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Parent reports of children's working memory, coping, and emotional/behavioral adjustment in pediatric brain tumor patients: A pilot study

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ABSTRACT

Neurocognitive problems in childhood survivors of brain tumors are well documented. Further, research has shown that problems in cognitive functioning may be associated with impairment in the use of complex strategies needed to cope with stress, including secondary control coping strategies (e.g., acceptance and cognitive reappraisal) which have been associated with fewer adjustment problems. The present study measured cognitive function, coping strategies, and adjustment in children ages 6–16 years at the time of brain tumor diagnosis and at two follow-up time-points up to 1 year post-diagnosis. In a prospective design, working memory was assessed in a total of 29 pediatric brain tumor patients prior to undergoing surgery, child self-reported coping was assessed at 6 months post-diagnosis, and parent-reported child adjustment was assessed at 12 months post-diagnosis. Significant correlations were found between working memory difficulties and secondary control coping. Secondary control coping was also negatively correlated with child attention and total problems. Regression analyses did not support secondary control coping mediating the association between working memory difficulties and child attention or total problems. These findings represent the first longitudinal assessment of the association between working memory, coping, and adjustment across the first year of a child's brain tumor diagnosis and suggest a possible role for early interventions addressing both working memory difficulties and coping in children with brain tumors.

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Brain tumors are the second most common type of pediatric cancer in the United States (Ward, DeSantis, Robbins, Kohler, & Jemal, 2014). Over 4000 children are diagnosed with brain tumors each year in the United States (Ostrom et al., 2015) and the incidence of pediatric cancer is rising (Ward et al., 2014). Progress in medical treatments for pediatric brain tumors has led to a significant decrease in mortality rate, with 5-year survival rates increasing from 58.9% in 1975–1977 to 74.4% in 2005–2011 (Howlader

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et al., 2013). Given that an increasingly large population of children diagnosed with brain tumors will transition into survivorship, examining factors influencing their quality of life is therefore a matter of great importance.

A growing body of research has highlighted clear areas in which children diagnosed with brain tumors appear to suffer adverse late effects. Specifically, cognitive executive functioning (Robinson, Fraley, Pearson, Kuttesch, & Compas, 2013; Robinson et al., 2010), especially working memory (Knight et al., 2014; Mabbott et al., 2011), and emotional/behavioral adjustment (Fuemmeler, Elkin, & Mullins, 2002; Schultz et al., 2007) have been identified as important aspects of the psychosocial sequelae of a pediatric brain tumor. Children diagnosed with brain tumors are also faced with a number of stressors, including disruptions in daily/role functioning (e.g., missing school, disrupted peer relationships), physical effects of treatment (e.g., feeling sick from treatments), uncertainty about the disease and its treatment (e.g., not understanding medical professionals), and fears about death (Rodriguez et al., 2012). The stressors associated with pediatric brain tumors are often uncontrollable and the presence of these stressors underscores the importance of understanding the ways that children cope with stress. Thus, taken together, previous research highlights working memory, coping, and emotional/behavioral adjustment as important areas warranting attention in children diagnosed with pediatric brain tumors.

Coping has been defined as controlled, volitional efforts to regulate cognitions, emotions, behavior, physiological reactions, and the environment in response to stress and can include either engaging with or disengaging from the stressor (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001). Drawing on Weisz and colleagues' (e.g., Band & Weisz, 1990; Han, Weisz, & Weiss, 2001; Rudolph, Dennig, & Weisz, 1995) model of child/adolescent perceived control (i.e., the capacity to cause an intended outcome), three types of coping can be distinguished – primary control coping, secondary control coping, and disengagement coping (Compas, Jaser, Dunn, & Rodriguez, 2012; Compas et al., 2001, 2017; Connor-Smith, Compas, Wadsworth, Thomsen, & Saltzman, 2000). Primary control coping includes strategies intended to directly change the source of stress (e.g., problem solving) or one's emotional reactions to the stressor (e.g., emotional expression and emotional modulation). Secondary control coping includes efforts to adapt to stress (e.g., cognitive reappraisal, positive thinking, and acceptance). Finally, disengagement coping includes efforts to orient away from the source of stress or one's reactions to it (e.g., avoidance, denial, and wishful thinking). Confirmatory factor analyses have supported the three-factor structure that is consistent with this model in culturally diverse samples of children and adolescents coping with a range of different types of stress, including illness related stress (e.g., Compas et al., 2006; Connor-Smith et al., 2000; Wadsworth, Reickmann, Benson, & Compas, 2004).

