Social Skills in Youth With Spina Bifida: A Longitudinal Multimethod Investigation Comparing Biopsychosocial Predictors

Christina E. Holbein,¹ PhD, James L. Peugh,¹ PhD, and Grayson N. Holmbeck,² PhD

¹Division of Behavioral Medicine & Clinical Psychology, Cincinnati Children's Hospital Medical Center and

²Department of Psychology, Loyola University Chicago

All correspondence concerning this article should be addressed to Grayson N. Holmbeck, PhD, Department of Psychology, Loyola University Chicago, 1032 W. Sheridan Road, Chicago, IL 60660. E-mail: gholmbe@luc.edu

Received October 7, 2016; revisions received March 3, 2017; accepted March 4, 2017

Abstract

Objective To examine the relative contributions of neuropsychological (attention and executive function), family (cohesion and conflict), and health (body mass index, lesion level, gross motor function) domains on social skills over time in youth with spina bifida (SB). **Methods** In all, 140 youth with SB (T1 mean age = 11.43 years) and their families participated in the study at baseline with an additional visit 2 years later. Study variables were assessed with multiple methods (questionnaire, medical chart review, observation, neuropsychological tests) and reporters (parents, teachers). Multivariate hierarchical linear regressions determined the predictive power of the three domains for T2 social skills. **Results** Neuropsychological variables accounted for significant variance in mother- and father-reported T2 social skills. Neither family nor health variables contributed significantly to later social skills when other domains were included in the model. **Conclusions** Neuropsychological factors are particularly important for social skill development in youth with SB. Findings can inform screening and intervention practices.

Key words: condition severity; family functioning; neuropsychological function; social skills; spina bifida.

Spina bifida (SB) is a birth defect caused by the failed closure of the neural tube during gestation, occurring in roughly 3 of every 10,000 live births (Centers for Disease Control and Prevention, 2013). The physical (e.g., orthopedic impairments, weakened bowel and bladder functions, hydrocephalus) and cognitive (e.g., attention and executive functioning [EF] deficits; Dennis, Landry, Barnes, & Fletcher, 2006) sequelae encountered by youth with SB appear to be related to multiple developmental outcomes, including autonomy development (Tuminello, Holmbeck, & Olson, 2012) and social skills (Rose & Holmbeck, 2007).

Youth with SB encounter multiple challenges in social skills development. Preschoolers with SB have been found to have poorer social problem-solving skills compared with typically developing children (Landry,

Taylor, Swank, Barnes, & Juranek, 2013), and they have difficulty incorporating newcomers into an existing social interaction (Fletcher et al., 2004). In social interactions with friends, children with SB from the present sample exhibited greater off-task behavior and less involvement in shared activities, maturity, dominance, and promotion of collaboration (Holbein et al., 2015). In addition, youth with SB often demonstrate less competent conversational skills (Barnes & Dennis, 1998; Holbein et al., 2015). Still, these children and adolescents possess numerous social strengths, including sociability, politeness, and social acceptance (Barnes & Dennis, 1998; Dennis et al., 2006).

Despite the established social skills difficulties observed in many youth with SB, little is known about the antecedents of these deficits. In fact, a lack of

knowledge about factors contributing to the social problems of children with disabilities has long been lamented (Yeates et al., 2007). To gain a clearer understanding of the social challenges in SB, we used an adapted version of a biopsychosocial model of psychosocial adjustment, as described by Holmbeck and Devine (2010), as a conceptual framework. The adapted model includes three domains that contribute to adjustment, health, neuropsychological, and social (e.g., peers, family), with additional attention to contextual factors (see Figure 1). Previous research has used this SB-specific model to investigate psychosocial adjustment (i.e., quality of life, self-management) in individuals with SB (Bellin et al., 2013; Psihogios, Murray, Zebracki, Acevado, & Holmbeck, 2017). In this study, constructs were selected in accordance with the three primary domains of the biopsychosocial model and with consideration of findings from previous research.

Neuropsychological Domain

High rates of hydrocephalus in youth with SB increase the likelihood of attention and EF deficits, which have

Figure 1. Biopsychosocial conceptual framework of social skill development.

Note. This model is an adaptation of the larger model presented by Holmbeck and Devine (2010).

been found to be associated with poor social function (Fletcher et al., 1996). Individuals who have difficulty shifting and sustaining attention, inhibiting behaviors, and mentally organizing verbal responses may struggle to participate in conversations and navigate complex social situations. Links between attention, EF, and social skills have been observed in multiple pediatric populations, such as attention deficit/hyperactivity disorder (ADHD; Miller & Hinshaw, 2010) and traumatic brain injury (Ganesalingam, Yeates, Taylor, Walz, Stancin, & Wade, 2011). Specific to SB, stronger attention and EF skills are associated with more well-developed social skills (Holbein et al., 2015; Jandasek, 2008; Lennon, Klages, Amaro, Murray, & Holmbeck, 2015; Rose & Holmbeck, 2007).

Family Domain

Children acquire social skills in part by observing and practicing within the context of family (Repetti, Taylor, & Seeman, 2002). Like research with typically developing samples (McDowell & Parke, 2009), children with SB from families high in cohesion and low in conflict tend to exhibit more adaptive social skills compared with their peers who reside in less cohesive and more conflictual families (Jandasek, 2008). However, Loomis and colleagues (1997) did not identify family conflict as a predictor of social adjustment in young adults with SB.

Health Domain

Children with more severe SB (e.g., higher lesion levels, poorer gross motor function) often have fewer opportunities to engage in social interactions with others owing to increased numbers of medical appointments as well as motor impairments that present logistical barriers to socializing with peers (Blum, Resnick, Nelson, & St. Germaine, 1991). Previous research has found links between greater SB condition severity and poorer social skills (Hommeyer, Holmbeck, Wills, & Coers, 1999; Verhoef et al., 2006), although not all studies have demonstrated significant associations (Hetherington, Dennis, Barnes, Drake, & Gentili, 2006).

