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Social Skills in Youth with Spina Bifida: A Longitudinal Multimethod Investigation of Bio-Neuropsychosocial Predictors

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LOYOLA UNIVERSITY CHICAGO

SOCIAL SKILLS IN YOUTH WITH SPINA BIFIDA: A LONGITUDINAL
MULTIMETHOD INVESTIGATION OF BIO-NEUROPSYCHOSOCIAL
PREDICTORS

A DISSERTATION SUBMITTED TO
THE FACULTY OF THE GRADUATE SCHOOL
IN CANDIDACY FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

PROGRAM IN CLINICAL PSYCHOLOGY

BY

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CHICAGO, ILLINOIS

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Reflecting back on my graduate education, I am humbled by the support I have been fortunate to receive along this arduous, rewarding process. Those well-acquainted with me know my love for both sports and metaphors. My doctoral degree has certainly been the elusive “Super Bowl” of my educational career. Just like the big game, it has required perseverance, determination, practice, a positive attitude, and a sense of humor. Most of all, I have relied on my “team” of friends, family, and mentors.

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CHAPTER 1

INTRODUCTION

Spina bifida (SB) is a birth defect caused by the failed closure of the neural tube during gestation, occurring in roughly three out of every 10,000 live births (Centers for Disease Control and Prevention, 2013). This health condition is associated with an array of health complications, including orthopedic impairments, weakened bowel and bladder functions, and hydrocephalus. Various cognitive deficits are associated with SB in the domains of executive functioning (EF; i.e., inhibiting, shifting, organizing, planning, working memory, and problem solving) and attention (Dennis, Landry, Barnes, & Fletcher, 2006; Burmeister et al., 2005). Taken together, the physical and cognitive impairments encountered by youth with SB appear to be related to autonomy development (Tuminello, Holmbeck, & Olson, 2012), emotional problems (Kelly et al., 2012), and social skills (Rose & Holmbeck, 2007). Specifically within the domain of social functioning, youth with SB tend to have more social problems, fewer close friendships, and poorer peer relations than their typically developing peers (Devine, Holmbeck, Gayes, & Purnell, 2012; Ellerton, Stewart, Ritchie, & Hirth, 1996; Holmbeck et al., 2003; Holmbeck et al., 2010; Mueller-Godeffroy et al., 2008; Wallander, Feldman, & Varni, 1989).

Social deficits often have profoundly negative effects on an individual's subsequent development and well-being. Social difficulties observed in childhood have been linked with lower academic and vocational achievement (Bagwell, Newcomb, &

Bukowski, 1998), greater likelihood of mental health problems (Modin, Oestberg, & Almquist, 2011), and poorer romantic relationships (Roisman, Booth-LaForce, Cauffman, Spieker, & The NICHD Early Child Care Research Network, 2009) in adolescents and adults. Pediatric interventions intended to improve social skills play key roles in optimizing long-term mental health outcomes and enhancing social development of children and adolescents. To maximize the effectiveness and cost efficiency of intervention implementation, it is crucial to identify factors that contribute to social difficulties (La Greca, 1990). For youth with SB, the lack of clearly identified antecedents of social skills deficits presents a clear obstacle to such implementation.

Despite research documenting social dysfunction in youth with SB, little is known about the etiology of these social difficulties. It has been suggested that deficits in advanced cognitive abilities may partially account for the social difficulties encountered by individuals with SB (Fletcher et al., 1996; Rose & Holmbeck, 2007). Specifically, children and adolescents 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. It has been proposed that hydrocephalus in youth with SB causes deficits in EF and attention, which are then associated with poor social function (Fletcher et al., 1996; Landry, Robinson, Copeland, & Garner, 1993). Similar links between cognitive deficits and social skills or outcomes have been found in other populations, including youth with attention deficit/hyperactivity disorder (ADHD; Maedgen & Carlson, 2000; Miller & Hinshaw, 2010), autism (McEvoy, Rogers, & Pennington, 1993), prenatal alcohol exposure (Schonfeld, Paley, Frankel, & O'Connor, 2006), and traumatic brain injuries (Muscara, Catroppa, &

Anderson, 2008; Ganesalingam, Yeates, Taylor, Walz, Stancin, & Wade, 2011).

Family-related variables have also been cited as potential causes of social deficits in this population (Holmbeck et al., 2003). Although family functioning has been linked to multiple psychosocial outcomes (e.g., emotional adjustment, coping strategy use, medical adherence; Lavigne, Nolan, & McLone, 1988; McKernon et al., 2001; Stepansky, Roache, Holmbeck, & Schultz, 2010), less is known about its influence on social skills. Like research with typically developing samples (Barber & Erickson, 2001; McDowell & Parke, 2009), children with SB from families high in cohesion are more likely to exhibit more adaptive social skills compared to their peers with less cohesive families (Jandasek, 2008). Family conflict has a more complex relationship with social adjustment. At high levels of family conflict, typically developing children tend to exhibit poorer social adjustment; when family conflict is at low levels, children's social skills may be compromised due to a lack of opportunities to learn adaptive conflict resolution skills (Floyd, Purcell, Richardson, & Kupersmidt, 2009; Laible, Carlo, Torquati, & Ontai, 2004; Pettit, Dodge, & Brown, 1988). Preliminary research with youth with SB supports the negative association between family conflict and social skill development (Jandasek, 2008), although research with young adults with SB has not identified family conflict as a predictor of social adjustment (Loomis, Javornisky, Monahan, Burke, & Lindsay, 1997).

In addition to cognitive explanations for social deficits, health-related variables may contribute to social dysfunction. Children with more severe SB may have fewer opportunities to engage in social interactions with others due to increased numbers of medical appointments and poorer mobility. The level of the child's lesion on the spinal

cord is linked with both functional and neurological status. Visible physical differences inherent to the condition (e.g., short stature, unusual gait, wheelchair or orthotic use) may lead to social difficulties when other children notice that youth with SB are different than them (Pinquart & Teubert, 2012; Roux, Sawin, Bellin, Buran, & Brei, 2007). Motor impairments (e.g., ambulatory difficulties) can also present logistical barriers to socializing with peers, such that youth with SB struggle to physically keep up with their typically developing peers (Blum, Resnick, Nelson, & St. Germaine, 1991). Further, weight has recently emerged as a potential contributor to the impaired social skills observed in youth with SB (Essner, Murray, & Holmbeck, 2014). Given the impressive body of work finding social difficulties in overweight and obese youth (e.g., Goldschmidt et al., 2010; Martinez, Carter, & Legato, 2011), it is crucial to investigate this construct in youth with SB due to the high rates of obesity observed in this population (Mcpherson, Swift, Yung, Lyons, & Church, 2013; Mita et al., 1993).

