently, the long-term impact of TBI in childhood has received more attention both in research and clinical practice. However, the negative consequences of TBI have been studied less in early childhood, defined herein as children between ages 0 and 5 years (Chapman et al., 2010). Consequently, outcomes, developmental trajectories, and recovery patterns are not yet well established for young children (Anderson et al., 2001), despite the increased vulnerability in early childhood.

Early Childhood TBI Associated With Increased Vulnerability

Rates of TBI are highest among young children aged <5 years primarily due to falls and accidents (Faul, Wald, Xu, & Coronado, 2010). Younger child age at injury predicts poorer postinjury outcomes and a more uncertain and extended course of recovery (Wade, Walz, & Bosques, 2009). For example, research has found that some skill deficits are stable or even worsen over time, while others show a transient lag or partial catch-up, making the extent to which young children recover from TBI unclear (Ewing-Cobbs et al., 2006). Despite the previous view that young children's brains are better able to adapt to the impact of brain injuries, recent research indicates that children aged <5 years are especially vulnerable to long-term deficits (Anderson, Catroppa, Haritou, Morse, & Rosenfeld, 2005). When a TBI occurs, underlying neurodevelopmental processes (e.g., attention, language, visuospatial abilities) may be affected and lead to long-lasting neurocognitive deficits (Stiles, 2000). The greatest percentage of brain maturation occurs from birth through 5 years, and, therefore, the degree of impairment is likely to be highest at this young age when parts of the brain are undergoing peak development.

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In addition to the association between younger age at injury and recovery (Anderson et al., 2005), studies have found that injury severity moderates this relation, such that children who are injured at an earlier age *and* sustain a more severe injury display the most negative long-term deficits (Anderson et al., 2006). Specifically, compared with children with severe injuries after age 5 years, children with severe injuries at earlier ages experience more adverse long-term outcomes (Catroppa, Anderson, Morse, Haritou, & Rosenfeld, 2008), including greater impairments in behavior (Karver et al., 2012), attention (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2005a), language (Ewing-Cobbs et al., 2006), and cognition (Taylor et al., 2008). Additionally, children who were injured between 3 and 7 years and sustained a moderate to severe injury experienced worse long-term academic functioning compared with children injured after 8 years (Catroppa et al., 2009). Thus, researchers have recently started to explore behavioral (i.e., difficult child behaviors that disrupt functioning in home and school settings) and cognitive (i.e., mental processes related to knowledge acquisition and understanding) outcomes following early childhood TBI.

Goals of Review

In light of the increased risk for young children, we conducted a topical review of recent research examining adverse behavioral and cognitive outcomes following TBI in early childhood to provide an overview of the current state of the literature. Owing to the recent focus on early childhood TBI and the advances that have been made in the past decade, this review includes research studies published since the year 2000, which are summarized in Table I. We included studies based on the following inclusion criteria: (1) sample included children injured between ages 0 and 5 years, (2) outcomes included measures of behavioral and cognitive functioning, and (3) publication date was between the years of 2000 and 2014. We conducted the literature review using *PubMed*, PsycINFO, and MEDLINE and included the following key words: traumatic brain injury, TBI, brain injury, head injury, pediatric or paediatric, children, early childhood, behavior, behavioral difficulties or problems, cognitive, and cognitive difficulties or problems. The searches also included key words for specific behavioral and cognitive problems, such as ADHD, externalizing, intelligence, and executive functioning. In addition, we highlight areas ripe for future research efforts, as well as implications of the current literature for clinical practice.

Negative Behavioral Outcomes and Early Childhood TBI

Externalizing behavior problems are the most common and persistent negative outcome following early childhood TBI (Catroppa et al., 2008). To date, most research studies have revealed long-term negative behavioral outcomes in children aged 3–7 years, including increased externalizing behavior problems persisting as long as 5 years following the injury (Catroppa et al., 2008). Following TBI, as many as 47% of preschool-age children display elevated levels of externalizing behavior problems (Chapman et al., 2010), and approximately 30–50% of children exhibit symptoms of attention deficit hyperactivity disorder (ADHD; Max et al., 2004). Specifically, children injured before the age of 2 years are twice as likely to be diagnosed with ADHD compared with a population-based comparison group (Keenan, Hall, & Marshall, 2008). Furthermore, studies have demonstrated that children who were injured before age 3 years performed lower than an uninjured control group on an executive function measure of attentional control (Crowe, Catroppa, Babl, & Anderson, 2013), suggesting that TBI may exacerbate preexisting behavior and attention problems and/or increase the risk for additional problems in young children.