It is well-established that many overweight and obese youth experience social difficulties (Martinez, Carter, & Legato, 2011). Weight may be particularly important to investigate in youth with SB owing to high rates of obesity, which have been estimated to occur in 37–41% of youth (Essner, Murray, & Holmbeck, 2014; Mcpherson, Swift, Yung, Lyons, & Church, 2013). Others have found that youth with SB who are overweight or obese, including those in the present sample, encounter more social challenges than those at a healthy weight (Essner et al., 2014; Simsek, Turkucuoglu, & Tezcan, 2015).

The Current Study

Numerous studies have examined the effects of single predictors on social skill development, precluding identification of the most salient predictors (by comparing across different predictor domains) of social skill development. The present multimethod (i.e., observation, questionnaire, neuropsychological testing, medical chart review), multi-informant (i.e., parent, teacher, observer) study incorporates multiple biopsychosocial (i.e., neuropsychological, family, and health) variables to determine the most important contributors to social skill development in youth with SB. By clearly identifying modifiable correlates (e.g., family functioning, attention and executive function skills, weight) of social difficulties in this population, screening practices and implementation of optimal interventions may be improved.

We hypothesized that neuropsychological variables would be the strongest predictors of social skills, followed by family and health variables (respectively). This specified order of predictor salience was supported by findings suggesting that higher-order cognitive abilities are particularly relevant in children with congenital central nervous system (CNS) conditions (Yeates et al., 2007) and serve as the primary building blocks for social skill development. Although neuropsychological factors were expected to be the strongest predictors of social skill development, the family context was also expected to contribute significantly to social skill development given the strength of the literature connecting family functioning and social skills. Given mixed findings regarding health variables, they were expected to be the weakest predictors of social skills over time.

Method

Participants

Participants were recruited from four local hospitals and a statewide SB association to participate in a longitudinal study investigating neuropsychological, family, and social functioning in children with SB. Inclusion criteria included: (1) diagnosis of SB, myelomeningocele (MM), lipomeningocele, or myelocystocele; (2) age between 8 and 15 years at Time 1 (T1); (3) ability to speak and read English or Spanish; (4) involvement of at least one primary caregiver; and (5) residence within 300 miles of the research lab. Of the 246 families approached, 163 families agreed to participate in the study. Twenty-one of those families were unable to be contacted or later declined and two families did not meet inclusion criteria, resulting in a sample size of 140 families (57% participation rate). SB characteristics were not significantly different between families who participated and those who did not: type of SB (i.e., MM vs. other), $\chi^2(1) = 0.0002$, $p > .05$, shunt status, $\chi^2(1) = 0.003$, $p > .05$, and occurrence of shunt infections, $\chi^2(1) = 1.08$, $p > .05$.

To observe and assess peer interactions, each family was asked to invite a close friend of the child with SB to participate. Inclusion criteria for friends included: (1) age between 6 and 17 years at T1, and (2) ability to speak and read English or Spanish. At T1, 122 families (87%) were able to recruit a peer to participate. Three peers (2% of all friends recruited) who were older than the age limit, 15 peers (12%) who were related to the target child, and 4 peers (3%) with a diagnosis of SB were included in the present study in an effort to maximize power. SB characteristics and demographics of the target children and their peers are reported in Table I.

Procedures

Before data collection, the study was approved by both university and hospital institutional review boards. At T1, data were collected via two 3-hr home visits by trained research assistants. Informed consent and assent were obtained in person from caregivers and youth, respectively; some guardians of friends provided consent via mail. Parents also completed release of information forms for study personnel to obtain medical chart information and administration of questionnaires to teachers. Across the two home visits, children with SB and their parent(s) completed questionnaires and engaged in videotaped family interaction tasks. Neuropsychological testing assessing intellectual functioning, attention, and EF of the target child was also performed. The target child and a friend engaged in videotaped structured interaction tasks (see Holbein, Zebracki, & Holmbeck, 2014, for a complete review of peer interaction tasks). Families and participating friends were compensated with small gifts (i.e., T-shirts and pens) and monetary payments (\$150 for families and \$50 for friends).

Approximately 2 years after the T1 home visits, participants were contacted to participate in a second home visit. Of the 140 families who were contacted, 16 declined participation, 12 could not be reached, and 1 child with SB had passed away. The final sample at Time 2 (T2) consisted of 111 youth with SB and their families (80% of the sample who participated at T1). Participants who did not participate at T2 tended to be older, $t(138) = 3.59$, $p < .001$, identify as non-Caucasian, $\chi^2(1) = 4.96$, $p < .05$, have more gross motor impairments, $t(130) = 2.74$, $p < .01$, or have poorer father-reported social skills, $t(97) = -2.29$, $p < .05$. No differences were found between T2 participants and nonparticipants in regards to gender, socioeconomic status (SES), SB type, lesion level, shunt status, shunt revisions, observed social skills, and mother- and teacher-reported social skills. Ninety-eight families (88%) recruited a close friend of the child with SB at T2; friends were not necessarily the same participants from T1. Data collection at T2