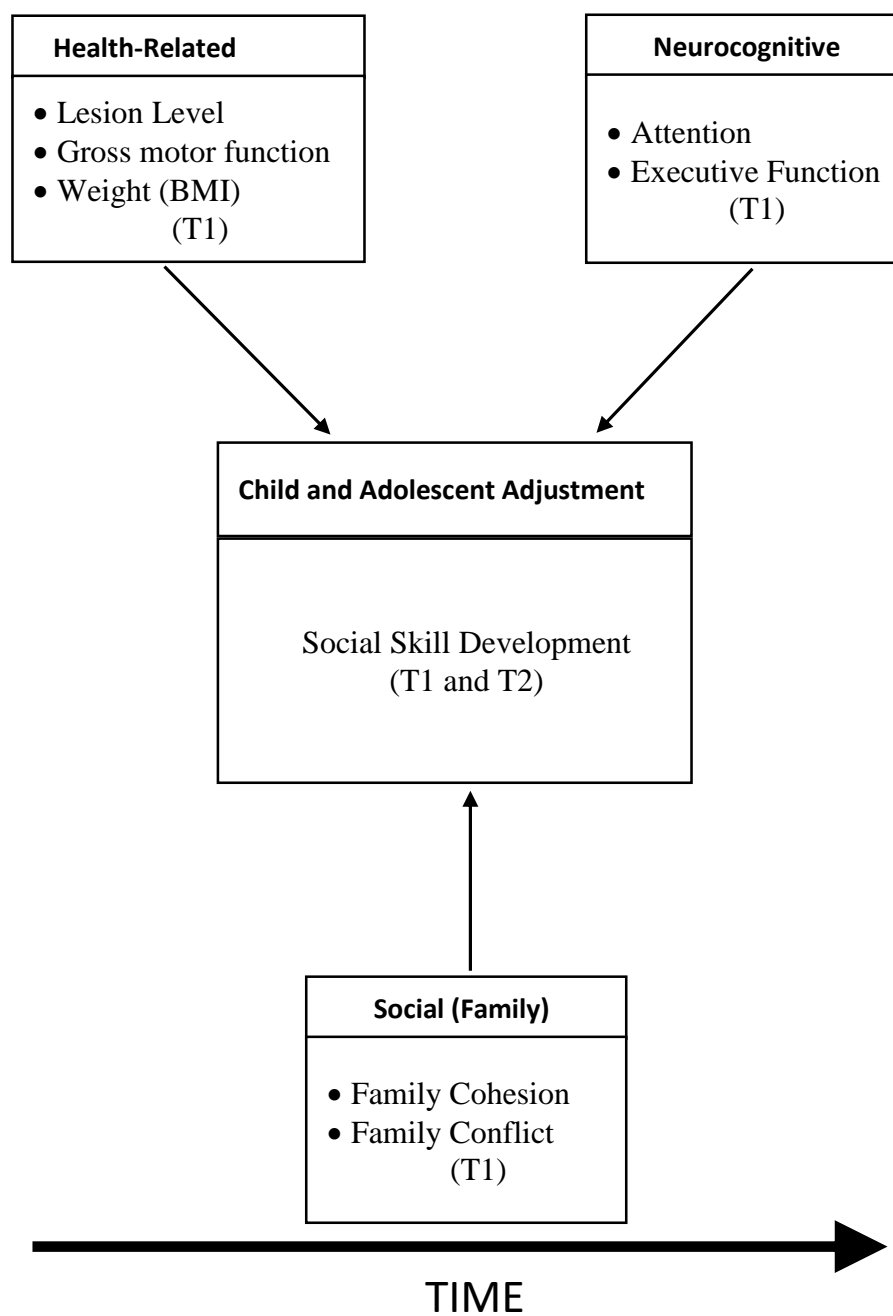
The present study utilizes a developmental conceptual framework adapted from the SB literature (Holmbeck & Devine, 2010) to investigate characteristics in three domains: (1) health-related: condition severity (i.e., lesion level, gross motor function) and body weight; (2) neurocognitive ability (i.e., EF and attention); and (3) family functioning (i.e., cohesion, conflict) and their association with later social skills using a multimethod approach in a sample of youth with SB. Relative influences of the three domains on subsequent social skills in youth with SB were compared. In the following review of the literature, the social functioning of youth with SB is described. Then, a developmental conceptual framework is presented (see Figure 1) and applied specifically to the social skill development of children and adolescents with SB. Components from

each section of the framework – neurocognitive ability, family functioning, and health-related factors – are then reviewed in detail, with specific attention to their connections to social skills. Finally, the current study is described, and hypotheses are proposed.

Social Skills in Individuals with SB

Social competence, an often ambiguous term in the literature, has been defined as “effective functioning within social contexts” (Cavell, 1990, p. 111). Cavell (1990) articulated three distinct aspects of social competence: (1) the child’s ability to achieve developmental milestones or goals deemed important by society, such as a healthy self-concept or acceptance by one’s peers (“social adjustment”); (2) appropriate responses to given social encounters (“social performance”); and (3) specific skills required to proficiently navigate social interactions (“social skills”). More specifically, social skills are considered necessary but insufficient for successful social performance and social adjustment (Cavell, 1990). Examples of social skills include decision-making skills (McFall, 1982), empathy (Caldarella & Merrell, 1997), self-control (Bierman, 2004), overt age-appropriate verbal behaviors (e.g., emotion expression, asking questions), and overt non-verbal behaviors (e.g., eye contact, gestures; Trower, 1980; Cavell, 1990).

Figure 1. Bio-neuropsychosocial conceptual framework of social skill development.



Note: This model is an adaptation of the larger model presented by Holmbeck and Devine (2010). The predictors of interest in the proposed study are included for each domain of the model.

This study focuses exclusively on social skills in children with SB for several reasons. First, social skills are conceptualized as the building blocks of successful social performances and more general social adjustment (Caldarella & Merrell, 1997; Nassau & Drotar, 1997). Thus, to better understand the greater challenges in overall social adjustment faced by youth with SB, it is important to examine social functioning at the level of specific skills. Second, social skills are a key component of many interventions because they are discrete behaviors that can be taught and practiced (Crick & Dodge, 1994). Third, although much of the research examines general social adjustment (Nassau & Drotar, 1997), children's social adjustment is largely a product of multiple factors in addition to social performance and skill (Cavell, 1990), including academic ability, emotional functioning, and others' treatment of the child with SB. Therefore, attempts to uncover predictors of impaired social functioning may be particularly confounded by other processes that commonly occur within children and families with disabilities. Finally, there has been a call for increased attention to the study of social skills for conditions of the Central Nervous System (CNS; Nassau & Drotar, 1997). At present, social skills have been investigated in several previous studies of social functioning in youth with SB (Devine et al., 2012; Holbein et al., 2015; Holmbeck et al., 2003; Roache, 2012; Rose & Holmbeck, 2007). One potential implication of the present study is to integrate previous investigations of social skills by accounting for predictors across multiple domains (neurocognitive, health-related, and family-related) rather than one domain by itself.

