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BrainSTARS: Pilot Data on a Team-Based Intervention Program for Students Who Have Acquired Brain Injury

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Objective: To conduct and evaluate an educational/consultation program for parents and teachers of children who have acquired brain injury (ABI). **Participants:** Parents, regular and special educators, and related school personnel of 30 students who had ABI and serious school problems. **Intervention:** BrainSTARS (Brain Injury: Strategies for Teams and Re-education for Students), an individualized consultation program that includes a comprehensive manual on pediatric ABI. The intervention included 3 meetings in the school of the child identified with ABI. **Design:** A pre/post single group design assessed the impact of BrainSTARS on ABI-related competencies in the adult participants as well as on measures of child behaviors. **Results:** Significant improvement was shown in the participants' self-rated proficiency in working with children who have ABI as well as on their ratings of student performance in targeted neurodevelopmental areas. There was no significant change on standardized measures of child behavior (the Behavior Rating Inventory of Executive Functions and the Behavior Assessment System for Children). **Conclusions:** BrainSTARS appears to increase the competencies of parents and educators related to students who have ABI; further study of BrainSTARS' impact on student performance and capacity to produce long-standing results is called for. **Keywords:** *consultation*, *education*, *family*, *intervention*, *pediatric*, *traumatic brain injury*

THE CONVENTIONAL WISDOM that "every brain injury is different"[1] recognizes the individual, unique, and varied outcomes of acquired brain injury (ABI) that have been well documented in the literature. This individualized presentation necessitates careful assessment to guide effective rehabilitation after ABI. Studies of adult traumatic brain injury (TBI) have cataloged its impact on neuropsychological abilities, psychiatric symptoms, functional skills, and social behavior, and targeted intervention programs have been developed and evaluated; these advances now support the development of theories of TBI in adults.[2–4]

The special case of *pediatric* brain injury poses an added clinical challenge: the injury occurs to a brain in the process of development, creating a moving target for both assessment and intervention.[5–8] Further, because children rarely participate in comprehensive cognitive rehabilitation programs after their acute care, the burden of understanding and treating their brain injury-related deficits falls largely on people who do not have cognitive rehabilitation expertise—their parents and teachers.[9,10] This article describes a model of pediatric ABI and a program that targets parents and teachers as change agents for children after ABI.

DEVELOPMENTAL CONSIDERATIONS IN PEDIATRIC ABI

The extensive neural growth and reorganization of the human brain from birth through the early 20s results in the development of cognitive, emotional, psychological, and social competencies in a robust stage-related fashion.[11–13] Broad metacognitive abilities (eg, attention), specific cognitive skills (eg, expressive language), and social competencies (eg, turn-taking) developed at early stages form the necessary foundation for more complex developments at later stages.[11–13] A brain injury acquired during childhood or adolescence interrupts skills that are emerging at that stage and can permanently derail development along many interrelated paths, a

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characteristic of pediatric TBI called "developmental stall."[14] Without appropriate intervention, weaknesses or frank deficits compound over time because of the developmental nature of skill and competency acquisition during childhood and adolescence. The younger brain appears more vulnerable to insult, so children who sustain serious TBIs at an earlier age are likely to evidence more widespread cognitive and behavior problems in subsequent development than those injured later in life.[15–17] A developmental perspective on pediatric ABI can account for the appearance of "latent sequelae"[18] several years after both the injury and apparent recovery in the following way. Complex neurologically based competencies (eg, the ability to plan and carry out long-range projects) that are not expected at an early developmental stage (preschool or early childhood) will typically not be detected as impaired until the child reaches an age at which that ability is manifest (adolescence). Because of the prolonged course of development of the executive control system, and because the frontal lobes essential to executive control are easily injured, pediatric TBI almost always causes impairments in executive functions.[9,19,20]

In addition to the neuropsychological consequences of pediatric ABI, substantial psychological and emotional concomitants have been documented.[21–23] As many as 76% of children and adolescents meet criteria for diagnosis with a "novel" psychiatric disorder (including attention-deficit/hyperactivity disorder (ADHD), oppositional defiant disorder, and organic personality syndrome) within 2 years of a moderate-severe TBI.[23] Finally, studies have pointed to a significant role played by parental stress and family functioning in determining outcomes of pediatric ABI.[24,25]

Intervention studies

Some interventions in pediatric ABI have followed the design of adult models, treating the individual more or less in isolation with medication, external aids and supports, self-instructional methods, and positive reinforcement.[26] Such studies are relatively few, and support for their efficacy in children and adolescents remains weak. On the other hand, interventions that include, or consist entirely of, educating parents and teachers about the child's injury appear to have been more successful for reducing the deficits associated with pediatric TBI.[10,27–33]

A NEURODEVELOPMENTAL MODEL OF PEDIATRIC ABI

The above-referenced literature is integrated into a neurodevelopmental model of pediatric ABI as shown in Figure 1.

