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Parent- and Adolescent-reported Executive Functioning in the Context of Randomized Controlled Trials of Online Family Problem-Solving Therapy

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Abstract

Objective: We examined parent- and adolescent-reported executive functioning (EF) behaviors following pediatric traumatic brain injury (TBI) in the context of Online Family Problem-Solving Therapy (OFPST) and moderators of change in EF behaviors. **Method:** In total, 274 families were randomized to OFPST or an internet resource comparison group. Parents and adolescents completed the Behavior Rating Inventory of Executive Function at four time points. Mixed models were used to examine EF behaviors, assessing the effects of visit, treatment group, rater, TBI severity, age, socioeconomic status, and family functioning. **Results:** Parents rated their adolescents' EF as poorer ($F(3,1156) = 220.15$, $p < .001$; $M = 58.11$, $SE = 0.73$) than adolescents rated themselves ($M = 51.81$, $SE = 0.73$). Across raters, EF behaviors were poorer for adolescents whose parents had less education ($F(3,1156) = 8.60$, $p = .003$; $M = 56.76$, $SE = 0.98$) than for those with more education ($M = 53.16$, $SE = 0.88$). Age at baseline interacted with visit ($F(3,1156) = 5.05$, $p = .002$), such that families of older adolescents reported improvement in EF behaviors over time. Family functioning also interacted with visit ($F(3, 1156) = 2.61$, $p = .049$), indicating more improvement in EF behaviors over time in higher functioning families. There were no effects of treatment or TBI severity. **Conclusion:** We identified a discrepancy between parent- and adolescent-reported EF, suggesting reduced awareness of deficits in adolescents with TBI. We also found that poorer family functioning and younger age were associated with poorer recovery after TBI, whereas adolescents of parents with less education were reported as having greater EF deficits across time points.

Keywords: TBI, Pediatric, Executive function, Self-report, Treatment, Adolescent

Executive functioning (EF) refers to a group of higher-level cognitive functions related to efficient, goal-directed, and problem-solving behaviors and includes aspects such as flexibility, planning, organization, and working memory (Alvarez & Emory, 2006; Gioia, Isquith, Guy, & Kenworthy, 2000; Hunt, Turner, Polatajko, Bottari, & Dawson, 2013). Executive functions also encompass aspects of behavioral and emotional regulation, such as inhibition, emotional control, and self-monitoring (Baggetta & Alexander, 2016; Gioia et al., 2000). Deficits in EF behaviors are one of the most common and persistent impairments after pediatric traumatic brain injury (TBI; Keenan, Clark, Holubkov, Cox, & Ewing-Cobbs, 2018; Krasny-Pacini et al., 2017; Kurowski et al., 2013; Narad et al., 2017). EF behaviors across childhood after TBI are often predicted by child and family characteristics—such as socioeconomic status (SES) and family

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environment—and injury-related factors, including preinjury abilities, injury severity, and age of injury (Krasny-Pacini et al., 2017; Nadebaum, Anderson, & Catroppa, 2007; Narad et al., 2017). Previous studies demonstrate that deficits in EF following TBI are found on both performance-based tests and behavioral rating scales (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2005; Babikian & Asarnow, 2009; Krasny-Pacini et al., 2017; Nadebaum et al., 2007). Although scores on performance-based measures typically improve over time following TBI, test performance may underrepresent ongoing daily functional deficits in EF (Krasny-Pacini et al., 2017). As such, caregiver-reported measures are also frequently used to assess real-word executive deficits following pediatric TBI. The most commonly used measure of EF is the Behavior Rating Inventory of Executive Functioning (BRIEF), which has been validated and widely used to assess everyday EF behaviors following pediatric TBI (McCauley et al., 2012).

Although the self-reported version of the BRIEF has been validated, few studies have used the self-report version of the BRIEF to assess EF behaviors following TBI (Byerley & Donders, 2013; Wilson, Donders, & Nguyen, 2011). Both studies documented that compared to their children, parents reported more problems in EF behaviors, contributing to the literature suggesting impaired awareness of deficits in pediatric TBI (Lloyd, Ownsworth, Fleming, & Zimmer-Gembeck, 2015). However, these studies examined adolescent-reported EF cross-sectionally within 1 year following injury. Additional research is needed to examine self-reported EF longitudinally and compare self- and parent-reported EF over time.