Injury severity is another important factor, as research suggests that young children with more severe injuries are more likely to develop higher levels of externalizing behavior problems that increase with time since the injury (Catroppa et al., 2008). However, research examining mild TBI in young children has been mixed, with some studies finding increased behavior problems among children injured before age 5 years (McKinlay, Dalrymple-Alford, Horwood, & Fergusson, 2002) and others finding no adverse postinjury behavioral outcomes (Wetherington, Hooper, Keenan, Nocera, & Runyan, 2010). These conflicting findings may be due to the limited utility of the Glasgow Coma Scale (GCS) in accurately identifying mild versus moderate or severe injuries in young children. While the GCS objectively measures depth of coma, most children with mild TBI are conscious by the time they receive medical attention. Therefore, estimates of severity using the GCS for mild cases are likely influenced by how quickly a child receives medical attention (McKinlay, 2010).

TBI also is associated with environmental factors (e.g., parenting), which are important predictors of postinjury functioning. Specifically, severe TBI has been associated with poor family functioning and elevated levels of parental burden and psychological distress at 6 months postinjury (Wade et al., 2002). Furthermore, studies have demonstrated that the effect of TBI on behavior problems can

Table I. *Summary of Studies Examining Behavioral and Cognitive Outcomes Following Early Childhood TBI*

Study	Sample type	Comparison group	*N*	Percent male	Age at injury	Summary of findings
Anderson, Catroppa, Morse, Haritou, & Rosenfeld (2005a)	Children with varying degrees of TBI severity	Age-matched controls	82	65	2.0–7.0 years	Young children with severe TBI are at risk for severe persisting attentional impairments, reduced accuracy, and slow processing. Moderate TBI is related to poor performance in the selective attention domain.
Anderson, Catroppa, Morse, Haritou, & Rosenfeld (2005b)	Children divided according to injury age and severity	Children injured before age 3.0 years	122	70	Infant (<3.0 years) Young (3.1–7.11 years) Old (8.0–12.11 years)	Significant relationship between injury severity and cognitive performance. Severe TBI at a younger age was associated with minimal, if any, recovery after injury. Better outcomes were observed after severe TBI among older children. Infants with moderate TBI showed poorer outcomes than did older children with an injury of similar severity.
Anderson, Godfrey, Rosenfeld, & Catroppa (2012a)	Children with varying degrees of TBI severity	None	76	63	2.0–12.11 years	By 10 years, post-TBI functional abilities fall within the average range. Severe TBI is associated with reduced adaptive abilities and processing speed. Individual rates of impairment were considerably higher than expected based on population estimates. Rates of social impairments were elevated but were less related to injury factors.
Chapman et al. (2010)	Children hospitalized for moderate or severe TBI	Children hospitalized for OI	169	56	3.0–7.11 years	Compared with OI, severe TBI was associated with significantly higher levels of externalizing behavior/executive function problems following injury that persisted through an 18-month follow-up. Emergence of clinically significant problems was positively associated with permissive parenting, family dysfunction, and low SES.
Crowe et al. (2012)	Children who experienced TBI before age 3.0 years	Uninjured control	80	49	6 days–2.11 years	Children with moderate to severe TBI performed significantly lower on a measure of IQ compared with an uninjured control group. All outcomes were significantly influenced by environmental factors, such as socioeconomic status, family function, and parental mental health.
Ewing-Cobbs et al. (2006)	Children who sustained moderate to severe TBI before age 6.0 years	Community comparison group	44	50	0.4–5.11 years	Children who sustained early TBI scored significantly lower than children in the comparison group on intelligence tests and in the reading, mathematics, and language domains of achievement tests. Cognitive and academic deficits after early TBI have a cumulative, negative impact on academic performance. The odds for unfavorable academic performance were 18 times higher for the TBI group.
Taylor et al. (2008)	Children with varying degrees of TBI severity	Children with OI	196	63	3.0–6.11 years	Severe TBI sustained during early childhood can result in generalized cognitive impairment and deficits in school readiness skills. Memory, spatial reasoning, and executive function are more likely to be affected than language skills.
Wade et al. (2011)	Parent dyads of children with TBI	Parent dyads of children with OI	147	55	3.0–7.0 years	Parenting quality may facilitate or impede behavioral recovery following early TBI. Specifically, parental warmth was associated with lower levels of externalizing symptoms and parental negativity was associated with higher levels of externalizing problems and ADHD symptoms following severe TBI.