Pediatric brain injury damages the normal structures and chemical and electrical processes of the developing brain, alters cognitive abilities, and presents primarily as disturbances of behavior. The main result of the injury may be to disrupt metacognitive abilities and overarching capacities that broadly affect the child's performance in multiple arenas, or it may interrupt acquisition of specific learning abilities. ABI can directly affect behavior, or it can alter behavior indirectly through its impact on these cognitive capacities. The child's emotional

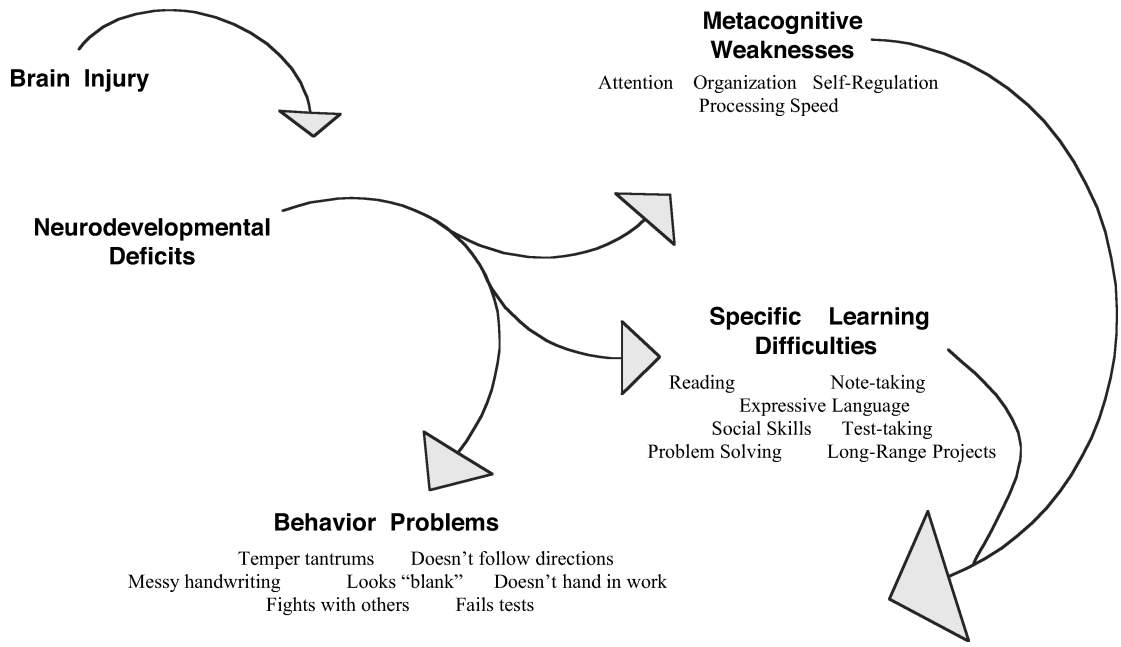

Figure 1. Neurodevelopmental model of sequelae of pediatric acquired brain injury.

reactions to lost skills and abilities–shame, frustration, anxiety, and grief–are almost always expressed indirectly as well through behavior problems.

In this model, behavior problems following ABI can be a signal that the neurodevelopmental deficits caused by the ABI have not been properly assessed and remediated. Changes in personality, behavior, and emotion can be conceptualized as the child's response to the poor fit between the environmental expectations held of him and his current neurodevelopmental capabilities. As the growing child encounters increasing demands, particularly for exercising executive control, the person-environment fit worsens, contributing to an expanding pattern of disability as time goes on. The rippling impact of an ABI on executive functions can further limit a child's full participation in the normal experiences that develop skills and keep him or her on track with her peers, including school, clubs, camps, sports teams, and other community activities. This model implies that many psychiatric and behavioral disorders comorbid with pediatric ABI might be understood, and ameliorated or even prevented, by targeting intervention not at the child but at the environment and by better accommodating the child's primary neurocognitive deficits to minimize any "snowballing" effect. This model of pediatric ABI is consistent with the literature indicating that (1) parental stress and adjustment appear to be more highly associated with a child's neuropsychological status one year after TBI than is the initial severity of the brain injury[25,30] and (2) interventions providing education and information appear most effective in reducing functional disability after ABI.[9,10,28–34]

BrainSTARS: A MODEL PROGRAM FOR STUDENTS WHO HAVE ABI

BrainSTARS (Brain Injury: Strategies for Teams and Re-education for Students) is an individualized intervention approach to ABI based on the preceding theoretical model in which the intent is to improve outcomes by educating parents and school personnel about the link between observed deficits in children's behaviors and their underlying neurodevelopmental weaknesses. Strategies for intervention and accommodation derived from best practices in the remediation of the underlying deficits are taught to parents and school personnel in an interactive, group consultation model.

The BrainSTARS program was developed through a US Department of Education Model Demonstration grant. The BrainSTARS program (1) provides comprehensive educational materials to parents of children with TBI and to their school personnel, (2) develops and educates a competent parent-school team, and (3) consults with the team to develop a comprehensive understanding of the student's challenges, create a plan of interventions, and track the student's progress.

The BrainSTARS manual

The BrainSTARS manual[35] is a 320-page manual on pediatric brain injury that, in addition to providing parents and school personnel with basic, understandable education about TBI, also provides decision trees for a symptom-based assessment of problems and recommended interventions. The manual, developed by a multidisciplinary pediatric rehabilitation team, was reviewed by a panel of national experts in pediatric ABI and critiqued and field-tested by 17 family-school teams. Comments from all sources were incorporated into the final revision.