Given the negative impact of EF deficits on behavioral, social, and emotional adjustment across home, school, and community settings, interventions are needed that target EF following pediatric TBI (Ganesalingam et al., 2011; Kurowski et al., 2013; Shultz et al., 2016). Previous reports of the effectiveness of Online Family Problem-Solving Therapy (OFPST) following pediatric TBI have noted improvements on a broad range of outcomes, including EF behaviors (Wade et al., 2019). OFPST is a web-based family problem-solving intervention that consists of online psychoeducational modules and therapist videoconference sessions. Most outcome studies note improvements in parent-reported child behavior (Kurowski et al., 2014; Wade et al., 2018; Wade et al., 2010); however, changes in self-reports of functioning by adolescents with TBI were less consistent. The current study examined data from three randomized controlled trials of OFPST—two trials of Teen Online Problem-Solving (TOPS) and one trial of Counselor-Assisted Problem-Solving (CAPS). The original TOPS study documented significant improvements in self-reported EF behaviors among adolescents with severe TBI receiving the intervention, with no associated improvement in parent-reported adolescent EF behaviors. The study also found that TBI severity moderated adolescent-reported outcomes, such that those with severe TBI benefitted more from OFPST than those with moderate TBI (Wade et al., 2010). The second trial, CAPS, was associated with improved parent-reported EF behaviors for older, but not younger, adolescents within the first year following TBI (Kurowski et al., 2014). The effect of CAPS on adolescent self-reported EF behaviors was not examined. In the second TOPS study, group differences favoring the treatment group were reported for the parent-reported BRIEF at 6 months (Wade et al., 2018). However, group differences were not found on the self-reported form of the BRIEF. We sought to expand the literature on EF following TBI by combining data from the three studies to examine both self- and caregiver-reported EF behaviors over time. We also explored moderators of change in EF behaviors over time, including visit, treatment group, rater, TBI severity, age at baseline, parent education, and family functioning. This research will help us understand modifiable (e.g., intervention, family functioning) and non-modifiable factors (e.g., parent education, age, injury severity) that contribute to EF over time to better elucidate who is most vulnerable to EF impairments and factors that can improve EF over time. We also aimed to better understand self-perceptions of EF and the relation between self- and parent-reported EF in pediatric TBI over time.

METHOD

Procedures

Adolescents aged 11 to 18 years were enrolled 1 to 18 months after hospitalization for complicated mild to severe TBI, using the lowest Glasgow Coma Scale (GCS) score (average time post-injury was 5.24 months, $SD = 3.85$). Complicated mild TBI was defined as a GCS score of greater than 12 with evidence of trauma-related abnormalities on clinical neuroimaging; moderate TBI as a GCS score of 9–12; and severe TBI as a GCS score of less than 9.

Institutional review board approval was obtained from all participating institutions, while informed consent was obtained from parents and written assent from participating adolescents younger than 18 years of age. Participants were randomized to the treatment group or an internet resource comparison (IRC) group at baseline. The total number of randomized participants was 41 in the original TOPS study (OFPST = 24, IRC = 17), 101 in the second TOPS study (OFPST = 52, IRC = 49), and 130 in the CAPS study (OFPST = 65, IRC = 65). Across studies, treatment groups were well matched demographically with no significant differences in age, time since injury, race, sex, or GCS score. The three studies also showed no statistically significant demographic differences apart from differences in time since injury (see Table 1).

Intervention Conditions

OFPST

The intervention group received a 6-month web-based, manualized, evidence-informed intervention comprised of 7 (CAPS) or 10 (TOPS) core sessions. An initial face-to-face

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Table 1. Participant characteristics by study; count (%) or mean (SD)

Characteristic	All	TOPS-Orig	CAPS	TOPS-RRTC
N[a]	272	41	130	101
Dates	2003–15	2006–9	2007–11	2010–14
Age range (y)[b]	11–18	11–18	12–17	11–18
Avg. age at baseline (y)[b]	14.82 (1.95)	14.44 (2.43)	14.81 (1.71)	14.97 (2.03)
Time since injury range (m)[c]	0–36	0–24	0–7	0–18
Avg. time since injury (m)[c]	5.37 (3.95)	9.28 (5.12)	3.62 (1.71)	6.05 (4.12)
Male	177 (65.1)	22 (53.7)	85 (65.4)	70 (69.3)
Caucasian	223 (82.0)	37 (90.2)	105 (80.8)	80 (80.2)
Child Hisp/Lat[d]ethnicity	15 (5.5)	2 (4.88)	6 (4.62)	7 (6.36)
TBI severity				
Severe	109 (40.1)	1888 (43.9)	51 (39.2)	40 (39.6)
Moderate/compl[e]	163 (59.9)	23 (56.1)	79 (60.8)	61 (60.4)
Primary caregiver				
Mother	239 (87.9)	38 (92.7)	115 (87.9)	88 (87.1)
Father	27 (9.9)	4 (8.0)	13 (10.0)	12 (11.9)
Other	6 (2.2)	1 (2.4)	4 (3.1)	1 (1.0)
Caregiver education[f]				
<=HS[g]	122 (44.9)	17 (41.5)	61 (46.9)	44 (43.6)
>HS[g]	150 (55.1)	31 (58.5)	69 (53.1)	57 (56.4)
Married	171 (62.9)	28 (68.3)	81 (62.3)	62 (61.4)
BRIEF parent-reported score at baseline	59.29 (11.41)	58.85 (12.44)	60.00 (10.35)	58.54 (12.45)
BRIEF self-reported score at baseline	52.88 (12.63)	53.68 (12.53)	52.73 (12.83)	52.74 (12.52)