This control-based model of coping has generated promising findings on the association between coping and emotional distress in pediatric populations (e.g., Compas et al., 2012). Notably, this model has been recently applied to understanding the relation between coping and adjustment in a large multi-informant study of children with cancer (Compas et al., 2014). This study examined children's coping and symptoms of anxiety/depression near the time of diagnosis based on mothers' reports, fathers' reports, and children's self-reports (Compas et al., 2014). Within and across

informant correlation and regression analyses indicated unique effects for secondary control coping being associated with better emotional adjustment in children diagnosed with cancer, including children diagnosed with brain tumors (Compas et al., 2014). These findings highlight the unique role of secondary control coping and its association with emotional adjustment in children coping with the uncontrollable stressors associated with a pediatric cancer diagnosis.

Recent research has highlighted the importance of examining the interrelation between cognitive functioning and coping (e.g., Andreotti, Root, Ahles, McEwen, & Compas, 2015). Specifically, it has been proposed that cognitive executive function skills provide a foundation for employing cognitive coping strategies including cognitive reappraisal, acceptance, and distraction (Andreotti et al., 2015; Compas, Campbell, Robinson, & Rodriguez, 2009). This association may be important to consider in those diagnosed with cancer and the relation between coping and cognitive functioning has been examined in a limited number of pediatric samples (Campbell et al., 2009; Hocking et al., 2011; Robinson et al., 2015). One specific aspect of cognitive function that is of particular interest is working memory (Baddeley, 2012). Working memory, which is the ability to manipulate information that is held in short-term memory, allows for the reappraisal of the current information in more neutral or positive terms, an important aspect of secondary control coping. Therefore, working memory may affect the ability to use secondary control coping strategies.

Working memory has been found to be positively correlated with the use of secondary control coping in childhood acute lymphocytic leukemia (ALL) survivors (Campbell et al., 2009) and neural activation during a working memory task was found to be associated with secondary control coping in survivors of a pediatric brain tumor (Robinson et al., 2015). Further, coping has been found to mediate the association between executive function and emotional/behavioral adjustment in individuals with multiple sclerosis (Grech et al., 2015; Rabinowitz & Arnett, 2009), youth with functional abdominal pain (Hocking et al., 2011), and children diagnosed with ALL (Campbell et al., 2009). These findings point to the importance of understanding the associations among working memory, coping processes, and adjustment. These associations may be particularly important to investigate in children diagnosed with brain tumors given the difficulties in working memory (e.g., Conklin et al., 2012) and emotional/behavioral adjustment (e.g., Schultz et al., 2007) they experience, as well as the stressors associated with diagnosis and treatment (Rodriguez et al., 2012).

Previous studies of working memory, coping, and adjustment in children diagnosed with brain tumors have been limited in two primary ways. First, studies have largely focused on survivors many months to years after their diagnosis (e.g., Robinson et al., 2015), not on children recently diagnosed or undergoing treatment. Second, no studies have examined the association between working memory, coping, and adjustment in children diagnosed with brain tumors longitudinally. Assessing this relation early on in the treatment process may be particularly valuable, given that impairments in working memory appear to increase over time in children diagnosed with brain tumors (Knight et al., 2014; Mabbott et al., 2011). Previous studies have shown that it is feasible to assess cognitive functioning beginning near the time of the child's brain tumor diagnosis (Thigpen et al., 2016).

In this study, we examine the longitudinal associations among working memory, coping, and adjustment over the first year after a pediatric brain tumor diagnosis. First, we hypothesized that working memory tested presurgery will be specifically and

positively related to child's use of secondary control coping 6 months later. Second, we hypothesized that secondary control coping specifically would be a predictor of adjustment at 12-month follow-up. Finally, we hypothesized that secondary control coping will mediate the relation between working memory and adjustment such that poorer working memory will be related to less use of secondary control coping, which in turn will be related to higher levels of adjustment problems.