Table 1. Condition-Specific Characteristics of Youth With SB at Time 1

Characteristic	%	N			
Type of SB					
Myelomeningocele	84.3				118
Lipomeningocele/meningocele/lipoma	10.0				14
Myelocystocele	1.4				2
Unknown or uncertain	4.3				6
Lesion level					
Sacral	27.1				38
Lumbar	50.0				70
Thoracic	18.6				26
Unknown	4.3				6
Shunt status (present)	78.4				109
	<i>M (SD)</i>				<i>N</i>
Number of shunt revisions	3.54 (6.03)				104
Number of nonshunt surgeries	4.26 (3.64)				137
FSIQ	85.68 (19.68)				132
		SB		Friend	
	%	N	%	N	
Racial identity					
African American	13.6	19	9.8	12	
Caucasian	52.9	74	60.7	74	
Latino	27.9	39	21.3	26	
Other/multiracial/unknown	5.7	8	8.2	10	
Gender (% female)	53.6	75	55.7	68	
		<i>M (SD)</i>		<i>M (SD)</i>	
Age (years)		11.43 (2.46)		11.11 (3.05)	

occurred during one home visit; children and their families participated in modified family interaction tasks and completed questionnaires assessing multiple psychosocial and medical-related domains. Youth with SB and their friends participated in modified peer interaction tasks. Current or recent teachers were contacted to complete a battery of questionnaires. All participants were compensated as noted above.

Measures

For all measures, raw scores were used in place of standardized scores (when applicable) so as not to control for demographic factors inconsistently across variables.

Outcome Variables: Social Skills

For all outcome variables, higher scores indicate greater observed or reported social skills.

Observational Peer Interaction Measure. The peer interaction tasks were coded using the Child–Peer Interaction Macro-Coding System (PIMS; Holmbeck, Zebracki, Johnson, & Belvedere, 2007), a complementary coding system to the Family Interaction Macro-Coding System (FIMS; see below). The PIMS scales were created to measure social competence via observational peer interaction data collected at T1 (Holbein et al., 2014). This study used the PIMS Prosocial Skills scale owing to its

specific focus on social skills. The Prosocial Skills scale assesses adaptive social skills exhibited by the child with SB that advance the social interaction in a positive manner (e.g., confidence in stating opinions, eye contact, listens to others, maturity, promotes dialogue and collaboration, receptive to statements made by other). At both T1 and T2, the PIMS Prosocial Skills scale yielded excellent interrater reliability ($ICC = .89$ and $.86$, respectively) and adequate internal consistency statistics ($\alpha = .86$ at both T1 and T2).

Questionnaire. The Social Skills Rating System (Gresham & Elliot, 1990) assesses social skills that are considered important to the development of social competence. This study used the parent and teacher versions where respondents were asked to rate how often the child demonstrated each social skill. The elementary level form (suited for grades K-6) was used owing to the age range of the participants at T1. Cronbach's alphas for each reporter ranged from .91 to .93 for both time points.

Predictor Variables: Neuropsychological Domain

Performance-Based Tests. The Cognitive Assessment System (Naglieri & Das, 1997) assesses planning, attention, and simultaneous cognitive processes in children. The present study used the Number Detection subtest, a measure of focused attention in which youth

must attend to given stimulus items while ignoring distractor stimuli under the pressure of time. Higher scores indicate better focused attention.

The Delis Kaplan Executive Function System (D-KEFS; [Delis, Kaplan, & Kramer, 2001](#)) is a battery of nine individually administered tests assessing higher level cognitive functions (reasoning, problem-solving, planning, etc.). The D-KEFS Verbal Fluency Test—Category Switching trial was included in this study as a measure of EF. Larger values reflect greater switching accuracy (i.e., better EF skills).

The Test of Everyday Attention for Children ([Manly, Robertson, Anderson, & Nimmo-Smith, 1999](#)) allows for assessment across different attentional capacities. The subtests used in this study include Sky Search (selective/focused visual attention), Score! (sustained auditory attention), Sky Search DT (sustained-divided visual and auditory attention), and Score! DT (sustained and divided auditory attention). For the Sky Search and Sky Search DT subtests, lower scores indicate better attention skills; the opposite is true for the Score! and Score! DT subtests.

The Wechsler Intelligence Scale for Children—Fourth Edition ([Wechsler, 2003](#)) is an individually administered clinical instrument for assessing intellectual functioning. The Digit Span subtest was used to assess working memory, a component of EF ([Fletcher et al., 1996](#)). Higher scores indicate better working memory.

Questionnaires. Parent report on the Behavior Rating Inventory of Executive Function ([Gioia, Isquith, Guy, & Kenworthy, 2000](#)) Metacognition Index measures task initiation, working memory, planning and organization, organization of materials, and self-monitoring. Cronbach's alphas were .96 and .95 for mother and father reports, respectively. Higher scores reflect poorer EF skills.

The 18-item Swanson, Nolan, and Pelham Teacher and Parent Rating Scale, version IV (SNAP-IV; [Swanson et al., 2001](#)) provides a dimensional scaling of the DSM-IV items for inattention, impulsivity, and hyperactivity. The SNAP-IV total score ($\alpha = .90$ and $.87$ for mother and father report, respectively) was used as a measure of parent-reported attention. Higher scores indicate weaker attention skills.

Predictor Variables: Family Domain

Observational Family Interaction Measure. Family interaction tasks were coded using the FIMS ([Holmbeck, Belvedere, Gorey-Ferguson, & Schneider, 1995](#); [Kaugars et al., 2011](#)). The Family Cohesion and Family Conflict scales ([Kaugars et al., 2011](#)) were used in the present study. The eight-item Family Cohesion scale assesses the comfort, engagement, agreeableness, and promotion of dialogue and collaboration within the family during the interactions. The three-item Family Conflict scale

measures the level of conflict within familial dyads, frequency of disagreements, and ability to reach resolutions. Both the FIMS Conflict scale and Cohesion scale yielded good interrater reliability (ICC = .66 and .78, respectively) and adequate (or nearly adequate) internal consistency ($\alpha = .65$ and $.90$, respectively).