Thus far, social adjustment has been a major focus of the literature, with relatively less attention devoted to social skills in this population (Devine et al., 2012; Nassau &

Drotar, 1997). Youth with CNS conditions tend to exhibit greater social impairments relative to children with other health conditions, such as diabetes, blood disorders, and obesity (Martinez et al., 2011; Nassau & Drotar, 1997). Specific to SB, poor social adjustment has been observed throughout the lifespan, from early childhood through adulthood (Landry, Taylor, Swank, Barnes, & Juranek, 2013; Castree & Walker, 1981). In general, parents report that their children with SB experience more social problems than their typically developing peers (Wallander et al., 1989). Youth with SB tend to have friends who are younger, and they are less likely to participate in active, organized activities with their peers (Blum et al., 1991). Consistent with parental report, children with SB also report poorer relationships with their peers (Mueller-Godeffroy et al., 2008). In fact, they indicate that they have been teased or excluded from activities due to their disability (Roux et al., 2007). Additional research suggests that youth with SB tend to be more passive and socially immature (Holmbeck et al., 2003).

During adolescence, a time in which social relationships become more salient, individuals with SB continue to report problematic social adjustment. Adolescents report that they struggle to make close connections with their peers, and they often rely on adults for social interaction (Roux et al., 2007). Some adolescents experience feelings of hopelessness related to the loneliness and social isolation they experience outside of school (Dorner, 1976).

In addition to more general social dysfunction, social difficulties occur within the context of friendships as well. Compared to their peers, youth with SB have fewer friends and reciprocated best friendships, and they spend less time with friends outside of school (Devine et al., 2012; Ellerton et al., 1996; Holmbeck et al., 2003). A longitudinal study

demonstrated the enduring nature of these social deficits; youth with SB who were followed for six years consistently reported having fewer friends compared to a sample of typically developing youth (Holmbeck et al., 2010). The quality of their friendships has been found to be lower too. One study found that children with SB rated their close friendships as lower in security, companionship, closeness, and emotional support relative to their peers (Devine et al., 2012).

Skills deficits appear to be partially responsible for the global social impairments that occur in this population. At the preschool age, young children with SB have been found to have poorer social problem solving skills compared to typically developing children (Landry et al., 2013). Preschoolers also have difficulty incorporating newcomers into an existing social interaction (Fletcher et al., 2004). In social interactions with friends, children with SB exhibit less involvement in shared activities, greater off-task behavior, less maturity, less dominance, and less promotion of collaboration (Holbein et al., 2015). In addition, youth with SB demonstrate poor conversational skills, such that they struggle to interpret the more complex core meanings of their conversations, have difficulty making inferences, show inappropriate social distance, and exhibit hyperverbosity (Barnes & Dennis, 1998). Another study found youth with SB to demonstrate poorer clarity of thought, less confidence in stating opinions, and fewer explanations for opinions compared to peers without SB (Holbein et al., 2015). In particular, social cognition has been noted as an area of weakness in this population (Roache, 2012), and it has been correlated with social deficits (Holbein et al., 2015). As a result, conversations often take on a stereotyped quality, referred to as “cocktail party speech.” These skills deficits likely contribute to the social immaturity and passivity

described by Holmbeck and colleagues (2003). In support of this notion, a recent investigation found that children and adolescents with SB struggled to understand nonliteral language, which was then related to their use of appropriate social skills (Roache, 2012). The same study showed that youth with poorer pragmatic judgment tended to demonstrate fewer social problem solving skills. Social competence appears to play an important role in the mental health of youth with SB. Youth with poorer social competence tended to have more internalizing symptoms two years later (Lennon, Klages, Amaro, Murray, & Holmbeck, 2015).

Despite these weaknesses, individuals with SB also possess a range of social strengths. They tend to be sociable, with the ability to carry out multiple prosocial behaviors (Dennis et al., 2006; Holbein et al., 2015). Indicators of politeness (i.e., taking turns, cooperation) are often evident as well (Barnes & Dennis, 1998). Other research has found comparable verbal and nonverbal conversational skills in children with SB and typically developing youth (Van Hasselt, Ammerman, Hersen, Reigel, & Rowley, 1991). Further, there were no differences in a measure of social acceptance between young adolescents with SB and their peers (Coakley, Holmbeck, & Bryant, 2006). As adults, individuals with SB tend to report similar numbers of friends compared to typically developing peers and report frequency of social interaction in the normative range (Hetherington, Dennis, Barnes, Drake, & Gentili, 2006; Zukerman, Devine, & Holmbeck, 2011). Although there is increasing evidence to suggest the presence of social difficulties, more research is clearly needed to identify the most influential predictors of social dysfunction.

The Bio-Neuropsychosocial Conceptual Framework of Social Development

Despite the established social skills deficits observed in many youth with SB, little is known about the predictors of these deficits. A lack of knowledge about the contributing factors of social problems in children with disabilities has long been lamented (Wallander & Hubert, 1987), and there continues to be uncertainty on this topic. To better understand the factors that underlie social dysfunction, it is imperative to adhere to a comprehensive framework of social skill development (Dirks, Treat, & Weersing, 2007). Theoretical frameworks ensure that factors from multiple domains are considered in the context of overall adjustment and development (Cavell, 1990; Yeates et al., 2007), and they provide an organizational guide for the development and refinement of interventions (Crick & Dodge, 1994; Guralnick, 1999). Although several frameworks for social skill development have been proposed, most do not adequately fit the unique characteristics of SB. For example, Yeates and colleagues' (2007) neurocognitive model for youth with brain disorders suggests that social dysfunction occurs as a result of impairments of cognitive-executive functions (EF, self-regulation, etc.), social-affective functions (pragmatic language, emotion recognition, etc.), and social problem solving. While this model's emphasis on the link between neurocognitive impairment and social skills is relevant to the clinical characteristics of individuals with SB, it fails to properly account for the multitude of contextual and intrapersonal factors that are known to contribute to social skills (Beauchamp & Anderson, 2010); instead, health characteristics and external factors (e.g., socioeconomic status, family background, culture) appear to take a supporting role. Similarly, Dodge and Crick's (1994) social information processing model as applied to normative development emphasizes the influence of cognitive

abilities on children's social adjustment, with little attention to the contributions of noncognitive factors such as emotions, family functioning, and environmental characteristics. The Socio-Cognitive Integration of Abilities (SOCIAL) model is a more integrative framework recently advanced by Beauchamp and Anderson (2010). According to the SOCIAL model, which has been applied to both healthy and clinical populations, the process of social skill development occurs when several cognitive abilities (i.e., attention and executive function, communication skills, and social-cognitive abilities) interact with brain development and internal and external variables. This model has utility in determining underlying reasons for social dysfunction in individuals with SB; however, similar to the models described above, its authors assume that cognitive factors are the primary cause of social deficits, considering crucial social influences such as family functioning and disease severity to merely serve as moderators.