[a]Number, [b]years, [c]months, [d]Hispanic and/or Latino, [e]complicated mild/moderate, [f]education of the primary caregiver, [g]high school

session was completed by a counselor, either a licensed clinical psychologist or master's level graduate student in clinical psychology under the supervision of a licensed psychologist, in the family's home. During this 90-minute meeting, the counselor established rapport, developed treatment goals, and oriented the family to the online website and Skype. Subsequent sessions consisted of self-guided, online, didactic content about problem-solving, communication, and self-regulation skills, video clips modeling the skills, and exercises and assignments to practice new skills. A total of six to nine Skype video conferencing sessions (45–60 min) were completed with the counselor to review the online materials and practice the problem-solving process using problems the family identified. Families could participate in up to four optional supplemental sessions with specialized content.

Internet Resource Comparison (IRC)

Families in the IRC group were given access to a website with links to online resources including local, state, and national brain injury association sites and sites specific to pediatric brain injury.

Measures

Information regarding TBI severity was obtained from hospital records, and caregivers completed a demographic form. Caregiver education level was dichotomized into less than or equal to a high school education and greater than a high school education.

Family Assessment Device–General Function Scale

The 12-item General Function Scale was used to reflect global family functioning (Miller, Epstein, Bishop, & Keitner, 1985). Parents rated how well each statement (e.g., "we don't get along well together" and "we confide in each other") described their own family. Scores range from 1 to 4, and higher scores indicate worse functioning.

Behavior Rating Inventory of Executive Functioning (BRIEF)

The BRIEF was created to gain insight into EF-related impairments outside of the clinical setting (Gioia et al., 2000; McAuley, Chen, Goos, Schachar, & Crosbie, 2010) and has satisfactory reliability and validity (Gioia et al., 2000). Extensive research has analyzed the utility of the BRIEF in various populations (Maiman et al., 2018; McCandless & Laughlin, 2007; Toplak, Bucciarelli, Jain, & Tannock, 2009). In fact, the BRIEF is one of the few measures found to be acceptable for use in TBI populations (Turkstra, Coelho, & Ylvisaker, 2005), making it the most widely used measure to assess EF in individuals with acquired brain injury (Chevignard, Soo, Galvin, Catroppa, & Eren, 2012).

Parents provided ratings of their child's EF behaviors on the parent-report BRIEF, and adolescents provided ratings of their own EF behaviors on the BRIEF-SR. Raters reported the frequency (never, sometimes, and often) of behaviors reflective of EF. BRIEF scores considered were the Behavioral Regulation Index (BRI), Metacognition Index (MCI), and

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Global Executive Composite (GEC). Higher *T*-scores indicate poorer EF behaviors, with *T*-scores greater than or equal to 65 indicating clinically elevated problems.

Data Analysis

Participants completed the BRIEF at baseline and 6, 12, and 18 (CAPS only) months posttreatment. Mixed models were used to examine the GEC, BRI, and MCI of the BRIEF, assessing the effects of visit, treatment group, rater, TBI severity (lowest GCS score), age, parent education, family functioning, and related interactions in the linear model. Study was accounted for as a fixed effect and subjects as random effects. We used backward elimination to trim all nonsignificant interactions and used *post hoc* "least square means" to examine moderators of group differences.