Questionnaire. The Family Environment Scale, Form R ([Moos & Moos, 1994](#)) measures parent-reported social and environmental characteristics of the family. For this report, the cohesion and conflict subscales were used. This study used a 4-point Likert-type scale (1 = *strongly disagree* to 4 = *strongly agree*) to increase internal consistency (for mother and father reports, cohesion scale: $\alpha = .64$ – $.68$, and conflict scale: $\alpha = .69$ – $.75$).

Predictor Variables: Health Domain

Lesion Level. Lesion level was obtained from medical chart review. For 15 participants, only the general location (e.g., sacral, lumbar, thoracic) was known. In these cases, the middle value for that general spinal region was used. Greater values are indicative of lesions located higher up on the spinal cord (i.e., more severe conditions).

Gross Motor Function. Gross motor function was assessed with a modified version of the Gross Motor Function Classification System—Expanded and Revised ([Palisano et al., 1997](#)). Based on parents' responses on ambulation items, children were assigned to one of four categories: (1) no braces, crutches, walker, or wheelchair; 100% unassisted walking; (2) uses braces, crutches, or walker; (3) some wheelchair use; able to walk with braces; >50% walking; and (4) uses wheelchair at school, long outings; <50% walking. Higher scores represent greater gross motor impairment.

Weight. Body mass index (BMI) values, presented as z-scores (zBMI), were used as an indicator of weight status. Parents provided written estimates of their child's weight and height. The zBMI scores were calculated separately for mother and father reports using the Pediatric Z-Score Calculator (The Children's Hospital of Philadelphia, n.d.).

Data Analytic Plan

Hypothesis testing was achieved by running multivariate hierarchical regressions in Mplus ([Muthen & Muthen, 1998-2015](#)). To compare the relative influence of a given domain with the other two domains, a base model containing covariates (i.e., age and gender) and independent variables from two domains (e.g., family and health) was run (i.e., the "base" model). Next, a second model with all three domains, including the added domain of interest (e.g., neuropsychological), was tested (i.e., the "full" model). Changes in

R^2 between the two models were assessed for significance using F -tests to determine whether the added domain of interest produced a nonzero increase in R^2 (indicated as $R^2\Delta$) between the “base” and “full” models. Magnitudes of $R^2\Delta$ values were also analyzed as indicators of the contributions of each domain on the dependent variables; effect sizes were determined by the following values: 0.01 = small, 0.09 = medium, and 0.25 = large (Cohen, 1988). An additional effect size measure (i.e., f^2 ; 0.02 = small, 0.15 = medium, 0.35 = large) was also calculated for all primary hierarchical regression results. This process was repeated to test the family and social domains as well, resulting in four multivariate hierarchical regressions (i.e., three different base models and one model with all domains included). The four dependent variables (i.e., T2 social skills measured by observation and mother, father, and teacher reports) were allowed to correlate and were regressed on their like measures at T1, as well as age and gender, to produce residualized change scores. Both missing data and nonnormally distributed response variable data were handled using the default robust maximum likelihood estimation algorithm in Mplus. Three auxiliary correlates (i.e., T1 shunt status, race, SES) were included in the base models to assist with accurate handling of missing data; inclusion of correlates in the full model was not possible owing to the larger number of parameters. For $N=140$ and assuming $\alpha = .05$, all primary analyses were powered (0.80) to find medium-to-large effects defined as $f^2 = 0.23$ –0.25 (or, $R^2 = 0.18$ –0.20).

Results

Preliminary Analyses

Correlations between T2 social skills measures and all covariates and independent variables for the full sample ($N=140$) are presented in Table II. Mother-reported social skills was significantly related to both father- and teacher-reported social skills. The observational measure was not significantly correlated with other social skills variables. Further, the majority of significant correlations between T1 neuropsychological measures and T2 social skills indicated that greater attention and EF skills were associated with better social skills. In contrast, mother-reported attention problems were positively related to later mother- and father-reported social skills, and higher levels of mother-reported EF difficulties were correlated in the positive direction with T2 teacher report of social skills. Few family and health variables were found to be significantly correlated with T2 social skills.

Neuropsychological Variables Predicting Social Skills at T2 Beyond Other Domains

The neuropsychological domain was expected to be the strongest predictor of social skills at T2, after

controlling for T1 social skills and covariates, relative to the family and health domains. In accordance with expectations, the neuropsychological domain was found to significantly predict later mother- and father-reported social skills beyond the other two domains (see Table III). In fact, the addition of the neuropsychological variables accounted for an additional increase of 19.2% and 21.5% of variance explained in T2 social skills for mother and father reports, respectively, in the full model. Examination of $R^2\Delta$ magnitudes also revealed that neuropsychological variables explained an additional 15.1% of the variance in T2 teacher-reported social skills and 9% of the variance in observed social skills (i.e., both medium effects) beyond covariates and the family and health variables.

Family Variables Predicting Social Skills at T2 Beyond Other Domains

It was anticipated that the family domain would be the second-strongest predictor of social skills. The family variables as a whole did not significantly account for T2 social skills beyond the neuropsychological and health variables for any of the four DVs (see Table III). In fact, $R^2\Delta$ values were all small in magnitude.

Health Variables Predicting Social Skills at T2 Beyond Other Domains

The health domain was expected to be the weakest predictor of social skills at T2. When the full model was compared with a base model containing neuropsychological and family variables, the health domain did not significantly predict T2 social skills (see Table III). However, closer inspection of $R^2\Delta$ values revealed a medium effect ($R^2\Delta = 0.15$) of the health variables predicting father-reported social skills. Effects of health variables on all other DVs were small.