To address the need for an inclusive model of adjustment in individuals with SB, Holmbeck and Devine (2010) proposed a bio-neuropsychosocial model of psychosocial adjustment. Framed within a developmental context, the model suggests that biological (i.e., health-related), psychological, social, and contextual factors influence psychosocial adjustment through interactions and evolutions that occur across time. There is no assumption that one domain is more important than the others in accounting for child and adolescent adjustment. Previous research has utilized this SB-specific bio-neuropsychosocial model to investigate psychosocial adjustment (i.e., community integration, self-care, quality of life, internalizing symptoms) in young adults with SB (Bellin et al., 2011; Bellin et al., 2013). An examination of the literature reveals multiple investigations of the associations between various social outcomes and health-related

(Hommeyer, Holmbeck, Wills, & Coers, 1999; Nassau & Drotar, 1997; Wallander et al., 1989), neurocognitive (Landry et al., 2013; Rose & Holmbeck, 2007), and family (Fussell, Macias, & Saylor, 2005) functioning. However, rather than adopting an integrative, multivariate approach, the majority of the literature focuses on individual domains of the model to explain the social deficits observed in SB. It is crucial to consider social skills within the context of multiple factors rather than each domain in isolation (Wallander & Hubert, 1987). In the current investigation, an adaptation of the bio-neuropsychosocial model is used to enable the comparison of multiple variables across multiple domains. The adapted organizational framework encompasses health-related, neurocognitive, and family-related variables.

Neurocognitive Influences of Social Skills

Given the complex neurocognitive profile of individuals with SB, a brief overview describes the brain anomalies and neurocognitive characteristics associated with SB. Next, the specific attentional and EF deficits commonly observed in individuals with SB are reviewed. For both attention and EF, the potential implications of deficits in these domains on subsequent social skills are discussed.

Neurocognitive profile of individuals with SB. A variety of brain abnormalities are commonly observed in individuals with SB. In the majority of children with SB, particularly those with the most common form of the condition (i.e., myelomeningocele; MM), a Chiari II malformation is present (Barkovich, 2000; Dennis et al., 2006). This malformation of the brainstem and cerebellum is manifested as an abnormally small posterior fossa, causing the contents of this area (i.e., the cerebellum) to herniate to other areas of the brain (Dennis et al., 2006). In approximately 95% of children with SB,

disruption in brain organization physically blocks the flow of cerebrospinal fluid (CSF) in the third and/or fourth ventricles, leading to hydrocephalus (Dennis et al., 2006; Reigel & Rotenstein, 1994). Most children with hydrocephalus undergo surgery as newborns to allow for the implantation of a shunt to divert the CSF through a tube into the stomach (Charney, 1992).

As a result of the structural abnormalities of the CNS, secondary brain anomalies often occur. Hydrocephalus has been linked to a thinning and stretching of the corpus callosum and posterior brain regions (Burmeister et al., 2005; Dennis et al., 2006). Cognitive functions most relevant to hydrocephalus include attention, EF, motor skills, memory, and learning, although impairment in other domains also occurs (Hampton et al., 2011; Iddon, Morgan, Loveday, Sahakian, & Pickard, 2004). It should be noted that individuals with SB who do not have hydrocephalus exhibit neurocognitive profiles that more closely resemble those of typically developing individuals. Children with SB without hydrocephalus perform better on neurocognitive tests than their counterparts who have arrested (i.e., unshunted) and shunted hydrocephalus (Hampton et al., 2011). However, their performances are still lower than typically developing children, with the largest differences occurring in the area of EF. The superior neurocognitive function of individuals with SB and no associated hydrocephalus appears to persist into young adulthood, with most scores falling within the average range (Iddon et al., 2004).

Shunt status (i.e., whether or not a child has a shunt) has been shown to predict general cognitive ability in toddlers (Lomax-Bream, Barnes, Copeland, Taylor, & Landry, 2007) and memory, motor skills, attention, and EF skills in school-aged children (Hampton et al., 2011; Rose & Holmbeck, 2007). Shunt infections or malfunctions can

also have enduring negative effects on brain development and function. Multiple shunt revisions are indicative of unstable medical management of hydrocephalus, which can lead to increased cognitive impairments (Dennis et al., 2006; Hetherington et al., 2006). Number of shunt revision surgeries has been associated with poorer EF in children (Brown et al., 2008) and lower IQ and functional math skill acquisition in young adulthood (Dennis & Barnes, 2002; Hetherington et al., 2006). Of note, not all studies have found links between shunt revisions and cognitive functioning (Burmeister et al., 2005).

Attention in youth with SB. Attention deficits in youth with SB are now well-established. Individuals with SB often exhibit features analogous to Attention Deficit/Hyperactivity Disorder (ADHD) – Inattentive Type (Ammerman et al., 1998). In fact, 23% of children with SB in one study met criteria for ADHD-Inattentive Type (Burmeister et al., 2005). Despite clinically similar presentations, it is important to differentiate the differences between the manifestations of attention problems in youth with SB compared to those with ADHD. Unlike the anterior attention system implicated in ADHD, the attentional characteristics of SB are thought to be related to a posterior attention system, which governs abilities such as orienting stimuli, shifting and disengaging from stimuli, and focusing (Swartwout et al., 2008). In fact, youth with SB tend to be slower at orienting their attention to important information (Dennis et al., 2005; Dennis et al., 2006), and they perform poorly on tasks of focusing and shifting attention (Brewer, Fletcher, Hiscock, & Davidson, 2001; Rose & Holmbeck, 2007). Once attention has been directed to the given stimulus, children require more time to disengage compared to typically developing youth (Brewer et al., 2001; Dennis et al., 2005).

Research in the area of sustained attention has yielded mixed results. Difficulty sustaining attention, an ability that is generally assessed by continuous performance tests (CPTs), have also been reported in youth with SB (Caspersen & Habekost, 2013; Loss, Yeates, & Enrile, 1998). Children with SB tend to exhibit greater total lapses of attention and response inhibition errors compared to controls (Caspersen & Habekost, 2013; Loss et al., 1998; Swartwout et al., 2008). However, Swartwout and colleagues (2008) argue that these results do not necessarily indicate deficits in sustained attention because total error rates (i.e., CPT omissions and commissions) are susceptible to other cognitive deficits (e.g., underarousal, orientation to stimuli). By examining children's ability to sustain attention consistently across the duration of the task, they did not find that youth with SB differ on a measure of sustained attention compared to youth with aqueductal stenosis (i.e., hydrocephalus) and typically developing controls. In other words, youth with SB were not more likely to demonstrate deteriorating attention with the passing of time. This finding was replicated more recently by Caspersen and Habekost (2013). In another study, individuals with shunted hydrocephalus actually improved on measures of sustained attention (i.e., reduced reaction times) after repeated exposure, while participants with ADHD demonstrated decreases in sustained attention over time (Brewer et al., 2001). These findings suggest again that the attention deficits observed in SB and ADHD are distinctly different. Teacher and parent reports have also failed to detect sustained attention deficits in youth with SB relative to typically developing children (Rose & Holmbeck, 2007). Overall, it appears that youth with SB have poorer attentional performances relative to typically developing youth, but their performances are stable and do not vary as a function of time.

According to the bio-neuropsychosocial model (Holmbeck & Devine, 2010), attention is implicated as a central predictor of social adjustment. Indeed, children engaging in social interactions are required to consistently attend to frequently changing visual and auditory information over sustained periods of time (Andrade, Brodeur, Waschbusch, Stewart, & McGee, 2009; Kiley-Brabeck & Sobin, 2006). Individuals with attention deficits may fail to actively participate in and pay attention to social interactions, resulting in insufficient social information processing and the appearance of inappropriate social behaviors (Andrade et al., 2009; McQuade & Hoza, 2008). It has been posited that children with symptoms characteristic of the inattentive subtype of ADHD actually lack the social knowledge required to successfully manage social situations (Maedgen & Carlson, 2010; Wheeler & Carlson, 1994), a theory that is particularly relevant given the inattentiveness commonly observed in youth with SB.