Section I of the manual provides background information about pediatric TBI, including common sequelae, normal developmental accomplishments, and the impact of brain injury at various developmental stages. Section II describes effective approaches to behavior and learning problems in children who have ABI. In this section, the limitations of consequences-based interventions are discussed, and the extensive literature on positive behavioral supports, positive replacement behaviors, and task analysis, which are effective with students who have serious executive function deficits,[36] is reviewed. Section III comprises 3 chapters on educational laws and rights, using the manual to create functional individualized education plans and classroom plans, and accessing community supports.

The centerpiece of the manual is the problem-solving index and neurodevelopmental clusters. In preparing this section, 50 multidisciplinary neuropsychological evaluations of children who had ABIs (10 from each of 5 developmental stages) were reviewed by the project team. Parents' and teachers' concerns and the children's reported behavior and learning problems were linked with the major diagnostic findings of the neuropsychological reports. A list was created of 20 common neurodevelopmental deficits, behavioral symptoms associated with those deficits, and interventions specific to the underlying neurodevelopmental weakness. Problems reported by parents and school personnel were sorted into functional categories (eg, school, chores and routines, social relationships), listed alphabetically using the parents' and teachers' language, and then linked to the neurodevelopmental deficit(s) most often associated with that symptom in the index.

BrainSTARS consultation: Values and competencies

The BrainSTARS manual was designed to be a standalone resource as well as the primary curriculum for a consultation program. The overarching goal of the latter is to improve student success by improving the

"goodness of fit" between the student's capabilities/weaknesses and the expectations/supports in his or her environment. As implemented in the present study, the consultation process is time-limited (3 sessions over 4 months) and has 2 objectives: (1) to create an ABI-educated and mutually supportive parent-school team and (2) to familiarize the team with the BrainSTARS manual so that they will be able and motivated to use it as a resource to develop effective interventions for students who have ABI.

Because ABI presents a confusing and often counterintuitive pattern of deficits, parents and school personnel often find themselves at odds with each other. The consultation program, therefore, requires representation from both family and school personnel at all meetings, the essential goals of which are (1) reframing negative attributions of the student ("unmotivated," "oppositional," "lazy"), (2) making conceptual links between observed problems and underlying neurodevelopmental weaknesses, and (3) discussing specific strategies for implementation at home and school. Data on the use of this program with 30 teams of students who had ABIs are reported below.

METHODS

Participants

Thirty children and adolescents, via their parent(s) and school personnel, participated in the complete BrainSTARS consultation program. Twenty students (67%) were male and 10 (33%) were female; 4 (13%) were from racial or ethnic minority backgrounds. Family socioeconomic status was as follows: lower-middle class: 40%; middle class: 55%; upper-middle class: 5%. Twenty-eight participants were enrolled in public school and 2 attended private schools; 10% were in early childhood education or kindergarten; 45% in elementary school, 15% in middle school, and 30% in high school. Community of residence was as follows: 40% urban, 35% suburban, 25% rural. The student's age at the time of ABI varied widely from 2 days to 18 years. At the time of injury, 5 children were under the age of 3; 3 were between 3 and 6 years; 14 were in the 6–12 year range; and 8 were between 12 and 18 years. Six students had preinjury learning problems, including attention, hyperactivity, and reading difficulties.

All students had been hospitalized after their brain injuries. The mean length of hospitalization was 60 nights, with a range from 2 nights to 270 nights. Excluding one participant at each extreme end of this range, the remaining 28 participants' length of inpatient stay ranged from 14 nights to 90 nights. The average Glasgow Coma Scale score was 6, with a range from 3–13; using Glasgow Coma Scale and radiological findings, the sample included one child with mild-complicated injury, 6 with moderate, and 23 with severe ABIs. The participants' mean age at enrollment was 11.1 years (SD = 4.0) with a range from 4.5 years to 18.8 years. The mean time between injury and enrollment in the BrainSTARS consultation program was 2.6 years (SD= 2.8), with a range of 10 months to 5 years. At the time of BrainSTARS consultation, 7 participants (27%) were taking psychoactive or neuroleptic medications such as paroxetine (Paxil), methylphenidate (Concerta), or carbamazepine (Tegretol).

All students had individualized education plans at the time of the consultation, but only 4 listed ABI/TBI as the primary special education classification. For all 30 participants, parent and teacher concerns about ongoing behavioral or learning failures at school prompted their participation in the study. At least one parent and one classroom teacher participated in the entire consultation program for each enrolled child participant, though many teams had additional members. In all, 41 parents/guardians and 66 school personnel (regular and special educators, occupational, physical, and speech language therapists) participated. Not all team participants completed both pre- and postconsultation questionnaires; therefore, the sample size varies across variables.

Measures

1. The ABI Parenting/Teaching Proficiency Scale[37] lists 16 psychoeducational competencies important for parents or school personnel working with children with ABI. The scale was piloted and field-tested with parents and school personnel during early development of the BrainSTARS consultation program. Each member of the BrainSTARS team completed the scale during both the pre- and postconsultation phases of the study. In the preconsultation phase, team members used a 5-point scale (1 = not at all, 5 = very much) to rate themselves on each of the 16 competencies on each of the 2 questions: "How proficient are you at the current time in this area?" and "How important to you is further training/consultation in this area?" At the end of the consultation program, team members used the same scale to rate their current proficiency in each of the 16 competencies and to indicate how much the consultation program contributed to their competency in each area.