Discussion

The purpose of the present study was to investigate the relative contributions of neuropsychological, family, and health predictors to later social skills in youth with SB. We are adding to the literature by using a developmental framework to provide a comprehensive, longitudinal evaluation of social skills and their predictors in a sample of youth with SB. This investigation is one of the first to compare the relative predictive utility of neuropsychological, family, and health domains on the development of social skills.

Correlational results between the four measures of social skills at T2 suggest that social skills differed based on informants and contexts (e.g., school, community, home). Children often exhibit different social skills depending on characteristics of the setting, and informants may observe or perceive different social behaviors as well (Dirks, Treat, & Weersing, 2007).

Table II. Correlations Between Dependent Variables and All Predictors in Regression Models

Variable	T2 observed social skills	T2 SSRS-M	T2 SSRS-F	T2 SSRS-T
T2 observed social skills	—	—	—	—
T2 social skills-M	-.21	—	—	—
T2 social skills-F	-.04	.75**	—	—
T2 social skills-T	-.27	.48**	.37	—
T1 observed social skills	.42**	—	—	—
T1 social skills-M	—	.50**	—	—
T1 social skills-F	—	—	.50*	—
T1 social skills-T	—	—	—	-.02
Covariates				
Age	-.17	.34*	.24	-.12
Neuropsychological domain				
WISC-digit span	.12	-.02	.02	-.01
TEA-Ch sky search	.16	-.26	.09	-.24
TEA-Ch score!	-.10	-.09	.30**	-.15
TEA-Ch sky search DT	-.11	-.21	-.38*	.35
TEA-Ch score DT	-.11	-.20	.61**	.21
CAS-number detection	.33*	.05	.25	.23
D-KEFS verbal fluency	.17	.05	-.00	-.07
SNAP total-M	-.06	.33*	.37*	-.28
SNAP total-F	.26	-.06	-.09	-.09
BRIEF metacognitive index-M	-.16	-.56*	-.60**	.45*
BRIEF metacognitive index-F	-.17	.31	.34	-.46
Family domain				
Family cohesion-M	.08	.13	.30	-.20
Family cohesion-F	-.01	-.30**	-.16	-.03
Observed family cohesion	-.01	.03	.32	.32
Family conflict-M	-.04	-.01	.05	-.03
Family conflict-F	.00	-.12	.15	-.04
Observed family conflict	-.09	.03	.40**	.01
Health domain				
zBMI-M	.16	-.33	-.47*	.26
zBMI-F	-.24	-.02	.10	-.17
Lesion level	.02	-.05	-.26	.05
Gross motor function	.04	.14	.34*	-.22

Note.

* $p < .05$;

** $p < .01$;

M = mother; F = father; T = teacher; CAS = Cognitive Assessment System; D-KEFS = Delis Kaplan Executive Function System; TEA-Ch = Test of Everyday Attention for Children; WISC = Wechsler Intelligence Scale for Children; BRIEF = Behavior Rating Inventory of Executive Function; SNAP = Swanson, Nolan, and Pelham Teacher and Parent Rating Scale; SSRS = Social Skills Rating System; $N = 120$ for all correlations.

The use of multiple reporters is certainly a strength of this study. Further, findings that youth with greater neuropsychological function or lower BMI tend to be more socially skilled are in line with those demonstrated in previous research (Essner et al., 2014; Jandasek, 2008; Lennon et al., 2015; Rose & Holmbeck, 2007). Several unexpected correlations were also found. For example, mothers and fathers tended to report higher social skills for children with more mother-reported attention problems. As the SNAP-IV assesses hyperactivity symptoms as well, parents may view children with high activity levels as more gregarious and extraverted (Shiner & Caspi, 2003). Higher observed family conflict was also associated with greater father-reported social skills; indeed, research suggests that moderate exposure to family conflict allows for opportunities to develop

adaptive conflict-resolution skills and coping strategies for future stressful peer situations (Floyd, Purcell, Richardson, & Kupersmidt, 2009).

Longitudinal analyses support the hypothesis that neuropsychological skills (i.e., attention and EF) contribute to the social skill development of youth with SB beyond family and health factors. When social skills were measured by parent report, attention and EF skills accounted for significant variance in social skills; inspection of $R^2\Delta$ magnitudes revealed a similar finding for observed and teacher-reported social skills. Although not presented here (in the interest of brevity), specific regression slope estimates generally showed that higher attention and EF consistently predicted significant increases in T2 social skills. Our results extend previous research that identified cross-sectional associations between attention, EF,

Table III. Multivariate Hierarchical Regressions Comparing Base Models With the Full Value-Added Model

Dependent variable	Full model (all domains)	Neuropsychological base model (Family + Health)				Family base model (Neuro. + Health)				Health base model (Neuro. + Family)			
	R^2	R^2	$R^2\Delta$	F	f^2	R^2	$R^2\Delta$	F	f^2	R^2	$R^2\Delta$	F	f^2
Observed social skills	0.58	0.49	0.09	0.94	0.22	0.55	0.03	0.32	0.08	0.54	0.04	0.40	0.10
SSRS—Mother	0.70	0.51	0.19	2.75*	0.65	0.67	0.03	0.45	0.11	0.66	0.05	0.61	0.16
SSRS—Father	0.75	0.53	0.22	3.58*	0.84	0.69	0.05	0.82	0.20	0.60	0.15	2.27	0.57
SSRS—Teacher	0.54	0.39	0.15	1.39	0.33	0.49	0.05	0.44	0.11	0.52	0.02	0.16	0.04

Note:

* $p < .01$.