Method

Participants

Eligible participants in the current study included 32 patients aged 6–16 years old who were identified as having a primary brain tumor over the course of 2 years of recruitment through the Department of Pediatric Neurosurgery at a university-affiliated children's hospital. Twenty nine of these 32 (91%) patients were referred to the psychology team and enrolled into the study as well as provided data prior to the patients' surgery (T1). Reasons for participants not enrolling prior to surgery included insufficient time between referral and scheduled resection for cognitive testing to take place and referral after surgery. Follow-up assessments occurred at 6 months (T2, $n = 14$) and 12 months (T3, $n = 20$) post-diagnosis. Mothers completed measures reporting on their children ages 6–16 at T1 and T3. A subsample of children ages 10–16 years old ($n = 14$) completed a self-report measure of coping at T2, accounting for the lower sample size at this time point. Reasons for missing data at individual time points included being unable to reach the family for a follow-up assessment ($n = 11$), family transferred care to another facility ($n = 1$), and the child's death ($n = 1$). Demographic and medical characteristics of the study sample are provided in [Table 1](#).

Measures

Digit span

The Digit Span subtest from the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV; Wechsler, 2003) was used as a performance-based task of working memory, consistent with previous studies (e.g., Vaquero, Gómez, Quintero, González-Rosa, & Márquez, 2008). Children completed the WISC-IV Digit Span subtest at the first assessment prior to surgery (T1). The WISC-IV Digit Span subtest was administered to participants ages 6–16. Subtest scaled scores range from 1 to 19 and have a standard mean of 10 and a standard deviation of 3.

Parent report of problems in working memory

The Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) provides an index of parents' concerns about their children's problems with working memory. Caregivers completed the BRIEF at the first assessment prior to surgery (T1). The standard BRIEF was used for participants 6 years and older. The working memory index score is presented as a T score, with a mean of 50 and a standard deviation of 10 (higher scores reflect greater problems in working memory). Scores above 65 are considered to reflect significant problems in executive function.

Table 1. Descriptive statistics: demographic and medical variables.

	<i>N</i>	%
Sex		
Males	18	62
Females	11	38
Age, <i>M</i> (<i>SD</i>)	10.79	(3.18)
Ethnicity		
White/Caucasian	17	59
Black/African American	8	28
Latino or Hispanic	2	7
Other (mixed)	2	7
Tumor type		
Astrocytoma	8	28
Glioma	7	24
Medulloblastoma	3	10
Other	11	38
Tumor location		
Posterior fossa	12	41
Cerebral hemispheres	12	41
Frontal	2	17
Temporal	3	25
Parietal	3	25
Other (diffuse)	4	33
Ventricles	3	10
Pineal	1	3
Brainstem	1	3
Temporal lobe epilepsy	10	34
WHO grade		
I	14	48
II	3	10
III	6	21
IV	6	21
Treatment		
Surgery only	14	48
Chemotherapy only	2	7
Radiation only	5	17
Chemotherapy and radiation	8	28

Other tumor types include primitive neuroectodermal tumor (1), glioblastoma (2), germinoma (2), ganglioglioma (2), ependymoma (1), dysembryoplastic neuroepithelial tumor (1), craniopharyngioma (1), and choroid plexus papilloma (1).

General cognitive functioning

The Wechsler Abbreviated Scales of Intelligence (WASI; Wechsler, 1999) provides a measure of child general cognitive functioning. The WASI was completed by children at T1. The WASI Full Scale IQ (FSIQ) score is presented as a standard score with mean of 100 and standard deviation of 15. The WASI FSIQ index was included in analyses in order to control for overall IQ in analyses of working memory indices and other variables.

Children's coping

This study used the Responses to Stress Questionnaire-Pediatric Brain Tumor Version (RSQ-PBT; Connor-Smith et al., 2000) to obtain children's self-reports of their coping with the diagnosis and treatment of a pediatric brain tumor. Children completed the RSQ-PBT at 6 months post-surgery (T2). The RSQ-PBT version includes a list of 12 stressors associated with the diagnosis and treatment of a brain tumor (e.g., missing school, frequent hospital or clinic visits, changes in personal appearance), and 57 items reflecting voluntary (coping) and involuntary (automatic) stress responses of children/