2. The Neurodevelopmental Inventory[37] was developed to identify profiles of specific neurodevelopmental weaknesses for each student, quantify the degree of impairment in each area, and assess the impact of the BrainSTARS consultation program on student performance in each of the 20 neurodevelopmental abilities detailed in the BrainSTARS manual.[35(pp109–246)] The measure lists the 20 neurodevelopmental abilities with a rating scale (0–100, with lower ratings denoting more

TABLE 1 *Neurodevelopmental inventory*

Neurodevelopmental clusters	Priority[a]	Rating[b]	Date
1. Attention			
2. Emotion regulation			
3. Expressive language			
4. Fine motor control			
5. Gross motor control			
6. Initiation			
7. Judgment			
8. Memory			
9. Mental flexibility			
10. Mental processing speed			
11. New learning			
12. Nonverbal learning			
13. Organization			
14. Planning			
15. Praxis			
16. Receptive language			
17. Self-regulation/adolescent self-regulation			
18. Sensory processing			
19. Social skills			
20. Word retrieval			

[a]Please rank order as many as 5 priority areas.

[b]Rating	Rating description
0–10	Total or almost total lack of capacity in this area, persistent inability to maintain even the most basic skills.
11–20	Gross impairment in this area of ability/skills.
21–30	Significant impairment of abilities/skills in this area.
31–40	Serious impairment of skills in this area that interferes regularly with day-to-day functioning.
41–50	Moderate difficulty with abilities/skills in this area that interferes with functioning on some days or in some settings.
51–60	Some mild difficulty with abilities/skills in this area that sometimes makes it more difficult to function effectively.
61–70	Some mild symptoms of difficulty but generally functioning OK in this area.
71–80	Symptoms of difficulty in this area are mild and transient and generally do not interfere with everyday functioning.
81–90	No difficulty with skills in this area and generally functioning well in this area.
91–100	Strong skills in this area, which support effective functioning and behavior.

impairment) modeled after the functional impairment scale in the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV*).[38(p32)] Descriptive anchor points are provided for each 10-point range. The neurodevelopmental inventory appears as Table 1.

3. The Behavior Rating Inventory of Executive Functions (BRIEF)[39] is an 86-item, behaviorally anchored measure designed to assess executive functioning in everyday environments. The BRIEF items contribute to 1 of 8 individual scales: inhibit, shift, emotional control, initiate, working memory, plan/organize, organize materials, and monitor. Summary scales for metacognitive and behavior regulation functions and a global executive composite are also derived: lower scores denote better functioning. The t scores of 65 or below are considered within the normal range, and t scores above 65 are considered significantly elevated and suggest clinical concern. Reliability and validity of the BRIEF's summary scores vary depending on age group but are generally high; test-retest reliability estimates (across 1–9.5 weeks) range from the mid 0.80s to 0.90s.[39]

4. The Behavior Assessment System for Children (BASC)[40] is a 126- to 131-item (depending on age) behaviorally anchored inventory designed to assist in the differential diagnosis of behavioral and psychological disorders and to aid in the formulation of treatment recommendations for a general clinical population. The BASC items contribute to 1 of 9 individual scales: hyperactivity, aggression, conduct problems, anxiety, depression, somatization, atypicality, withdrawal, and attention problems. Three summary indices, externalizing problems, internalizing problems, and overall behavioral symptoms are also derived. Lower scores denote fewer weaknesses. The *t* scores of 59 or below are considered to be within the normal range; *t* scores between 60 and 70 are considered to indicate "At Risk" scales of traits that bear close monitoring; *t* scores above 70 are considered to be significantly elevated and of clinical concern. Reliability and validity of the BASC's summary scores vary depending on age group but are generally high; stability of the individual and summary scales over time is high (0.90s).[40]

Procedures

Participants were recruited from referrals to the outpatient psychology program in the Department of Rehabilitation Medicine of the Children's Hospital in Denver. Parents whose child had a history of ABI and who expressed concerns about serious current school difficulties were approached. Thirty consenting participants were enrolled and completed the study. Before beginning the consultation program, the student's parent(s) and school personnel who planned to participate rated themselves on the ABI Parenting/Teaching Proficiency Scale. At least 1 parent and 1 teacher, who knew the student well, completed the BRIEF and the BASC about the student. When this information was returned to the consultant, the first consultation appointment was scheduled. The second and third meeting times were scheduled to provide intervals of 6 to 8 weeks between sessions.

The BrainSTARS manual was the primary resource for the consultation program. At the first meeting, the ABI Parenting/Teacher Proficiency Scale ratings were summarized and discussed. Copies of the manual were given to the student's parents and school personnel, and sections that address the team members' self-identified educational needs were highlighted. During the team's discussion of the student's problems at home and school, the consultant helped the team to conceptualize these problems as indicators of weaknesses in 1 or more neurodevelopmental abilities and to prioritize up to 5 neurodevelopmental abilities on which to focus. The student's level of impairment in each identified area was discussed and the team used the Neurodevelopmental Inventory to assign a consensus rating of level of functional deficit in each targeted area. Pertinent sections of the BrainSTARS manual were used to develop a working plan of accommodations and interventions. The second and third consultation sessions included discussion of the student's functional progress, tracking ongoing or new problems, and reviewing and changing the working plan of accommodations. At the end of the final session, ratings in each targeted area were again made by team consensus on the Neurodevelopmental Inventory, and ratings of the student on the BRIEF and BASC were made by the same parent and teacher who had provided preconsultation ratings. Finally, individuals who had participated in all 3 consultation sessions rated themselves on the ABI Parenting/Teaching Proficiency Scale. An anonymous follow-up survey requesting the participant's evaluation of the intervention and its perceived impact on themselves, the team, and the student was sent to all participants 3 months after the last session.