Links between attentional skills and social skills have been a primary focus in the ADHD literature. Compared to controls, children with ADHD-Inattentive Type have been found to contribute less often in conversations with peers, generate more off-topic responses during discussions, and possess poorer memory for conversations (Mikami, Huang-Pollock, Pfiffner, McBurnett, & Hangai, 2007). They also tend to be socially isolated, passive, and shy (Hinshaw, 2002; Hodgens, Cole, & Boldizar, 2000; Maedgen & Carlson, 2010). In typically developing youth, attention has also been identified as a predictor of social competence (Diamantopoulou, Rydell, Thorell, & Bohlin, 2007; Murphy, Laurie-Rose, Brinkman, & McNamara, 2007).

In a sample of adolescents with SB, attentional skills were one of the most robust predictors of social skills in one cross-sectional investigation (Jandasek, 2008). Children

rated to have fewer attentional problems were more likely to have more well-developed social skills and higher numbers of close friendships. When combined with level of physical attractiveness, attentional skills were able to correctly classify approximately 60% of adolescents on a measure of social skills. In a recent study using the same study sample as the present investigation, attention skills were positively linked to children's clarity of idea expression, provision of explanations for opinions, maturity, and promotion of collaboration; a negative association between attention skills and off-task behaviors was also observed (Holbein et al., 2015). Associations between attentional skills and social skills in youth with SB have been implicated in additional research as well (e.g., Rose & Holmbeck, 2007). Although these studies point to the predictive value of attention on social skills, the evidence is still quite preliminary; additional longitudinal research is needed to demonstrate the relationship between attention and subsequent social function. Further, the relative effect of attention on the development of social skills within the context of other health-related and family-related variables is unknown.

EF in youth with SB. There is currently a strong evidence base for EF deficits in youth with SB. This is not surprising, given well-established associations between EF and attention abilities (Barkley, 1997). It should be noted that EF describes a collection of related constructs, including inhibition, cognitive flexibility, working memory, planning, organizing, and inhibition (Anderson, 2002). Although EF skills are thought to be controlled by frontal brain regions (Anderson, 1998), it has been suggested that the anomalies occurring in posterior regions may be responsible for poor EF in this population (Burmeister et al., 2005). Measures of EF inherently capture neurocognitive constructs controlled by other brain areas (e.g., attention, fine motor skills) that are

known to be weaker in individuals with SB, which may result in lower levels of EF skills (Fletcher et al., 1996). Fletcher and colleagues also hypothesized that the posterior-controlled arousal-activation system may be responsible for the apparent EF dysfunction, as youth with SB are underaroused and rarely fully engage in problem solving tasks. However, more research is needed to fully understand the neurological origins of EF skills in individuals with SB (Burmeister et al., 2005).

Despite the lack of knowledge regarding the reasons underlying executive dysfunction in this population, research suggests that many individuals with SB struggle with EF skills on performance-based measures. Relative to typically developing youth, children and adolescents with SB perform poorly on measures tapping cognitive flexibility and abstract reasoning (Burmeister et al., 2005; Hampton et al., 2011; Snow, 1999). In one study, children with SB made more perseverative responses, indicative of difficulties with mental shifting (Snow, 1999). In contrast, Fletcher and colleagues (1996) did not find youth with SB to make more perseverative errors; instead, children with hydrocephalus, including those with SB, made errors on problem solving tasks that were more consistent with impaired sustained attention. They also observed that children with hydrocephalus exhibited greater difficulty on a measure of problem solving and planning. Poorer performances by both youth and adults with SB have been demonstrated on Trails A and B (and similar tests); such measures capture cognitive flexibility, visual planning, sequencing, and switching (Rose & Holmbeck, 2007; Snow, 1999; Stubberud & Riemer, 2012; Tuminello et al., 2012). In social situations, these types of deficits may cause an individual to have difficulty following and participating in conversation, navigating interactions with multiple people, switching eye contact appropriately, and so forth.

Working memory has been discussed as an area of concern for individuals with SB as well. When required to perform mental operations on verbally presented digits, children with SB score lower than their typically developing peers (Burmeister et al., 2005). Adults with SB also appear to have working memory deficits, with 42% of participants in one study scoring in the clinically significant range (Stubberud & Riemer, 2012). These deficits likely have implications for later social skills. In typically developing children, poor working memory has been linked with greater peer rejection, poorer social competence, higher levels of aggression, and poorer conflict resolution skills (Alloway et al., 2005; McQuade, Murray-Close, Shoulberg, & Hoza, 2013). Additional deficits in this population have been found on tests of EF that measure inhibition (Stuberrud & Riemer, 2012) and planning (Tuminello et al., 2012).

Questionnaire measures of EF provide unique information about the individual's everyday functioning that is not captured by performance-based neurocognitive tests. The Behavior Rating Inventory of Executive Functioning (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000), a rating scale of EF, has been included in numerous studies of individuals with SB. Scores on the BRIEF indicate the level of an individual's EF abilities in the context of everyday life (Tarazi, Zabel, & Mahone, 2008), and they often are not highly correlated with performance-based measures of EF (Anderson, Anderson, Northam, Jacobs, & Mikiewicz, 2002; Ganesalingam et al., 2011). Parent and teacher ratings on the BRIEF have shown evidence of EF difficulties in children and adolescents with SB (Burmeister et al., 2005; Tuminello et al., 2012; Rose & Holmbeck, 2007), with more concerns reported in the area of metacognition (i.e., task initiation, working memory, planning, organization, and self-monitoring; Brown et al., 2008; Zabel et al.,

2011). Item analysis of the most commonly endorsed items by parents revealed significant concerns with children's ability to complete self-help tasks that require motor skills, multiple steps, and speed (Mahone & Zabel, 2004). Concerns related to behavioral control (i.e., shifting, inhibition, and emotion regulation) have also been found (Tarazi et al., 2008). Of note, EF deficits on the BRIEF appear to endure into adulthood (Stubberud & Riemer, 2012; Zabel et al., 2011).

Like attention, EF skills are included as predictors of social outcomes in the bio-neuropsychosocial model (Holmbeck & Devine, 2010). Indeed, social interactions are complex, dynamic events that require sophisticated cognitive evaluation skills (Kiley-Brabeck & Sobin, 2006). For instance, children must update multi-faceted information, monitor a constantly changing course of interaction, and flexibly respond to novel situations (Gilotty, Kenworthy, Sirian, Black, & Wagner, 2002; Kiley-Brabek & Sobin, 2006). It has been suggested that EF abilities serve as building blocks for the social problem solving skills utilized in positive social interactions (Muscara et al., 2008). Further, successful interactions with others depend in part on an individual's ability to regulate his or her attention, emotions, and behaviors (i.e., executive control; Gansalingam et al., 2011; Shields & Cicchetti, 1998). Youth with poor behavioral regulation abilities often struggle to negotiate the multiple facets of social situations and fail to respond appropriately (Jacobson, Williford, & Pianta, 2011; Repetti, Taylor, & Seeman, 2002). Instead, they may speak or act without first considering the implications of their behavior. This issue is particularly problematic when the child engages in physical or verbal aggression toward peers.