adolescents in response to cancer-related stressors. Because this study was focused on children's coping responses, only the three voluntary coping scales are reported. The coping scales include primary control coping (i.e., problem solving, emotional modulation, and emotional expression), secondary control coping (i.e., acceptance, cognitive restructuring, positive thinking, and distraction), and disengagement coping (i.e., avoidance, denial, and wishful thinking). Using the standard method for scoring the RSQ-PBT, and to control for possible response bias and individual differences in base rates of item endorsement, proportion scores were calculated by dividing the total score for each factor by the total score for the entire RSQ-PBT (e.g., Connor-Smith et al., 2000; Osowiecki & Compas, 1998, 1999; Vitaliano, DeWolfe, Maiuro, Russo, & Katon, 1990). In the current sample, internal consistencies of children's self-reports (ages 10–17) were primary control, $\alpha = 0.89$; secondary control, $\alpha = 0.87$; and disengagement, $\alpha = 0.84$.

Children's emotional and behavioral adjustment

Parents' reports of their children's attention problems, symptoms of anxiety and depression, and total emotional/behavioral problems were assessed at 12 months (T3) post-diagnosis with the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001). Reliability and validity are also well established for the CBCL, and normative *T* scores are derived from parents' reports on a nationally representative sample of children and youth ages 6–17 years old (Achenbach & Rescorla, 2001). The attention problems scale provided an indicator of difficulties in concentration and ability to focus on tasks. The anxiety/depression scale served as the measure of child emotional distress. The total problems scale provided an indication of global difficulties in adjustment.

Treatment and neurological risk factors

The Neurological Predictor Scale (NPS; Micklewright, King, Morris, & Krawiecki, 2008) was used to examine the possible association of tumor treatment and other neurological sequelae with the study dependent measures. The NPS provides a cumulative score that is based on treatment factors (i.e., radiotherapy, chemotherapy, and neurosurgery) and presence or absence of neurological risk factors (i.e., hormone deficiency, hydrocephalus, and seizure medication). Information regarding the presence or absence of temporal lobe epilepsy (TLE) within the first year from diagnosis was also extracted from the child's medical chart to examine possible differences in findings across groups.

Procedure

The pediatric neurosurgery team identified newly diagnosed brain tumor patients and provided contact information to the psychology research team. A member of the research team then contacted the parents of identified patients to review the study in detail and determine their desire to participate. Parents provided informed consent and children over the age of 6 years provided assent. The test battery included direct performance-based assessment of neurocognitive function as well as parent report of their children's functioning. As described above, specific subtests were administered dependent upon participant age. These patients were a subset of a larger sample of participants in a study assessing overall neurocognitive and psychological functioning

of pediatric brain tumor patients. Patients were excluded if there was recurrence of a previous cancer or a previous history of another form of cancer.

Data analyses

All analyses were conducted using the Statistical Package for the Social Sciences (IBM SPSS version 23) and results were determined to be significant at $p < .05$. Power analyses using G* Power (Faul, Erdfelder, Buchner, & Lang, 2009) indicated that analyses with 14 participants provide power to detect correlations of 0.67 or greater at the $p < .05$ level of significance, analyses with 20 participants provide power to detect correlations of 0.58 or greater at the $p < .05$ level of significance, and analyses with 29 participants provides power to detect correlations of 0.49 or greater at the $p < .05$ level of significance. In multiple regression analyses, this sample provides power to detect R^2 of 0.49 or larger with two predictors. To test the first hypothesis, bivariate Pearson correlation analyses examined the associations between measures of working memory at T1 and child's coping strategies at T2. To test the second hypothesis, bivariate Pearson correlation analyses examined the associations between child's use of coping strategies at T2 and parent report of child adjustment at T3. Finally, tests of mediation were performed to determine if T2 secondary control coping mediates the relation between T1 working memory and T3 adjustment (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002).

Results

Descriptive statistics

Means, standard deviations, and sample sizes are reported in Table 2 for children's performance on the Digit Span subtest of the WISC-IV, parents' reports of children's working memory problems on the BRIEF, children's self-reports on coping on the RSQ-PBT, and parents' reports of symptoms of attention problems, anxiety/depression, as well as total problems on the CBCL. This sample of children with brain tumors performed approximately one-half standard deviation below the normative mean on the Digit Span subtest of the WISC-IV ($M = 8.76$, $SD = 2.85$; $d = 0.42$) and approximately half a standard deviation above the normative mean on the BRIEF WM ($M = 55.46$, $SD = 11.30$; $d = 0.51$). Parents' reports of children's problems on the CBCL indicate, on average, mild-to-moderate effect sizes on the attention problems ($M = 58.50$, $SD = 9.29$; $d = 0.84$), anxiety/depression symptoms ($M = 57.16$, $SD = 9.34$; $d = 0.71$), and total problems ($M = 53.47$, $SD = 13.61$; $d = 0.17$) CBCL scales.