RESULTS

Participant characteristics are summarized in Table 1. We found the overall pattern of results was the same on the GEC, BRI, and MCI; thus, we only report the results of the GEC. Correlations between the self- and parent-reported GEC ranged between .47 and .64 at the four visits. We identified main effects of rater ($F(1, 1102) = 210.40$, $p < .001$); across the four time points, parents rated their adolescents' EF behaviors as poorer ($M = 58.15$, $SE = 0.74$) than adolescents rated themselves ($M = 51.80$, $SE = 0.74$). A main effect of parent education was identified ($F(1, 1102) = 8.02$, $p = .005$), in that across raters and visits, families whose parents had less than or equal to a high school education reported poorer EF ($M = 56.76$, $SE = 1.00$) than those whose parents had more than a high school education ($M = 53.18$, $SE = 0.89$). An age by visit interaction was significant ($F(3, 1102) = 4.52$, $p = .004$); across raters, results revealed more improvement over time for older, but not younger, adolescents (See Figure 1). A family functioning by visit interaction was also identified ($F(3, 1102) = 2.61$, $p = .049$), such that EF behaviors improved more over time in adolescents from higher functioning families, across raters. We did not identify a treatment by time since injury interaction, suggesting that adolescent's and parent's ratings of EF behaviors did not differ as a function of treatment group. We also did not find a main effect or interactions with injury severity.

DISCUSSION

We identified a number of factors that influenced EF behaviors over time, including rater (adolescent versus parent), parent education, age, and family functioning. We found that adolescents reported their EF as within the average range across time points and consistently rated themselves as having better EF behaviors than did their parents, suggesting a reduced awareness of EF deficits. Underestimation of EF deficits has also been found in adults with TBI and adolescents

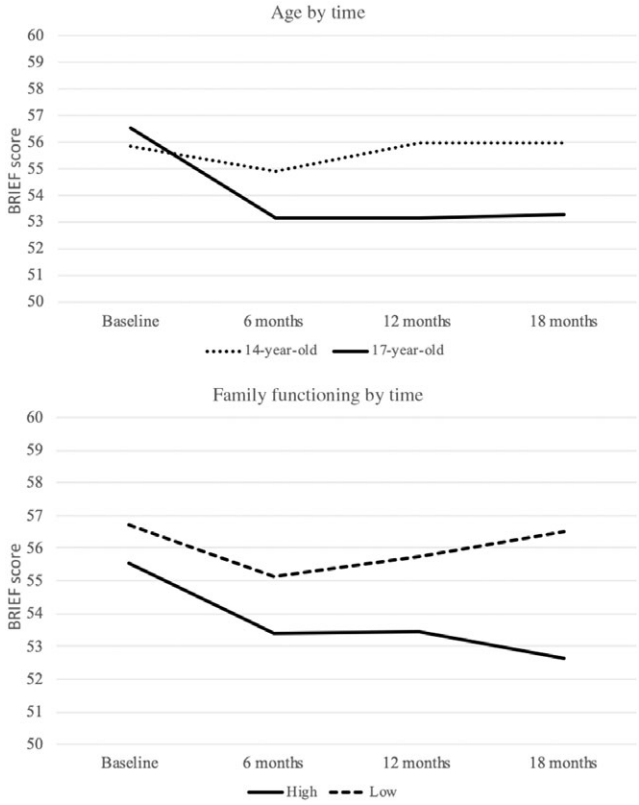

Fig. 1. Age by time and family functioning by time interactions on the Behavioral Rating Inventory of Executive Function.

with ADHD (Bivona et al., 2008; Steward, Tan, Delgaty, Gonzales, & Bunner, 2017). Our findings add to literature suggesting a lack of awareness of EF deficits in adolescents with TBI (Byerley & Donders, 2013; Wilson et al., 2011). Previous research has found that children with severe TBI have poorer awareness of their deficits in comparison to the awareness of deficits in children with less severe injuries (Wilson et al., 2011). In our study, we identified differences between parent- and self-reports of EF behaviors across injury severity, in that children, regardless of injury severity, reported fewer deficits than their parents. Overall, these findings suggest that rater discrepancy on the BRIEF could potentially be used as a metric for awareness of deficits in youth following TBI. Awareness of deficits is an important factor to understand and address in pediatric TBI, as awareness of deficits may contribute to motivation to participate in treatment and improvement in outcomes (Ownsworth & Clare, 2006; Robertson & Schmitter-Edgecombe, 2015; Sawchyn, Mateer, & Suffield, 2005).

Across the four time points in this study, we found that parents with less education and their adolescents reported poorer EF behaviors than those with more education, which also parallels previous findings in the literature (Keenan et al., 2018; Krasny-Pacini et al., 2017; Nadebaum et al., 2007; Roy & Raver, 2014). Parent education is often considered a proxy for SES and correlates with other environmental factors, including access to resources, likelihood of experiencing life

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stressors, the quality of the school district, and available housing (Conger & Donnellan, 2007; Raver, 2012). In fact, parent education has been found to be the most salient SES factor in the prediction of developmental outcomes (Bornstein, Hahn, Suwalsky, & Haynes, 2003).