Associations between EF skills and social skills have been found in populations of

children with medical or neurobehavioral conditions characterized in part by EF deficits. For example, children with traumatic brain injuries who have greater behavioral EF deficits post-injury tend to exhibit fewer socially competent behaviors, even when intellectual ability is controlled (Ganesalingam et al., 2011; Yeates et al., 2004). In fact, Muscara and colleagues (2008) found that social problem solving skills mediated the association between EF skills and adaptive social skills in their sample of adolescents and young adults who had experienced a traumatic brain injury in childhood. A study of pediatric survivors of brain tumor demonstrated relationships between both performance-based and behavioral reports of EF skills and parent-reported social skills (Wolfe et al., 2013). EF deficits have also been suggested as contributors to the social dysfunctions characteristic of autism spectrum disorder. For these youth, EF skills have been found to be related to adaptive social skills, with working memory and the ability to initiate behaviors producing the strongest correlations (Gilotty et al., 2002). In a study of preschool children with autism, a performance-based measure of EF was associated with observed social behaviors (McEvoy et al., 1993). Regarding ADHD, results are more mixed. Although EF skills predicted later social skills in a longitudinal study (Miller & Hinshaw, 2010), another investigation only found EF skills to predict a portion of studied social behaviors (Huang-Pollack, Mikami, Pfiffner, & McBurnett, 2009). In the latter investigation, there was little support for a model testing the mediating role of EF skills in the association between ADHD status and social skills.

Additional health conditions with evidence of a connection between EF skills and social skills include 22q11 deletion syndrome (Kiley-Brabeck & Sobin, 2006), prenatal alcohol exposure (Schonfeld et al., 2006), and cortical malformations and stroke (Gomes,

Spencer-Smith, Jacobs, Coleman, & Anderson, 2012). Moreover, EF skills appear to predict social outcomes in typically developing youth, suggesting that the association is not specific to the presence of an identifiable medical or psychological diagnosis (Jacobson et al., 2011; Miller & Hinshaw, 2010; Nigg, Quamma, Greenberg, & Kusche, 1999). Still, not all studies have found links between EF skills and social functioning (e.g., Diamantopoulou et al., 2007), suggesting that more research is needed to clarify the relationships between these constructs.

Rose and Holmbeck (2007) found preliminary evidence supporting the notion that neurocognitive variables contribute to social deficits in youth with SB, although their cross-sectional design limits the ability to conclude that neurocognitive function is a true predictor of social skills. Both self-report and performance-based measures of EF predicted social competence and skills. Moreover, EF skills mediated the association between SB status (i.e., whether a child was typically developing or diagnosed with SB) and social skills, leading to the conclusion that EF skills are a crucial piece to the puzzle of social dysfunction in youth with SB. Another cross-sectional study showed that greater EF skills were associated with greater social acceptance and social skills in a sample of adolescents with SB (Jandasek, 2008). A recent study found further evidence for a cross-sectional relationship between neurocognitive factors (e.g., attention, EF, and IQ) and social competence in youth with SB (Lennon, et al., 2015). Additional research suggests that EF skills are predictive of better adaptive skills (i.e., adaptability, social skills, leadership, functional communication, and activities of daily living) in youth with SB (Kelly et al., 2012). The direct association between EF and social competence appears to endure into adulthood. Zukerman and colleagues (2011) found that children with SB who

had better EF abilities later reported having more friends and were more likely to have been in a romantic relationship in adulthood.

Familial Influences of Social Skills

Family functioning is an additional domain with strong implications for psychosocial development and adjustment of youth with SB (Holmbeck & Devine, 2010). With respect to social skills as an outcome, the model reflects the widely held notion that family characteristics serve as a foundation for subsequent social development (Bell, Avery, Jenkins, Feld, & Schoenrock, 1985). Indeed, children first explore their social environments within the context of the family environment and experience a variety of social experiences that facilitate acquisition of social skills (Bennett & Hay, 2007; Repetti et al., 2002). The family context has even been described as “the most immediate and stable social environment for the child” (Wallander & Varni, 1998, p. 40). At a young age, children begin to form models of interpersonal relationships based on interactions with family members (Laible et al., 2004). As they age, interactions with family members and the development of close familial relationships provide children with opportunities to acquire and practice social skills (Amato, 1989).

Family relationships may be particularly important for the development of social skills in youth with disabilities (Haven, Manangan, Sparrow, & Wilson, 2014). Unlike families of typically developing children, families of youth with disabilities are faced with unique stressors (e.g., financial strain, anxiety about the child’s future health, time required to care for the child, navigating multiple medical appointments, etc.) that may alter family dynamics (Bennett & Hay, 2007). Families also influence the child’s ability to cope with and adapt to a chronic health condition or disability (Varni, Rubenfeld,

Talbot, & Setoguchi, 1989). One study found that abnormal family functioning (e.g., maladaptive communication, poor task completion, low affective expression) strongly predicted social skills impairment in youth with epilepsy but not their siblings (Tse, Hamiwka, Sherman, & Wirrell, 2007), suggesting that the development of social skills in a child with a disability may be influenced by the family to a greater degree when compared with typically developing youth. More adaptive family relationships have also been linked with better social adjustment in children with Tourette's syndrome (Carter et al., 2000).

Family cohesion. Family cohesion is a characteristic of family life that has been studied in previous investigations of pediatric social competence. Cohesion reflects multiple components of family life, including emotional closeness, frequency of interaction, shared interests, common goals, mutual support, and interdependence (Olson & McCubbin, 1983). In typically developing youth, social competence has been associated with more cohesive family environments (Amato, 1989; Bell et al., 1985). In fact, warm, supportive relationships with both parents and siblings appear to be important for later social skills (Barber & Erickson, 2001; Guralnick, Neville, Connor, & Hammond, 2003; Hillaker, Brophy-Herb, Villarruel, & Haas, 2008; McDowell & Parke, 2009; Zhou et al., 2002). Nurturing and connected family members serve as positive role models by demonstrating prosocial skills and encouraging similar behaviors in younger family members (Paterson & Sanson, 1999). Taken together, highly cohesive families facilitate social development by providing children with opportunities to observe and practice prosocial skills in a safe, supportive environment.

Family cohesion has also been studied in samples of youth with disabilities and

chronic health conditions. Families of children with medical needs may become more nurturing and connected due to the increased demands the child requires of parents and siblings (Thornton et al., 2008). Similar to research with typically developing youth, cohesive family environments have been found to benefit subsequent social development in pediatric populations (Haven et al., 2014; Wallander & Varni, 1998). Children with newly diagnosed cancer who had more cohesive family relationships were rated to have greater social competence both concurrently and six months later (Varni, Katz, Colegrove, & Dolgin, 1996). Another study demonstrated the importance of family cohesion to the development of social adaptation in a sample of youth with limb deficiencies (Varni et al., 1989). This study in particular lends support to the hypothesis that family cohesion is predictive of social skill development in children and adolescents with SB. Like SB, limb deficiencies result in obvious physical differences and impaired mobility or motor skills. Evidence for the association between parent-child cohesion and social skills has also been found in children with autism (Haven et al., 2014), a condition in which social deficits are a primary characteristic.