Hypotheses

It was hypothesized that the BrainSTARS consultation program would increase both parents' and teachers' ability to understand and intervene effectively for a child with ABI as assessed by self-report ratings on the ABI Parenting/Teaching Proficiency Scale. Further, it was hypothesized that there would be improvement in students' functioning in targeted neurodevelopmental areas, as assessed by the neurodevelopmental inventory. The BRIEF and the BASC, as 2 well-established and highly regarded child behavior instruments, were included for exploratory analysis. It was hypothesized that the students would have significantly elevated scores on the BRIEF and the BASC before consultation and that these scores would be lower after BrainSTARS consultation. However, it was expected that these effects would be smaller than those on the 2 instruments tailored to the BrainSTARS program.

RESULTS

Impact of the BrainSTARS program on parents' and teachers' proficiencies

A total of 59 adult participants attended all 3 consultation sessions and provided complete self-rating data on the ABI Parenting/Teaching Proficiency Scale at both the pre- and postconsultation assessments. Summing the 16 items on the scale, the mean self-rating at the preconsultation assessment was 3.68 and the mean at postconsultation was 4.06, a statistically significant difference ($t = 5.70$, $P < .001$) that reflects improved ability on parents' and teachers' part to understand and respond effectively to their children with ABI. The same results obtained when the sample was divided into parents ($n = 21$) and teachers ($n = 38$): the overall postconsultation scores were higher than preconsultation scores and the difference was statistically significant for both groups (parents' $\text{mean}_1 = 3.50$; $\text{mean}_2 = 3.97$; $t = 4.34$, $P < .001$; teachers' $\text{mean}_1 = 3.78$; $\text{mean}_2 = 4.11$; $t = 3.91$, $P < .001$). Finally, the pre- and postconsultation means for the proficiency scale's 16 items were computed for the combined sample; these data are presented in Table 2 along with the results of paired-sample t tests for each pre-post difference. Applying the Bonferroni correction for inflation of alpha due to multiple comparisons (which lowers the statistical significance level from 0.05 to 0.003), 9 of the 16 item mean differences are statistically significant.

Impact of the BrainSTARS program on students who have Acute Brain Injury

The neurodevelopmental inventory

Each student's team targeted up to 5 deficit areas for intervention, and this rating scale was used to quantify degree of impairment on each. At least one neurodevelopmental deficit area was targeted, and complete pre- and postconsultation data were provided by each of 30 teams. Because fewer than 5 areas were identified for some students, the sample sizes vary.

The mean ratings of students' neurodevelopmental deficits pre- and postconsultation were computed, and paired-sample t tests for the difference between the means were conducted. These data are summarized in Table 3. Each prioritized ability shows statistically significant improvement from pre- to postconsultation at the traditional .05 level of significance, and all remain so after the Bonferroni correction is applied (which lowers the statistical significance level from .05 to .01). The mean differences are not only statistically significant but also reveal substantively meaningful degrees of improvement in all prioritized neurodevelopmental areas.

TABLE 2 *Ratings on the ABI Parenting/Teaching Proficiencies Scale*

	Preconsultation		Postconsultation				
Self-rated proficiency of respondent	**Mean**	**SD**	**Mean**	**SD**	***t***	**df**	***P* value**
1. Identify student's cognitive or behavior problems clearly and specifically to allow for accurate observation and measurement.	3.34[a]	0.96	3.96[a]	0.75	4.94	66	<.001[a,b]
2. Link student's problems/symptoms to underlying neurodevelopmental deficits/challenges.	2.97[a]	1.14	3.72[a]	0.90	6.2	66	<.001[a,b]
3. Identify specific and progressive learning objectives for student.	3.61[a]	1.00	4.00[a]	0.87	3.45	66	.001[a,b]
4. Perform a task analysis of a complex skill.	3.60[a]	1.09	3.91[a]	0.88	2.56	66	.013
5. Structure the environment to support positive behavior and effective learning.	3.82[a]	1.06	4.21[a]	0.83	3.28[a]	66	.002[a,b]
6. Arrange positive antecedent conditions to support organized, successful behavior.	3.55[a]	1.05	3.94[a]	0.89	3.17[a]	63	.002[a,b]
7. Use visual cues and physical prompts to support student's successful behavior.	3.91[a]	1.00	4.06[a]	0.88	1.49	64	.142
8. Respond effectively to a behavior problem.	3.84[a]	1.04	4.19[a]	0.92	2.81	63	.007
9. Identify causes of a recurring behavior problem.	3.42[a]	0.96	3.72[a]	0.81	2.45	63	.017
10. Modify lessons and assignments to meet student's learning and social needs.	3.89[a]	1.08	4.08[a]	0.97	1.80	65	.077
11. Understand how student's challenges have affected his/her family and identify and meet family needs/priorities.	3.63[a]	1.03	4.03[a]	0.92	3.11	66	.003[a,b]
12. Collaborate with parent/school team.	4.64[a]	0.77	4.64[a]	0.75	0.00	66	1.00
13. Hold a similar understanding of student's needs and how to intervene.	3.94[a]	1.22	4.43[a]	0.94	3.52[a]	66	.001[a,b]
14. Use testing information effectively in planning programs and accommodations.	3.55[a]	1.21	4.08[a]	0.95	3.82[a]	65	.001[a,b]
15. Participate in the individualized education plan process to address student's educational needs specifically and comprehensively.	4.28[a]	1.08	4.50[a]	0.85	1.81	63	.075
16. Identify and obtain community supports and services.	3.15[a]	1.15	3.48[a]	1.04	2.20	66	.032
Mean of the 16 subscales	3.68[a]	0.65	4.06[a]	0.59	5.70	58	<.001[a,b]

[a] $P \leq .05$.
[b] Statistically significant with Bonferroni correction applied.