Correlational analyses

Hypothesis 1a: Time 1 working memory will be related to children's use of secondary control coping. Correlations between children's working memory at T1 and coping at T2 are reported in Table 3. Time 1 BRIEF working memory index was significantly and negatively correlated with child self-reported use of secondary control coping at T2 ($r = -0.75$, $p < .01$). The positive correlation between the Time 1 WISC-IV digit span

Table 2. Means, standard deviations, and sample sizes of child working memory, coping, and adjustment.

Measure	Time point	<i>n</i>	Mean	<i>SD</i>	Range	Clinical
Full scale IQ (WASI)	1	25	98.16	18.03	66–130	8%
NPS	1	29	1.76	1.40	0–4	–
Hydrocephalus (%)	1	13	(45)	–	–	–
Hormone deficiency (%)	1	0	(0)	–	–	–
Seizure medication (%)	1	10	(34)	–	–	–
Radiation (%)	1	0	(0)	–	–	–
Chemotherapy (%)	1	0	(0)	–	–	–
NPS	2	28	4.89	1.85	0–8	–
Hydrocephalus (%)	2	14	(50)	–	–	–
Hormone deficiency (%)	2	0	(0)	–	–	–
Seizure medication (%)	2	14	(50)	–	–	–
Radiation (%)	2	13	(46)	–	–	–
Chemotherapy (%)	2	10	(36)	–	–	–
Digit Span (WISC-IV)	1	25	8.76	2.84	2–14	16%
Working Memory Problems (BRIEF)	1	26	55.46	11.30	36–72	27%
Primary Control Coping (RSQ-PBT)	2	14	0.18	0.05	0.10–0.27	–
Secondary Control Coping (RSQ-PBT)	2	14	0.28	0.07	0.15–0.42	–
Disengagement Coping (RSQ-PBT)	2	14	0.16	0.04	0.13–0.26	–
Attention Problems (CBCL)	3	20	58.50	9.29	50–80	10%
Anxiety/Depression Symptoms (CBCL)	3	20	57.16	9.34	50–80	10%
Total Problems (CBCL)	3	20	53.47	13.61	31–75	15%

The WASI Full Scale score is presented as a standard score, the WISC-IV Digit Span score is presented as a scale score, the BRIEF and CBCL scores are presented as T scores, and the RSQ-PBT scales are presented as ratio scores. WASI: Wechsler Abbreviated Scale of Intelligence; WISC-IV: Wechsler Intelligence Scale for Children-Fourth Edition; BRIEF: Behavior Rating Inventory of Executive Function; RSQ-PBT: Responses to Stress Questionnaire-Brain Tumor Version; CBCL: Child Behavior Checklist. The clinical range was denoted by <70 WASI, <6 WISC-IV Digit Span, ≥65 BRIEF, and ≥70 CBCL. NPS: Neurological Predictor Scale.

Table 3. Longitudinal correlations between time 1 working memory and children's self-reports of coping at 6 months.

		BRIEF WM T1	WISC-IV Digit Span T1
T2 Child self reported coping	Primary Control Coping (CRSQ-PBT)	–0.43	0.16
	Secondary Control Coping (CRSQ-PBT)	–0.75**	0.52
	Disengagement Coping (CRSQ-PBT)	0.41	–0.02

WISC-IV: Wechsler Intelligence Scale for Children-Fourth Edition; BRIEF: Behavior Rating Inventory of Executive Function; RSQ-PBT: Responses to Stress Questionnaire-Brain Tumor Version; CBCL: Child Behavior Checklist.