There are also studies that fail to confirm associations between family cohesion and adaptive social skills. For example, family cohesion was found to be unrelated to the number of social activities in which adolescents with cerebral palsy engage (Kang et al., 2010). The authors suggested that the increasing autonomy of adolescence may reduce the influence the family environment has on adolescents' social participation. As individuals with cerebral palsy or spina bifida both encounter limitations in autonomy (Donkervoort, Roebroek, Wiegerink, van der Heijden-Maessen, & The Transition Research Group South West Netherlands, 2009; Friedman, Holmbeck, DeLucia,

Jandasek, & Zebracki, 2009), similar family processes may apply to youth with SB.

Families of youth with SB tend to be less cohesive compared to families of typically developing youth, especially for families from lower socioeconomic backgrounds (Holmbeck, Coakley, Hommeyer, Shapera, & Westhoven, 2002). Holmbeck and colleagues suggest that lower levels of cohesion may be attributed in part to the child with SB having less involvement and poorer communication within the family, consistent with the resilience-disruption hypothesis (Costigan, Floyd, Harter, & McClintock, 1997). This hypothesis postulates that families of youth with disabilities are both affected both positively and negatively by the stress of caring for a child with multiple needs. For instance, relative to families of typically developing youth, a family of a child with SB may appear to be less cohesive while also experiencing lower levels of family conflict and family stress (Holmbeck, Coakley, et al., 2002). Further, it appears that the lower cognitive functioning observed in youth with SB may be a significant contributor to group differences in family cohesion because the child with SB is more likely to take a passive role in family discussions and activities. Others have posited that the presence of psychopathology in youth with SB may account for low levels of family cohesion (Ammerman et al., 1998).

Although there appear to be differences in family cohesion by health status, examination of the construct over time provides a more nuanced view of families of children with SB. Throughout adolescence, observed family cohesion appears to decrease to a lesser degree in families of adolescents with SB compared to families of typically developing youth, although parent reports of cohesion remain stable over time (Coakley, Holmbeck, Friedman, Greenley, & Thill, 2002; Jandasek, Holmbeck, DeLucia, Zebracki,

& Friedman, 2009). Thus, although families of youth with SB tend to have lower levels of cohesion than their typically developing counterparts, the families of children with SB are resilient to the developmental changes of adolescence.

Overall, research has shown that children with SB who have more cohesive families have fewer behavior problems (Lavigne et al., 1988), use more problem-focused coping strategies (McKernon et al., 2001), and are more adherent to their medical regimens (Stepansky et al., 2010). Further, a cohesive family environment can act as a buffer against depression for adolescents with SB who face uncontrollable life stressors (Murch & Cohen, 1989).

Despite the available knowledge of the role of family cohesion on psychosocial adjustment in children with SB, little is known about the influence of cohesive family environments on the development of social skills in this population. Consistent with the literature, family cohesion in childhood predicted social skills and friendship closeness in adolescents with SB (Jandasek, 2008). Alternatively, another study found that social activity in young adulthood was not related to the young adults' recollections of family cohesion during childhood (Loomis et al., 1997). However, this study was limited because it was not longitudinal, featured a small sample size ($N = 32$), and used a single dichotomous item as an outcome measure of social adjustment. This study expands upon these findings through analyses with a larger sample, use of multiple methods and informants, and a longitudinal study design.

Family conflict. In addition to family cohesion, conflict within the family has also been shown to affect the social development of children and adolescents. Conflict occurs within all families to some degree, but it is more likely to have detrimental effects

on youth when situations are laden with negative emotions and poorly managed by family members (Burke, Woszidlo, & Segrin, 2012). In fact, well-developed social skills are required for the effective resolution of family conflict. For instance, individuals must listen to each other and communicate their feelings and opinions in a rational manner, all while inhibiting harsh criticism and managing their emotions. Burke and colleagues (2012) found that individuals in high conflict families reported less adaptive self-disclosure skills and poorer relationships with others. Poorer conflict management and less sensitivity to peers' needs have also been found in families in which more conflict occurs and fewer prosocial skills are demonstrated (Herrera & Dunn, 1997; Lindsey, Mize, & Pettit, 1997).

Further, parents and siblings in more chaotic families are weak models of prosocial skills, and they provide fewer active opportunities for children to acquire social skills (Repetti et al., 2002). In support of this concept, children's social skills used in peer conflict situations often resemble those demonstrated by their parents and siblings (Herrera & Dunn, 1997). Overall, children raised in households characterized by more coercion and conflict have been found to demonstrate fewer of the prosocial skills that are needed to successfully navigate peer interactions (Barber & Erickson, 2001; Crockenberg & Lourie, 1996; Laible et al., 2004; Pettit et al., 1988; Webb & Baer, 1995).

Family conflict can also contribute to deficits in social information-processing that negatively affect social skills (Repetti et al., 2002). Children raised in high conflict family environments have been found to exhibit dysregulated cortisol reactivity, serotonergic functioning, and cardiovascular responses to stressful social situations (Luecken, Kraft, & Hagan, 2009; Luecken & Roubinov, 2012; Repetti et al., 2002). As a

result, these youth appear to be more vigilant regarding potential social threats, falsely attribute neutral social interactions as having hostile origins, and struggle to inhibit anger impulses (Luecken, Roubinov, & Tanaka, 2013; Repetti et al., 2002). In other words, children and adolescents who grow up in high conflict families may be biologically and mentally primed to anticipate negative occurrences in their interactions with peers. Thus, they may respond to otherwise benign social scenarios with anger or aggression, and they are less likely to flexibly adapt to dynamic social interactions (Ramani, Brownell, & Campbell, 2010). It is not surprising that children exposed to high levels of conflict at home are more likely to behave in an aggressive, antisocial manner than are those raised by families with less conflict (Ehrlich, Dykas, & Cassidy, 2012; Schwartz, Dodge, Pettit, & Bates, 1997).

While high levels of family conflict clearly have a negative influence on children's social development, low levels of conflict can also be maladaptive. Children who are not exposed to conflict within the family have fewer opportunities to develop conflict resolution skills or cope with stressful peer situations (Fergus & Zimmerman, 2005; Floyd et al., 2009). Constructive conflicts that include intellectual conversations and justification of one's opinions provide crucial experiences for children and adolescents to learn social skills needed in peer interactions (Laursen & Hafen, 2010). In fact, parent-child conflict is a key component of identity development and autonomy in adolescence. Moreover, a lack of conflict can be indicative of disengaged family relationships (Floyd et al., 2009). It is likely that there is an optimal amount of family conflict that allows for healthy social development and appropriate acquisition of conflict-related social skills.