Some neurodevelopmental areas were prioritized by the parent-teacher teams more than others. The 10 most commonly targeted skill areas were as follows: new learning, mental flexibility, organization, mental processing speed, memory, attention, expressive language, initiation, emotion regulation, and planning. As summarized in Table 4, all 10 skill areas showed statistically significant mean improvement from pre- to postconsultation at the traditional .05 level, and 7 remained significant using a Bonferroni correction (which lowers the statistical significance level from .05to .005). In all cases, the estimated mean differences also reveal substantively meaningful degrees of improvement in each skill area.

The Behavior Rating Inventory of Executive Functions

Pre- and postconsultation ratings on the BRIEF were obtained from one parent of each child for 18 children and from one teacher per child for 20 children. As there are different forms of the BRIEF for teachers and parents, the data were not combined for analysis; teacher and parent data were analyzed separately. The pre- and postmeans for the 3 BRIEF composites were computed and the significance of the difference was evaluated by paired-sample t test. The mean index scores were in the "average" range for parents' ratings, both pre- and postconsultation (global executive control = 64.9 pre, 64.3 post). The mean index scores were in the "elevated"

TABLE 3 *Ratings of prioritized neurodevelopmental abilities pre- and postconsultation*

	Preconsultation		Postconsultation				
	Mean	**SD**	**Mean**	**SD**	***t***	**df**	***P* value**
Neurodevelopmental ability priority #1	28.7[a]	15.3	50.7[a]	20.1	7.05	29	<.001[a]
Neurodevelopmental ability priority #2	30.8[a]	12.2	53.9[a]	16.1	8.04	29	<.001[a]
Neurodevelopmental ability priority #3	34.8[a]	11.8	51.5[a]	17.8	5.59	27	<.001[a]
Neurodevelopmental ability priority #4	39.1[a]	14.2	57.1[a]	13.7	6.07	25	<.001[a]
Neurodevelopmental ability priority #5	46.9[a]	15.5	62.3[a]	18.8	4.49	14	.001[a]

[a] $P \leq .05$.

range for teachers' ratings, both pre- and postconsultation (global executive control = 68.6 pre, 67.5 post). None of the comparisons was statistically significant, indicating no change on the BRIEF.

The Behavior Assessment System for Children

Pre- and postconsultation scores on the BASC were obtained from a single parent of each child for 16 children and from one teacher per child for 18 children. As there are different forms of the BASC for teachers and parents, the data were not combined for analysis; teacher and parent data were analyzed separately. The pre- and postmeans for the 3 BASC composites were computed, and the significance of the difference was evaluated by paired-sample *t* test. The mean index scores were all solidly in the "average" range for both parents' and teachers' ratings, both pre- and postconsultation (parent BSI = 56.5 pre, 54.6 post; teacher BSI = 57.4 pre, 53.9 post). None of the comparisons was statistically significant, indicating no change on the BASC indices.

Ratings of the importance of TBI training

On average, both parents and teachers rated training and consultation in each of the 16 TBI proficiencies as important, but the parents reported the greater overall interest (mean "importance" rating for parents (n = 32) = 4.49, SD = 0.7; for teachers (n = 49) = 3.75, SD = 1.1). The group difference was statistically significant (t = 3.48, df = 79, $P < .001$). For the parents, the 5 most highly rated educational needs were as follows (mean rating in parentheses): (1) learning to participate more effectively in the individualized education plan process (4.70), (2) developing a shared understanding with school personnel of their child's needs and what to do to help him or her (4.64), (3) identifying specific and progressive learning objectives (4.61), (4) linking observed problems/symptoms to underlying neurodevelopmental deficits (4.58), and (5) using test information to plan interventions and accommodations (4.55).

For the school personnel, the 5 most highly rated educational needs were as follows (mean rating in parentheses): (1) identifying appropriate supports and services

TABLE 4 *Ratings of the most frequently prioritized neurodevelopmental deficits*

	Preconsultation		Postconsultation				
	Mean	**SD**	**Mean**	**SD**	***t***	**df**	***P* value**
New learning	35.6[a]	17.9	56.6[a]	22.0	4.97	15	<.001[a]
Mental flexibility	41.4[a]	14.1	53.6[a]	16.1	4.96	12	<.001[a]
Organization	36.5[a]	11.9	52.5[a]	13.4	4.48	10	.001[a]
Mental processing speed	33.5[a]	10.8	52.8[a]	14.5	4.46	10	.001[a]
Memory	46.9[a]	15.5	62.3[a]	18.8	4.24	9	.002[a]
Attention	33.8[a]	16.0	53.3[a]	20.5	4.30	8	.003[a]
Expressive language	29.8[a]	14.7	51.7[a]	20.6	3.74	8	.006[a]
Initiation	33.7[a]	11.6	65.1[a]	11.9	4.89	8	.001[a]
Emotional regulation	35.9[a]	14.9	55.6[a]	17.6	3.83	7	.006[a]
Planning	34.6[a]	13.4	50.6[a]	16.4	2.48	7	.042[a]

[a] $P \leq .05$.

for the student and family (4.14), (2) understanding impact of ABI on student's family and helping to meet family needs/priorities (4.08), (3) identifying cognitive and behavior problems clearly and specifically (4.02), (4) linking observed problems/symptoms to underlying neurodevelopmental deficits (3.96), and (5) setting positive antecedent conditions to support more successful behavior and learning (3.86).