Note. TBI = traumatic brain injury; OI = orthopedic injuries; IQ = intelligence quotient; ADHD = attention deficit/hyperactivity disorder.

be buffered by more positive family environments and exacerbated by poorer environments (Yeates, Taylor, Walz, Stancin, & Wade, 2010). Similarly, recent research has highlighted the important role of parental warmth and negativity in early childhood TBI, such that parental warmth was associated with lower levels of child externalizing symptoms and parental negativity was associated with higher levels of child externalizing problems and ADHD symptoms following severe TBI (Wade et al., 2011).

Negative Cognitive Outcomes and Early Childhood TBI

In addition to behavior problems, the literature has demonstrated increased vulnerability for cognitive impairments following early childhood TBI (Catroppa et al., 2008). Researchers propose that younger children may be more vulnerable to negative cognitive outcomes following a brain injury because they have fewer established abilities than older children, and, therefore, damage to a more rapidly developing brain is more likely to disrupt the learning of new abilities (Crowe, Catroppa, Babl, & Anderson, 2012). Similar to the literature on behavior problems, there is far less research examining cognitive impairments following TBI in younger compared with older children. Among school-aged children, intellectual functioning is often intact or improves over time following the injury (Anderson, Godfrey, Rosenfeld, & Catroppa, 2012b). In contrast, studies of children with moderate and severe TBI in early childhood (i.e., 2–6 years) have found little to no ‘‘recovery’’ of intellectual function up to 30 months postinjury (Anderson, Morse, Catroppa, Haritou, & Rosenfeld, 2004). These findings suggest children injured in early childhood may experience difficulties acquiring new skills and knowledge at age-appropriate rates, resulting in global and persisting cognitive deficits (Anderson et al., 2012b).

Studies also have demonstrated worse academic outcomes in children injured in early childhood, with up to 48% of children failing a grade or being placed in special education classrooms and 39% of children requiring therapeutic support (e.g., speech/language; Ewing-Cobbs et al., 2006). Furthermore, studies have found that preschool children who were injured before age 3 years performed significantly lower on measures of intelligence compared with an uninjured control group (Crowe et al., 2012). These findings suggest certain cognitive skills may be more vulnerable to disruption during this early stage of development (Ewing-Cobbs, Prasad, Landry, Kramer, & DeLeon, 2004).

These negative cognitive and academic outcomes also can vary as a function of injury severity. Research has provided support for a dose–response relationship, such that more severe injuries result in greater impairments in cognitive abilities (Anderson et al., 2012a). Specifically, children with moderate to severe TBI typically perform more poorly on achievement and neuropsychological tests than children with mild TBI (Ewing-Cobbs et al., 2006). While children with moderate to severe TBI usually experience greater cognitive impairments, studies have found evidence that children with mild TBI also may experience some cognitive difficulties depending on the child’s developmental stage at injury (McKinlay, 2010).

Summary and Future Directions

This topical review illustrates the public health impact of TBI, particularly related to the negative behavioral and cognitive outcomes associated with injury in early childhood. Recent research has demonstrated elevated risk for psychological problems persisting as long as 16 years postinjury (Rosema et al., 2014), further highlighting the need for follow-up care. Children also may experience other negative outcomes following TBI (e.g., physical impairment), which were not discussed given the limited scope of the current review. We focused on the negative behavioral and cognitive outcomes because these are the most common problems following early childhood TBI and are more highly associated with detrimental long-term effects, such as difficulties in school performance and peer relationships (Li & Liu, 2013).