** $p < .01$.

index score and child self-reported use of secondary control coping at T2 was large in magnitude but nonsignificant ($r = 0.52, p = .10$). Time 1 measures of working memory were not significantly correlated with child's use of primary control coping or disengagement coping at T2 (all $ps > .10$). Additional analyses were conducted to examine possible association between the NPS and measures related to working memory and coping, as well as the possible effects of overall cognitive function and coping. The NPS was not significantly correlated with any of the measures related to working memory or coping (all $ps > .05$). The T1 WASI FSIQ was not significantly correlated with any of the coping variables (all $ps > .05$). The association between BRIEF T1 with T2 Primary Control Coping was significantly stronger for those with TLE absent ($r = -0.97^{**}, n = 5$) than TLE present ($r = -0.32, n = 9$), $Z = 2.16, p < .05$. All other correlations between working memory and coping did not differ based on TLE status (present vs. absent, $ps > .05$).

Hypothesis 1b: Time 1 working memory will be related to children's emotional/behavioral adjustment. Correlations between children's working memory at T1 and children's adjustment at T3 are reported in Table 4. Time 1 BRIEF working memory index was significantly and positively correlated with T3 parent report of child attention problems ($r = 0.79, p < .001$), anxiety/depression ($r = 0.56, p < .05$), and total problems ($r = 0.72, p < .01$). The Time 1 WISC-IV digit span index score was not significantly correlated with any of the child adjustment scales at T3 (all $ps > .10$). Additional analyses were conducted to examine possible association between the NPS and overall cognitive function on emotional/behavioral adjustment. Neither the NPS nor the T1 WASI FSIQ were significantly correlated with any of the emotional/behavioral adjustment variables (all $ps > .05$). The correlations between working memory and adjustment did not differ based on TLE status (present vs. absent, all $ps > .05$).

Hypothesis 2: Secondary control coping will be related to children's emotional/behavioral adjustment. Bivariate correlations between children's self-reported coping at T2 and parent report of child attention problems, anxiety/depression, and total problems at T3 are reported in Table 4. Child self-reported use of secondary control coping at T2 was significantly negatively correlated with parent report of child T3 attention problems ($r = -0.70, p < .05$) and T3 total problems ($r = -0.79, p < .01$). The correlation between child self-reported use of secondary control coping at T2 and parent report of child anxiety/depression at T3 was large in magnitude but nonsignificant ($r = -0.55, p = .07$). Child self-reported primary control coping and disengagement coping at T2 were not significantly correlated with parent report on any measures of child adjustment at T3 (all $ps > .10$). The correlations between coping and emotional/behavioral adjustment did not differ based on TLE status (present vs. absent, all $ps > .05$).

Hypothesis 3: Secondary control coping will mediate the relation between working memory and child emotional/behavioral adjustment. Stepwise forward linear regression analyses were conducted to determine whether there is evidence to suggest that coping mediates the relation between working memory and child adjustment. Given the significant correlations between the BRIEF working memory index, secondary control coping and child attention problems and total problems, multiple linear regression analyses were conducted to further elucidate the association of each independent variable and the two indices of adjustment. The results of these regressions are presented in Table 5. Within the hierarchical linear regressions predicting child attention problems and total problems at T3, the T1 BRIEF working memory index (T1) entered in the first step and T2 secondary control coping entered in the second step.

Table 4. Longitudinal correlations between time 1 working memory, children's self-reports of coping at 6 months, and parents' report of child adjustment at 12 months.

	T3 Attention problems	T3 AX/DP	T3 Total problems
T1 BRIEF WM	0.79***	0.56*	0.72**
T1 WISC-IV Digit Span	-0.27	-0.24	-0.24
T2 Primary Control Coping (CRSQ-PBT)	-0.35	0.01	-0.13
T2 Secondary Control Coping (CRSQ-PBT)	-0.70*	-0.55	-0.79**
T2 Disengagement Coping (CRSQ-PBT)	0.35	-0.10	0.04

BRIEF: Behavior Rating Inventory of Executive Function; WISC-IV: Wechsler Intelligence Scale for Children-Fourth Edition; RSQ-PBT: Responses to Stress Questionnaire-Brain Tumor Version.

* $p < .05$; ** $p < .01$; *** $p < .001$.

Table 5. Effects of working memory at time 1 and child coping at 6 months on child attention problems and total problems at 12 months.