Bold indicates medium effects based on magnitude (Cohen, 1988); f^2 effect size values: 0.02—small, 0.15—medium, 0.35—large; SSRS = Social Skills Rating System; “base model” refers to regression models with variables from two domains (excluding the domain of interest); base models were then compared with the full model to determine the added explained variance of the domain of interest.

and social function in this population (Barnes & Dennis, 1998; Holbein et al., 2015; Rose & Holmbeck, 2007). These cognitive strengths and weaknesses may shape opportunities for socialization as children grow. In addition, specific social skills (e.g., clear verbal expression, cooperation, on-task behavior) require strong attentional and EF skills (Holbein et al., 2015). As youth with SB mature, it is apparent that their abilities to concentrate and perform higher-order cognitive functions facilitate their acquisition and performance of social skills.

Results did not support our hypothesis that family functioning would be the second strongest predictor of social skills; the addition of family variables to the base model containing health and neuropsychological variables contributed minimal additional variance in social skills. These findings are in opposition to previous studies in other populations that found family variables to be strong predictors of social skills (Haven, Manangan, Sparrow, & Wilson, 2014; McDowell & Parke, 2009). While family factors cannot be dismissed as important components for a child’s social development, they failed to account for residualized changes in social skills beyond the other two domains. In particular, the attention and EF skills of youth with SB may outweigh the effects of a cohesive, low-conflict family environment during middle childhood and adolescence (i.e., ages 10–17 years). It is possible that family function may have a greater influence on social skills earlier in development (e.g., early childhood). However, it must be acknowledged that limited variability in the family measures (i.e., many parents reported high cohesion and low conflict) contributed to relatively lower internal consistencies; as a result, the influences of family functioning on social skills may have been underestimated. Further, other aspects of family functioning, such as specific parenting behaviors or parent stress, provide greater contributions to social skills development. Future research is required to determine family constructs that are most protective for strong social skills in youth with SB.

The association between health factors and residualized changes in father-reported social skills produced a medium effect. While speculative, fathers’ assessments of their children’s social skills may be particularly sensitive to physical or health differences. Investigation of regression slope estimates for individual variables revealed that greater residualized changes in social skills were associated with lower mother-reported BMIs and greater gross motor impairment. Although the finding regarding gross motor function is in opposition to hypotheses, use of mobility equipment (e.g., wheelchairs) may in fact foster independence and reduce social isolation (Bray, Noyes, Edwards, & Harris, 2014). More research is needed to better understand this association specific to fathers. Otherwise, health variables did not significantly predict later social skills when controlling for the other two domains. Indeed, the literature contains numerous studies that have not found health-related variables to predict subsequent social function in youth with SB (Hetherington et al., 2006). Additional research suggests that cognitive abilities, rather than markers of physical condition severity (e.g., lesion level) in this population, have greater effects on long-term developmental outcomes (Holbein, Zebracki, Bechtel, Papadakis, Bruno, & Holmbeck, 2017). The process of acquiring and implementing specific social skills in this population appears to be influenced by cognitive abilities; physical differences and health issues appear to play a much smaller role in the development of social skills.

Study results have implications for clinical practice in the medical and mental health fields. The longitudinal association between attention/EF and social skills reinforces the importance of screening children with SB, particularly those with known attention and EF deficits, for social difficulties. Evaluation of social skills can be accomplished through validated behavior checklist questionnaires, clinical interviews, and behavioral observations. Youth with SB who are identified as having difficulties with social skills can then be referred for appropriate therapeutic interventions.

Further, this study emphasizes the need to select or adapt appropriate social skills interventions for youth with SB. Given the likelihood that youth with SB referred for social skills treatment may have lower attention and EF abilities, social skills interventions may need to be adapted to include specific, socially relevant attention and EF strategies (e.g., asking for clarification, thinking before speaking, awareness of social cues). Social skills training programs validated in youth with attention and EF deficits (e.g., ADHD, autism spectrum disorder) may be particularly helpful for youth with SB; further study is needed to test the effectiveness of specific social skills interventions for this population. Our findings also suggest that separate skills groups for children with SB of varying condition severity may not be needed.

Results should be interpreted in the context of several limitations. First, although efforts were made to examine multiple predictors across three domains, study variables represent only a subset of potentially relevant predictors. Future research may examine the effects of other variables (e.g., social cognition, specific parenting behaviors, pain, sleep) that are likely to be associated with social skill development (Essner et al., 2014; Yeates et al., 2007). Second, height and weight were reported by parents, although there is research suggesting that parents are relatively accurate raters of these variables (Goodman, Hinden, & Khandelwal, 2000). Third, the lack of a comparison sample of typically developing youth and their parents precluded the ability to compare models of social skill development in youth with and without SB. In the future, research with other samples should attempt to replicate the findings presented here. Also, a subset of peers included in the interaction tasks exceeded the defined age limit or were related to the target child, which may have elicited unique patterns of social skills and characteristics that may not generalize to dyadic interactions involving same-age, unrelated peers. Fourth, the wide age range of the participants in this study (i.e., 8–15 years old at Time 1) makes it challenging to isolate the dynamic process of social development that occurs during specific developmental periods. Additional attention to social skill acquisition during earlier developmental periods is needed. Fifth, findings must be interpreted with a consideration of common method variance. In addition, given attrition effects, caution must be taken in generalizing findings to youth who are older, non-Caucasian, have more impaired gross motor function, or lower levels of father-reported social skills.

Using a biopsychosocial framework, this multimethod longitudinal study examined the relative predictive utility of neuropsychological, family, and health variables on later social skills in youth with SB. Results suggested that neuropsychological factors are

most associated with changes in social skills over time. Family and health domains contributed little to social skill development beyond the effects of neuropsychological factors. Screening practices and social skills interventions may be implemented with consideration of the attention and EF skills that characterize this population.

Funding

This research was supported in part by grants from the National Institute of Nursing Research (R01 NR016235), the National Institute of Child Health and Development (R01 HD048629; T32 HD068223), and the March of Dimes Foundation (12-FY13-1273). This study is part of an ongoing, longitudinal study.