Anonymous postconsultation evaluation

Fifty-one participants returned the anonymous evaluation survey 3 months after the end of the intervention. The survey asked to what degree the BrainSTARS program specifically led to desired positive outcomes. On average, the respondents rated the program favorably, with mean scores' ranging from 3.6 to 4.6 on a 5-point scale. Specifically, respondents indicated that the program led to increased understanding of the student (4.34), improved morale (4.33), improved family/school working relationship (4.24), positive change in educational programming for the student (4.14), and significantly improved learning on the student's part (3.90). The usefulness of the BrainSTARS manual as a resource was rated very highly, at 4.56.

DISCUSSION

The primary site of cognitive rehabilitation for children and youths following ABI is their home and school community. Although TBI has been identified as an educational disability under Individuals with Disabilities Education Act since 1990, school personnel typically lack adequate education and training about this disability. Studies of school personnel preparedness in pediatric TBI indicate that formal preservice coursework is rare, and most teachers, special educators, and school psychologists learn about TBI through "on-the-job experience."[31,32] Educators often feel inadequate in their ability to understand and provide appropriate accommodations for students with TBI. Often, these students' Individualized Education Plans are based on a better-understood disability classification such as attention-deficit/hyperactivity disorder, perceptual/communicative disorder, or emotional/behavioral disturbance, but the students continue to fail despite significant effort by the school team. For effective school programming to occur, school personnel and parents must first understand that the child's behavioral and learning challenges reflect underlying disruptions of fundamental neurodevelopmental abilities and skills. Next, they need to understand that the child's disability stems not just from their impairments but also from the poor fit between the child's abilities/impairments and environmental demands/expectations. Because of the almost inevitable impact of pediatric TBI on the developing executive control system,[9,10,41] parents and school personnel must use evidence-based interventions (modeling, positive behavioral supports, environmental and task analysis, and specific skill building) for remediation of major executive function impairments when they address learning, behavioral, and social problems.[10,15,41] Finally, models that focus on increasing the capacity of parents and teachers to work together offer benefits such as mutual education, shared goal setting, creative problem solving, and the consistent application of instructional methods across home and school environments.[7,9,10,19,37,42] The more thoroughly parents and teachers understand the impact of TBI on development, the more effectively they can structure developmentally relevant learning opportunities to reduce the functional disability associated with brain injury.

The BrainSTARS manual provides a model for understanding and treating the learning and behavioral sequelae of pediatric ABI using a method that is both standardized and tailored to the individual's unique needs. In particular, the BrainSTARS program offers a comprehensive informational/educational resource that can be used to address the particular challenges of each student as well as the individual skill-building needs of each parent and school member. The flexibility of the consultation program allows parents and school personnel to assess their own skills in working with a particular child and to target ways to become more effective change agents.

Although other educational disabilities such as attention deficit disorder, attention-deficit/hyperactivity disorder, and significant emotional/behavior disorders have symptoms that resemble those of TBI, the educational problems caused by TBI are often unique. Because of damage to frontal and prefrontal cortices typically associated with moderate to severe TBI, children with TBI often have difficulty learning from consequences-based approaches such as school suspension, disciplinary referral, time-out, or even privilege/incentive-based behavior programs. Children who have TBI repeatedly find themselves in trouble for the same problem behaviors. Although they can often say what they should not do, they do not seem to make use of that knowledge, a hallmark of executive dysfunction. The BrainSTARS manual and consultation program teach parents and teachers to use positive behavior supports, task analysis, positive replacement behaviors, and antecedent-based "stage setting" to address these special needs of students who have ABI. For example, by explaining how a child's failure to hand in homework can stem from organizational deficits rather than stubbornness, the BrainSTARS manual destigmatizes the behavior and focuses on teaching specific organizational skills important for meeting everyday life expectations.

The results of this pilot study suggest that the BrainSTARS manual and consultation program can increase

certain parent and teacher proficiencies in addressing the needs of their children who have ABI. This increased skill appears to improve students' functioning in the areas of neurodevelopmental deficit that were targeted by the parent and teacher teams. Both parents and teachers reported that they found the BrainSTARS manual and consultation program helpful in several ways, including increased understanding of the student, improved morale and optimism, and improved working relationship between parents and teachers. In the 3-month follow-up survey, they also reported that the program contributed to "significantly improved" behavior, social adjustment, and learning on the student's part. However, trait behaviors and competencies assessed by the BRIEF and BASC, which were not directly tailored to the BrainSTARS manual or program, did not improve significantly. One explanation for this finding is that both instruments were designed to yield stable scores on subscales and summary indices; both tests demonstrate high reliability over the 4-month test-retest interval that was our pre- to posttest period. A second plausible explanation involves the finding that teachers' and parents' ratings on the BASC and parents' scores on the BRIEF were solidly "average," both pre- and postconsultation. The BRIEF summary scores for teachers were in the "elevated" range, but just barely so, with mean *t* scores' ranging from 65 to 69. Our small sample size did not permit more extensive data analysis of scores on individual subscales. This type of analysis would be very instructive, particularly for students whose teams prioritized executive functions as their primary neurodevelopmental deficits. A larger sample would permit, for instance, an *a priori* hypothesis of pre- to postchange on the planning/organization scale of the BRIEF for those students whose teams prioritized organization deficits on the neurodevelopmental inventory. Additional corroborative data pertaining to the impact of the BrainSTARS program on student outcomes, both behavioral and academic, are clearly needed.