Overall, socioenvironmental disadvantages serve as additional stressors that may contribute to poorer EF behaviors (Lawson, Hook, & Farah, 2018). Fewer social resources contribute to EF deficits in areas such as self-regulation, emotion regulation, working memory, inhibitory control, attention, and cognitive flexibility (Hackman et al., 2015; Raver, 2012; Raver, Roy, Pressler, Ursache, & Charles McCoy, 2016). This is particularly important given the well-established relation between EF and functional and academic outcomes in pediatric TBI (Arnett et al., 2013; Ganesalingam et al., 2011; Kurowski et al., 2013; Shultz et al., 2016).

Additionally, previous literature has found that the impact of SES on EF behaviors persists across development (Hackman, Gallop, Evans, & Farah, 2015; Last, Lawson, Breiner, Steinberg, & Farah, 2018), which parallels our finding that parent education did not modify the course of recovery from a TBI. Rather the association between parent education and EF behaviors was stable across visits. Future research could examine specific factors related to EF (e.g., access to resources) that account for the relation between parent education and EF behaviors in children with TBI.

Our finding that adolescents with better family functioning reported more improvements in EF behaviors over time supports the growing literature on the importance of family environment to recovery. Families have an essential role in the adolescent's recovery, as positive family functioning acts as a protective environmental factor against EF deficits (Kurowski et al., 2011; Vangel, Rapport, & Hanks, 2011; Yeates, Taylor, Walz, Stancin, & Wade, 2010). Recovery outcomes are moderated by family dynamics and interactions, parenting style, parental warmth, and well-being, all of which are important components of positive family functioning (Kurowski et al., 2011; Vangel et al., 2011; Yeates et al., 2010).

We also found that adolescents that were older at the time of injury showed greater improvement in EF over time than younger adolescents, across raters (i.e., parents and adolescents). Age has been found to be a significant predictor of outcomes following TBI, with children who sustain injuries at a younger age demonstrating greater long-term effects in numerous domains (Keenan et al., 2018; Krasny-Pacini et al., 2017). However, previous literature focused largely on the differences between preschool age, middle childhood, and adolescence (Karver et al., 2012; Keenan et al., 2018; Prasad, Swank, & Ewing-Cobbs, 2017; Zhang et al., 2019). This is one of the first studies to demonstrate differences between the recovery of EF in younger in comparison to older adolescents.

We did not identify a treatment group by time interaction, suggesting that across raters, participants did not report improvement in EF behaviors as a function of participating in the treatment. This is contrary to previous results demonstrating improvements in parent-reported EF following treatment, particularly among families of lower SES and adolescents with more severe injuries (Kurowski et al., 2014; Wade et al., 2018; Wade et al., 2010). Thus, adolescent self-report is likely driving the lack of treatment effects, as EF behaviors remained stable and within the average range over time in both the control and treatment group, according to adolescent report. Finally, although previous research has suggested injury severity may contribute to recovery of EF behaviors over time (Ganesalingam et al., 2011; Krasny-Pacini et al., 2017; Nadebaum et al., 2007; Shultz et al., 2016), our analyses did not support such findings.

Our findings should be interpreted in the context of the study's limitations. Individuals who participated in trials of OFPST may not represent the general population of children who sustain TBI. Similarly, our study is also limited by a lack of diversity in terms of race and ethnicity. Future research would need to confirm the generalizability of our findings. With 130 participants, only one study (CAPS) collected data at the 18-month time point, which may result in this study having a disproportionate influence on the long-term findings. In addition, we did not assess preinjury functioning, which has shown to be an important predictor of EF recovery in previous studies (Narad et al., 2017). Finally, we used parent education to measure SES. Future studies could incorporate other modifiable, proximal environmental factors that may be driving the relation between EF behaviors and SES, such as healthcare utilization or quality of the school and other factors that may be important adolescent recovery of EF, such as self-esteem and parenting style (Hackman et al., 2015; Hawley, 2012; Narad et al., 2017).

Despite these limitations, our study contributes to the growing literature on EF behaviors after pediatric TBI. This is also one of the few studies that incorporates adolescent self-report over multiple time periods. Our finding that adolescents rated themselves in the average range across time points highlights the potential utility of interventions targeting self-awareness of deficits after pediatric TBI. We also found that, across raters, whereas older adolescent EF behaviors improved over time, younger adolescent EF behaviors did not. This, coupled with previous findings that older adolescents benefit more from OFPST (Kurowski et al., 2014), highlights both the significance and challenges of targeting EF behaviors following TBI in younger individuals. Finally, our study parallels the large literature suggesting the importance of family functioning to recovery following TBI in numerous domains. Our findings, in combination with previous literature, underscore the need to assess and address family functioning throughout adolescents' recovery from a TBI.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

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