Conflicts of interest: None declared.

References

- Barnes, M. A., & Dennis, M. (1998). Discourse after early-onset hydrocephalus: Core deficits in children of average intelligence. *Brain and Language*, 61, 309–334.
- Bellin, M. H., Dicianno, B. E., Osteen, P., Dosa, N., Aparicio, E., Braun, P., & Zabel, T. A. (2013). Family satisfaction, pain, and quality-of-life in emerging adults with spina bifida. *A Longitudinal Analysis. American Journal of Physical Medicine and Rehabilitation*, 92, 641–655.
- Blum, R. W., Resnick, M. D., Nelson, R., & St. Germaine, A. (1991). Family and peer issues among adolescents with spina bifida and cerebral palsy. *Pediatrics*, 88, 280–285.
- Bray, N., Noyes, J., Edwards, R. T., & Harris, N. (2014). Wheelchair interventions, services and provision for disabled children: A mixed-method systematic review and conceptual framework. *BMC Health Services Research*, 14, 309.
- Centers for Disease Control and Prevention. (2013). Neural tube defect ascertainment project. Retrieved from <http://www.nbdpn.org>. Retrieved July 16, 2015.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.
- Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis kaplan executive function system: Examiner's manual*. San Antonio, TX: The Psychological Corporation.
- Dennis, M., Landry, S. H., Barnes, M., & Fletcher, J. M. (2006). A model of neurocognitive function in spina bifida over the life span. *Journal of the International Neuropsychological Society*, 12, 285–296.
- Dirks, M. A., Treat, T. A., & Weersing, V. R. (2007). Integrating theoretical, measurement, and intervention models of youth social competence. *Clinical Psychology Review*, 27, 327–347.
- Essner, B. S., Murray, C. M., & Holmbeck, G. N. (2014). The influence of condition parameters and internalizing symptoms on social outcomes in youth with spina bifida. *Journal of Pediatric Psychology*, 39, 718–734.
- Fletcher, J. M., Brookshire, B. L., Landry, S. H., Bohan, T. P., Davidson, K. C., Francis, D. J., . . . Morris, R. D. (1996). Attentional skills and executive functions in children with

- early hydrocephalus. *Developmental Neuropsychology*, 12, 53–76.
- Fletcher, J. M., Dennis, M., Northrup, A., Barnes, M. A., Hannay, H. J., Landry, S. H. . . . Francis, D. J. (2004). Spina bifida: Genes, brain, and development. *International Review of Research in Mental Retardation*, 29, 63–117.
- Floyd, F. J., Purcell, S. E., Richardson, S. S., & Kupersmidt, J. B. (2009). Sibling relationship quality and social functioning of children and adolescents with intellectual disability. *American Journal on Intellectual and Developmental Disabilities*, 114, 110–127.
- Ganesalingam, K., Yeates, K. O., Taylor, H. G., Walz, N. C., Stancin, T., & Wade, S. (2011). Executive functions and social competence in young children 6 months following traumatic brain injury. *Neuropsychology*, 25, 466–476.
- Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). Test review behavior rating inventory of executive function. *Child Neuropsychology*, 6, 235–238.
- Goodman, E., Hinden, B. R., & Khandelwal, S. (2000). Accuracy of teen and parental reports of obesity and body mass index. *Pediatrics*, 106, 52–58.
- Gresham, F. M., & Elliot, S. N. (1990). *Social skills rating system*. Circle Pines, MN: American Guidance Service.
- Haven, E. L., Manangan, C. N., Sparrow, J. K., & Wilson, B. J. (2014). The relation of parent-child interaction qualities to social skills in children with and without autism spectrum disorders. *Autism*, 18, 292–300.
- Hetherington, R., Dennis, M., Barnes, M., Drake, J., & Gentili, F. (2006). Functional outcome in young adults with spina bifida and hydrocephalus. *Child's Nervous System*, 22, 117–124.
- Holbein, C. E., Lennon, J. M., Kolbuck, V. D., Zebracki, K., Roache, C. R., & Holmbeck, G. N. (2015). Observed differences in social behaviors exhibited in peer interactions between youth with spina bifida and their peers: Neuropsychological correlates. *Journal of Pediatric Psychology*, 40, 320–335.
- Holbein, C. E., Zebracki, K., Bechtel, C. F., Papadakis, J. L., Bruno, E. F., & Holmbeck, G. N. (2017). Milestone achievement in emerging adulthood: A longitudinal investigation of parental expectations in a sample of young people with spina bifida. *Developmental Medicine and Child Neurology*, 59, 311–316.
- Holbein, C. E., Zebracki, K., & Holmbeck, G. N. (2014). Development and validation of the Peer Interaction Macro-Coding System scales (PIMS): A new tool for observational measurement of social competence in youth with spina bifida. *Psychological Assessment*, 26, 1235–1246.
- Holmbeck, G. N., Belvedere, M., Gorey-Ferguson, L., & Schneider, J. (1995). *Family macro-coding manual—march of dimes triadic version*. Unpublished manual, Department of Psychology, Loyola University Chicago, Chicago, IL.
- Holmbeck, G. N., & Devine, K. A. (2010). Psychosocial and family functioning in spina bifida. *Developmental Disabilities Research Reviews*, 16, 40–46.
- Holmbeck, G. N., Zebracki, K., Johnson, S. Z., & Belvedere, M. (2007). *Child-peer interaction macro-coding manual*. Unpublished manual, Department of Psychology, Loyola University Chicago, Chicago, IL.
- Hommeyer, J. S., Holmbeck, G. N., Wills, K. E., & Coers, S. (1999). Condition severity and psychosocial functioning in pre-adolescents with spina bifida: Disentangling proximal functional status and distal adjustment outcomes. *Journal of Pediatric Psychology*, 24, 499–509.
- Jandasek, B. (2008). Predictors of social competence in adolescents with spina bifida (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses. (Accession No. 3332352)
- Kaugars, A. S., Zebracki, K., Kichler, J. C., Fitzgerald, C. J., Greenley, R. N., Alemzadeh, R., & Holmbeck, G. N. (2011). Use of the family interaction macro-coding system with families of adolescents: Psychometric properties among pediatric and healthy populations. *Journal of Pediatric Psychology*, 36, 539–551.
- Landry, S. H., Taylor, H. B., Swank, P. R., Barnes, M., & Juranek, J. (2013). Longitudinal mediators of social problem solving in spina bifida and typical development. *Rehabilitation Psychology*, 58, 196–205.
- Lennon, J. M., Klages, K. L., Amaro, C. M., Murray, C. B., & Holmbeck, G. N. (2015). Longitudinal study of neuropsychological functioning and internalizing symptoms in youth with spina bifida: Social competence as a mediator. *Journal of Pediatric Psychology*, 40, 336–348.
- Loomis, J. W., Javornisky, J. G., Monahan, J. J., Burke, G., & Lindsay, A. (1997). Relations between family environment and adjustment outcomes in young adults with spina bifida. *Developmental Medicine and Child Neurology*, 39, 620–627.
- Manly, T., Robertson, I. H., Anderson, V., & Nimmo-Smith, I. (1999). *TEA-Ch: The test of everyday attention for children*. London: Harcourt Assessment.
- Martinez, W., Carter, J. S., & Legato, J. L. (2011). Social competence in children with chronic illness: A meta-analytic review. *Journal of Pediatric Psychology*, 36, 878–890.
- McDowell, D. J., & Parke, R. D. (2009). Parental correlates of children's peer relations: An empirical test of a tripartite model. *Developmental Psychology*, 45, 224–235.
- McPherson, A. C., Swift, J. A., Yung, E., Lyons, J., & Church, P. (2013). The assessment of weight status in children and young people attending a spina bifida outpatient clinic: A retrospective medical record review. *Disability and Rehabilitation*, 35, 2123–2131.
- Miller, M., & Hinshaw, S. P. (2010). Does child executive function predict adolescent functional outcomes in girls with ADHD? *Journal of Abnormal Child Psychology*, 38, 315–326.
- Moos, R., & Moos, B. (1994). *Family environment scale manual: Development, applications, research* (3rd ed.). Palo Alto, CA: Consulting Psychologist Press.
- Muthen, L. K., & Muthen, B. O. (2014). *Mplus user's guide*. Los Angeles: Muthen and Muthen.
- Muthen, L. K., & Muthen, B. O. (1998–2015). *Mplus user's guide* (7th ed.). Los Angeles, CA: Muthen and Muthen.
- Naglieri, J. A., & Das, J. P. (1997). *Cognitive assessment system administration and scoring manual*. Itasca, IL: Riverside Publishing.
- Palisano, R., Rosenbaum, P., Walter, S., Russell, D., Wood, E., & Galuppi, B. (1997). Development and reliability of a