Though research to date has made significant strides toward the understanding of early childhood TBI, several limitations and challenges remain. First, owing to a focus on severe TBI, few studies have included children with a mild TBI, despite evidence that these children also demonstrate elevated levels of externalizing behavior problems (McKinlay et al., 2002). Second, only a limited number of studies have examined behavioral and/or cognitive functioning of children injured in early childhood, partly owing to age cutoffs on commonly used measures. Third, heterogeneity in outcome measures (e.g., Child Behavior Checklist vs. Strengths and Difficulties Questionnaire) used in previous research limits the ability to compare outcomes across studies. Lastly, it is important to consider that preinjury cognitive and behavioral problems can exacerbate postinjury outcomes. Identification of preexisting problems may be more challenging in younger children where research on assessment tools has been more limited

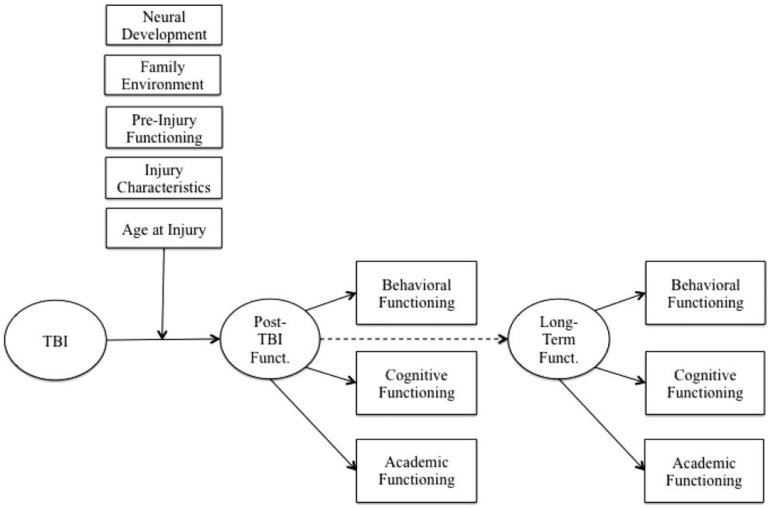

Figure 1. Model highlighting future directions for TBI research with young children.

compared with older children (Bagner, Linares, Rodríguez, Carter, & Blake, 2012).

As illustrated in Figure 1, to address these limitations, future multidisciplinary work is needed to optimize and accelerate research to answer critical questions relevant to the prevention, detection, diagnosis, and treatment of TBI in young children. For example, research studies should focus on risk factors (e.g., family environment, parenting practices) that moderate outcomes of TBI, processes occurring at a cellular level throughout the course of recovery (e.g., changes in neuronal circuitry that underlie injury consequences), and the effect of preinjury functioning and injury characteristics (i.e., severity, timing, location) on postinjury functioning. Additionally, increased exchange of knowledge is needed between researchers and health care providers to ensure families receive optimal care through the development of clear clinical guidelines for children with TBI. For instance, researchers should prioritize the examination of brief screening tools for behavioral and cognitive problems that can be easily integrated into clinical practice rather than lengthy assessments. Directing services toward young children with TBI and their families is likely to make the most comprehensive and extensive impact on improving outcomes for this vulnerable population.

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VITA

DAINELYS GARCIA

EDUCATION

2010	B.A., Psychology with Distinction, Summa Cum Laude Florida International University Miami, Florida
2013	M.S., Psychology Florida International University Miami, Florida
2015 to Present	Pre-Doctoral Internship University of Florida Gainesville, Florida
2011 to Present	Doctoral Candidate in Psychology Florida International University Miami, Florida

PUBLICATIONS AND PRESENTATIONS

Bagner, D. M., Coxe, S., Hungerford, G. M., Garcia, D., Barroso, N. E., Hernandez, J., & Rosa-Olivares, J. (2015). Behavioral parent training in infancy: a window of opportunity for high-risk families. *Journal of Abnormal Child Psychology*, 1-12.

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