	T3 Attention problems			T3 Total problems		
	<i>b</i>	β	R^2	<i>b</i>	β	R^2
Step 1			.60**			.44*
Intercept	-6.98*	-		-40.10	-	
T1 BRIEF	0.68	.80**		3.92	.70*	
Step 2			.58**			.56*
Intercept	-1.71	-		71.01	-	
T1 BRIEF	0.55	.65		1.31	.24	
T2 SCC	-10.51	-.19		-221.62	-.60	

BRIEF: Behavior Rating Inventory of Executive Function; SCC: secondary control coping.

* $p < .05$; ** $p < .01$.

The regression predicting child attention problems from the BRIEF working memory index and child secondary control coping was significant, $F(11) = 8.50$, $p < .01$ ($R^2 = 0.60$). In the final step, the BRIEF working memory index was large, but not significant ($\beta = 0.65$, $p = .07$) and child secondary control coping was also not a significant predictor ($\beta = -0.19$). The regression predicting child total problems from the BRIEF working memory index and child secondary control coping was also significant, $F(11) = 7.92$, $p < .05$ ($R^2 = 0.64$). In the final step, child secondary control coping was large, but not significant ($\beta = -0.60$, $p = .09$) and the BRIEF working memory index was not a significant predictor ($\beta = 0.24$). Given that secondary control coping was not a significant predictor in the second step of either linear regression analysis, mediation was not supported.

Discussion

Children diagnosed with brain tumors face challenges in multiple domains of functioning, including working memory and adjustment (e.g., Knight et al., 2014; Schultz et al., 2007). The diagnosis of a brain tumor also presents children with stressors and highlights the importance of understanding how children with brain tumors cope. Previous findings have highlighted a relation between cognitive functioning and coping in pediatric populations (Campbell et al., 2009; Hocking et al., 2011), including in children diagnosed with brain tumors (Robinson et al., 2015). The current study adds to this growing body of literature and addresses limitations of previous studies by longitudinally investigating the relations among working memory, coping, and adjustment in children diagnosed with pediatric brain tumors within the first year of diagnosis.

Consistent with our first hypothesis, parent report of child working memory difficulties near diagnosis was significantly correlated with use of secondary control coping 6 months later in cross informant analyses. The significant association between the BRIEF working memory index and secondary control coping is consistent with current evidence of the association between executive functioning and coping in pediatric populations (e.g., Campbell et al., 2009; Hocking et al., 2011; Robinson et al., 2015) and builds on previous findings in pediatric cancer survivors (e.g., Campbell et al., 2009; Robinson et al., 2015) by demonstrating this relationship across time, beginning near diagnosis. Notably, general cognitive ability was not associated with coping. Working memory may be particularly important to secondary control coping in that it allows an

individual to consider alternate interpretations of a situation as when cognitively reappraising a problem. Findings from this study highlight the importance of assessing cognitive functioning-related abilities early on in the diagnostic and treatment process. Further, findings suggest the need for early intervention in addressing cognitive difficulties in children diagnosed with brain tumors. Interventions that address early impairments in working memory may not only stave off declines seen in this domain (e.g., Knight et al., 2014) but also benefit important processes, such as coping, that have implications for the emotional health of children with brain tumors.

A further consideration is the possible role of selective attention in secondary control coping as contrasted with working memory and this may explain the differential pattern of significance between the BRIEF WM, the WISC-IV DS, and secondary control coping. The BRIEF WM index includes many items that may be more closely related to focused attention (e.g., “forgets what he/she was doing”, “needs help from an adult to stay on task”) than working memory. Selective, focused attention and working memory are closely related, but distinct, constructs (Diamond, 2013). Those with poor selective attention may have difficulty focusing on maintaining a positive thought, distraction activity, or acceptance statement, thereby impeding their ability to successfully use secondary control coping. Exploratory analyses examining the Digit Span Forward (DSF; a measure of attention) and Digit Span Backwards (DSB; a measure of working memory) separately did not reveal a differential pattern of findings from the Digit Span scale, with neither the DSF and DSB variables being significantly associated with any of the coping or emotional/behavioral adjustment variables (all $ps > .05$). It is possible that a larger sample size would be needed to detect effects. Further research is needed in order to explore the associations between selective attention, working memory, and secondary control coping in children with brain tumors.

Consistent with our second hypothesis, unique effects were found for secondary control coping in relation to indices of child adjustment. Children with brain tumors face a number of uncontrollable stressors associated with their diagnosis, including surgery and treatment side effects. Previous studies have highlighted secondary control coping strategies as the most adaptive when faced with uncontrollable stressors, including stressors associated with the diagnosis of pediatric cancer (e.g., Compas et al., 2014). These findings expand upon previous findings by demonstrating the longitudinal effects of secondary control coping on the adjustment of children diagnosed with brain tumors.