- system to classify gross motor function in children with cerebral palsy. *Developmental Medicine and Child Neurology*, 39, 214–223.
- Psihogios, A. M., Murray, C. B., Zebracki, K., Acevedo, L., & Holmbeck, G. N. (2017). Testing the utility of a bio-neuropsychosocial model for predicting medical adherence and responsibility during early adolescence in youth with spina bifida. *Journal of Pediatric Psychology*, 42, 910–921.
- Repetti, R. L., Taylor, S. E., & Seeman, T. E. (2002). Risky families: Family social environments and the mental and physical health of offspring. *Psychological Bulletin*, 128, 330–366.
- Rose, B. M., & Holmbeck, G. N. (2007). Attention and executive functions in adolescents with spina bifida. *Journal of Pediatric Psychology*, 32, 983–994.
- Shiner, R., & Caspi, A. (2003). Personality differences in childhood and adolescence: Measurement, development, and consequences. *Journal of Child Psychology and Psychiatry*, 44, 2–32.
- Simsek, T. T., Turkucuoglu, B., & Tezcan, S. (2015). Examination of the relationship between body mass index (BMI) and functional independence level in children with spina bifida. *Developmental Neurorehabilitation*, 18, 149–154.
- Swanson, J. M., Kraemer, H. C., Hinshaw, S. P., Arnold, L. E., Conners, C. K., Abikoff, H. B. . . . Wu, M. (2001). Clinical relevance of the primary findings of the MTA: Success rates based on severity of ADHD and ODD symptoms at the end of treatment. *Journal of the American Academy of Child and Adolescent Psychiatry*, 40, 168–179.
- Tuminello, E. R., Holmbeck, G. N., & Olson, R. (2012). Executive functions in adolescents with spina bifida: Relations with autonomy development and parental intrusiveness. *Child Neuropsychology*, 18, 105–124.
- Verhoef, M., Barf, H. A., Post, M. W., van Asbeck, F. W., Gooskens, R., & Prevo, A. J. (2006). Functional independence among young adults with spina bifida, in relation to hydrocephalus and level of lesion. *Developmental Medicine and Child Neurology*, 48, 114–119.
- Wechsler, D. (2003). *WISC-IV administration and scoring manual*. San Antonio, TX: Harcourt Assessment.
- Yeates, K. O., Bigler, E. D., Dennis, M., Gerhardt, C. A., Rubin, K. H., Stancin, T. . . . Vannatta, K. (2007). Social outcomes in childhood brain disorder: A heuristic integration of social neuroscience and developmental psychology. *Psychological Bulletin*, 133, 535–556.