Designing a randomized clinical study of the BrainSTARS intervention would be challenging due to the huge contribution of individual variation to outcomes of ABI[43] and due to the practical difficulties of establishing an alternative treatment or no-treatment control group in the school setting.[44] However, the results of this pilot study should be interpreted with caution because it used a quasi-experimental one-group pretest-posttest design.[45–47] As a result, changes in pre- to posttest mean scores could be due to factors other than the consultation program. One alternative explanation is regression toward the mean.[46] Parents were recruited into the study because they were concerned about the difficulties their children with TBI were experiencing at school. Regression toward the mean would bias the results if (1) the participants' competencies fluctuated over time and (2) participants started the study when their competence was at a relatively low point, in which case positive changes might indicate nothing more than their competencies' returning naturally to more typical (ie, higher) levels. Arguing against this explanation is the strong sense we obtained from both parents and teachers that participants' proficiencies were higher at the time of the postconsultation than they had ever been rather than at average levels, as would be the case if the regression-toward-the-mean explanation were correct. Another alternative explanation is that pre-post changes were due to maturation that the parents, teachers, and students were experiencing in their proficiencies and deficits. However, the facts that (1) many of the pre-post changes that were found were substantial, (2) the students had been expressing the developmental consequences of ABI for a relatively long period of time (an average of 2.6 years), (3) disability associated with pediatric ABI increases rather than decreases with development,[48] and (4) the consultation program lasted a relatively short period of time (ie, 4 months) argue against this alternative explanation. Finally, one should also consider whether the results are due to nothing more than a response bias (or placebo effects) wherein parents and teachers report positive changes to please either themselves or the researchers or respond positively because any (nonspecific) intervention can have a positive impact on behavior.[48] Arguing against this alternative explanation is the fact that pre-post changes were not uniformly positive. The largest changes were in the areas most likely to be influenced by the consultation program (such as the parent and teacher proficiencies explicitly targeted by the program) and not in the areas that would ultimately be most pleasing to either the participants or researchers (such as the behaviors assessed on the BRIEF and the BASC). Nonetheless, we cannot conclude that response biases were not present, though we note that when self-report measures are used, such biases can just as easily be present in randomized experiments as in quasi-experimental designs.[47]

While caution is warranted in interpreting these pilot data, we believe the results are sufficiently encouraging to justify further investigation of the BrainSTARS program using more rigorous experimental methods and more objective measures of proficiency and student behavior.[44,49] Future research could profitably address a range of additional questions as well. Should the BrainSTARS manual be used as effectively without the assistance of a consultant? If not, what are the essential ingredients of the consultation program? Might less intensive forms of consultation (eg, televideoconferencing) be particularly applicable in rural and/or other underserved areas? Even if a 3-session program of consultation is sufficient to produce improvements, would a "booster shot" of consultation sessions (as suggested in informal

interactions with parents and teacher) be valuable as well, particularly at times of developmentally sensitive changes (eg, early adolescence, young adulthood), major personnel change, or environmental transitions (preschool to elementary, elementary to middle, and middle school to high school)? Best practices for students who have ABI would likely include a parent-school team meeting at least once each year to keep pace with the student's changing profile and school personnel's evolving needs.

The timing of the consultation intervention also needs to be investigated. In the current study, there was substantial variation in the time between ABI and the implementation of the BrainSTARS consultation program. It would be valuable to assess the effects of consultation initiated immediately after ABI compared with a waitlist control group. Similarly, it would be worth evaluating individual variables that might affect the program's effectiveness such as (1) current age and grade and (2) developmental stage at the time of injury. It would also be helpful to look at the school year cycle to determine whether there might be an optimal time to initiate the BrainSTARS consultation program. Finally, a longer time to follow up on the effects of the BrainSTARS program would help assess the potential rippling impact of the program over time and assess related behavior change on the part of parents and students.

Parents and school personnel appreciated that the consultants provided ABI-specific education, trained a capable team, and developed plans of neurodevelopmental, educational, and psychological accommodations targeted at the individual student's current needs. Not only because of natural constraints of time, distance, and availability of expertise but also because of our bias that it is better for children and their families to have their educational needs met through existing community resources, we hope that the intervention could be carried out by school district personnel in collaboration with the student's parents. The BrainSTARS manual was designed to be an appealing, essentially nontechnical, self-instructional handbook; comments by the teams suggest that the manual could be used independently by district-based TBI consultants or even by school-based teams who have no prior education in ABI, providing appropriate interventions over the years as a student grows and develops after brain injury. Further research on the necessary and sufficient supports to accomplish this outcome is planned.

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