Contrary to our third hypothesis, secondary control coping did not mediate the relation between working memory and child adjustment. In the equation predicting child attention problems, when entered in the equation together, the BRIEF working memory index effect was large (Cohen, 1988, 1992) but not significant, while secondary control coping was nonsignificant. Conversely, in the equation predicting total problems, secondary control coping effect was large but not significant while the BRIEF working memory index was nonsignificant when both variables were entered in the equation. Our sample size and statistical power was likely not sufficient to detect effects within these regressions. Future studies should examine this association in a larger sample of children diagnosed with brain tumors.

There were several methodological strengths to this study. First, this is the first study to assess the longitudinal relation between working memory and coping in pediatric

brain tumor survivors. Second, the T1 measures provide a valuable insight into child functioning early in the diagnosis and treatment process, prior to surgery. Third, this study used a measure of coping based on an empirically validated model of coping (Connor-Smith et al., 2000). Previous studies that have assessed coping in children diagnosed with cancer via other measures have generated limited insight regarding coping strategies that would improve adjustment in these children (Aldridge & Roesch, 2007). In contrast, the RSQ-PBT has allowed for the identification of specific coping strategies that are associated with better adjustment in children diagnosed with brain tumors, as well as other pediatric populations (Compas et al., 2012).

Although this study contained notable strengths, several limitations may also be described. First, the small sample size limited the statistical power of the study. Because of the longitudinal design of this study, and the complicated demands of working with children undergoing treatment for a brain tumor, a portion of the participants were missing data at one or more time points. Also, sample size for certain analyses was limited by measure constraints, in that the child self-report RSQ-PBT is only applicable to children older than 9 years of age. Analyses were also not corrected for family-wise error rate due to the preliminary nature of the analyses. Future, larger studies are needed in order to further examine these associations. Second, our sample was fairly homogeneous as a result of the constraints of a one-site study. There may be some self-selection in which families have the resources and are in the proximity to receive treatment at the participating hospital. For similar studies in the future, recruiting from multiple sites may help reduce both of the above limitations. Third, findings on the associations between the BRIEF WM index and CBCL variables may have been influenced by shared method variance. Larger, multiple informant (e.g., mother, father, teacher, and child) studies would further clarify the associations between working memory, coping, and emotional/behavioral adjustment. Fourth, it would be important to examine measures of other core cognitive skills. It is possible that other factors, such as sustained attention or processing speed, may be influencing the working memory-related findings in this study. Particularly, it will be important that future longitudinal studies explore associations between coping and further performance-based measures (including working memory, attention, and processing speed), versus subjective questionnaire reports of working memory and attention problems. Further, larger empirical investigations are needed in order to assess these associations. Fifth, although we did not find any significant associations between the NPS and key study variables, it is possible that the sample size in this study was insufficient to detect an effect, or that the effects of neurological severity on factors such as working memory may be more pronounced in long-term survivors of pediatric brain tumors at later follow-ups than those included in the current study (e.g., Taiwo, Na, & King, 2017). Further studies examining this association, and how it may evolve over time, are needed. Finally, further exploration of subgroup-based differences within children diagnosed with brain tumors (e.g., based on tumor locations, TLE, treatments, and complications) within larger samples is needed in order to identify potential differences in findings across subgroups.

In summary, this study examined the relations among working memory, coping, and emotional and behavioral adjustment in children diagnosed with brain tumors and extended current knowledge by highlighting the longitudinal nature of these relations, beginning at diagnosis. Future studies should examine these relations in larger samples

that would allow for additional analyses of parent report of coping in young children. Future work should also focus on understanding how these associations might change over time, given evidence for declines in working memory over time (e.g., Knight et al., 2014) and that children diagnosed with cancer will likely face different cancer-related stressors as they move into survivorship (e.g., attending follow up appointments, maintaining a healthy regimen). Finally, these findings indicate the need for, and promise of, early multifaceted interventions addressing both working memory and coping, in order to ameliorate the multiple areas affecting the quality of life of those diagnosed with pediatric brain tumors.

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