It should also be noted that cohesion and conflict are not mutually exclusive concepts within the family context. While there are families high in conflict and low in cohesion (and vice versa), there are also families who are either high or low in both characteristics. Research has shown that moderate levels of conflict are associated with positive psychosocial functioning in adolescents with high quality family relationships; however, frequency of family conflict has a linear relationship with psychosocial functioning for adolescents with low quality family relationships (Adams & Laursen, 2007). Varni and colleagues (1996) have called for measurement of multiple domains of family functioning given their differential effects on psychosocial adjustment. Clearly, it is important to study both family cohesion and conflict when investigating determinants of social skills development.

Family conflict is relevant to the study of social skills in youth with chronic health conditions and disabilities. There is evidence to suggest that conflict is higher in families of youth with chronic health conditions and compared to families of typically developing youth (Bennett & Hay, 2007; Pai et al., 2007), although other research has failed to find such differences (Hamlett, Pellegrini, & Katz, 1992; Mahoney, O'Sullivan, & Robinson, 1992). Parents of children with chronic health conditions (e.g., juvenile rheumatoid arthritis, asthma, etc.) also tend to express greater criticism toward their children relative to parents of typically developing children (Aasland, Novik, Flato, & Vandvik, 1998; Schobinger, Florin, Reichbauer, Lindemann, & Zimmer, 1993). Conflicts may occur in families of children with chronic health conditions due to changing family roles and expectations or the stress associated with the practical demands the health condition places on the family (Pai et al., 2007). Within families of children with disabilities, the

severity of the child's disability has been associated with greater family distress (Mahoney et al., 1992).

At present, very few studies have examined the association between family conflict and social skill development in pediatric populations. Several investigations have found positive effects of family conflict on social outcomes. Floyd and colleagues (2009) found a link between sibling relationships high in conflict and greater social competence in children with intellectual disabilities (Floyd et al., 2009). Similarly, children with cerebral palsy who had higher levels of parent-reported family conflict participated in more social activities with friends (Kang et al., 2010). In contrast, family conflict was not related to social competence in samples of children with either limb anomalies or cancer (Varni et al., 1989; Varni et al., 1996).

Family conflict has received some attention in the SB literature. The majority of study findings suggest that there is less conflict within families of youth with SB compared to families of typically developing youth (Holmbeck & Devine, 2010; Holmbeck & Faier-Routman, 1995). Unlike typically developing youth, changes in the amount of conflict in families with a child with SB tend to be less dramatic during the adolescent period (Coakley et al., 2002; Jandasek et al., 2009; Wasserman, Holmbeck, Lennon, & Amaro, 2012). These families tend to be less responsive to the child with SB's physical and developmental changes associated with puberty. Qualitative research also supports the notion of low family conflict as reported by adolescents, although disagreements with parents about issues of control and power have been noted (Bellin, Sawin, Roux, Buran, & Brei, 2007). Sibling relationships are described by most adolescents with SB as having typical, transient periods of conflict. A meta-analysis of

parents' psychosocial adjustment to SB concluded that conflict was less common in families of youth with SB (Vermaes, Gerris, & Janssens, 2007). Lower levels of conflict may be due to lower motivation to establish autonomy and to challenge parents' authority. Conversely, conflict did not differ in families of school-aged children with SB compared to levels reported by and observed in typically developing youth (Holmbeck, Coakley, et al., 2002).

Family conflict in families of children with SB has been connected with multiple outcomes of interest. For example, parents of children with SB were less likely to exhibit adaptive parenting when higher levels of conflict occurred within the family (Greenley, Holmbeck, & Rose, 2006). This finding supports the notion that parents in high conflict households are poorer models of prosocial skills. Further, lower family conflict acts as a buffer for the development of depressive symptoms in the context of stressful life events in adolescents with SB (Murch & Cohen, 1989). Families of children with SB may be more resilient towards life stress given their experiences raising a child with a disability; this strength may enable families to cope with additional stressors and protect the adolescent from significant depressive symptoms. Medical adherence is also negatively affected by a high conflict family environment as well (Stepansky et al., 2010).

Evidently, family conflict plays a role in multiple domains of psychological functioning.

Research investigating the relationship between family conflict and social skills specific to youth with SB is scarce. A longitudinal study revealed that lower levels of family conflict experienced when youth with SB were 8 or 9 years old predicted greater social skills and friendship closeness in adolescence (Jandasek, 2008). Unlike research with other pediatric populations (Floyd et al., 2009; Kang et al., 2010) described above,

this finding supports the notion that high conflict families provide less competent role models of social skills and prime children to respond in an inappropriate manner to social situations (Repetti et al., 2002). In contrast, Loomis and colleagues (1997) failed to find a significant correlation between retrospectively reported family conflict experienced in childhood and current social activity in a small sample of young adults with SB. Clearly, there is a gap in the literature examining associations between family conflict and social skill development. On the other hand, given the preliminary research, family conflict may be expected to be negatively related to social skill development in this population.

Health-related Influences of Social Skills

Condition severity. Health-related variables are often investigated in researchers' attempts to better understand social skills in youth with disabilities. Condition severity is thought to be a significant predictor of social skill development in pediatric populations (Holmbeck & Devine, 2010). The magnitude of an individual's illness or disability may impact social skills due to cognitive delays, functional limitations, and visible physical differences (Curtin & Siegel, 2003; Nassau & Drotar, 1997; Wallander et al., 1989). Links between condition severity and social adjustment have been demonstrated in multiple pediatric populations, including conditions with significant CNS involvement; there has been less attention to social skills in these children. A review of research investigating social competence in children with CNS conditions found six of the seven reviewed studies to support the conclusion that greater condition severity is related to poorer social competence, despite differing measurements of severity (i.e., medical intervention, functional impairment, neurocognitive function, and educational placement; Nassau & Drotar, 1997). Further, children with less severe traumatic brain injuries

exhibited better social adjustment compared to children with more severe injuries (Dennis, Guger, Roncadin, Barnes, & Schacher, 2001; Muscara et al., 2008). In a sample of adolescents with epilepsy, loneliness was associated with greater visibility of epilepsy symptoms (Curtin & Siegel, 2003). However, not all studies have confirmed such associations. Seizure-related variables were not linked with social competence in a cross-sectional study of children with epilepsy (Caplan et al., 2005). Taken together, the differing indicators of condition severity preclude absolute conclusions about its influence on social skill development in youth with chronic health conditions.

Condition severity in youth with SB has been assessed in different ways. Indicators of condition severity used in past research include lesion level, type of SB (myelomeningocele, lipomeningocele, etc.), shunt status, number of shunt revisions, and ambulation status (Hommeyer et al., 1999). A condition severity composite comprised of four of the above characteristics (i.e., lesion level, type of SB, shunt status, and ambulation status) has also been used (Hommeyer et al., 1999). In the present study, lesion level and gross motor function serve as potential predictors of social skill development. SB type is not included due to minimal variability in the study sample (86% of participants had myelomeningocele). In addition, shunt status and number of shunt surgeries are not included due to significant overlap with neurocognitive measures (Hampton et al., 2011; Lomax-Bream, Barnes, et al., 2007; Rose & Holmbeck, 2007), which is categorized within another domain according to the conceptual framework used in this examination. Previous research suggests that individuals with shunted hydrocephalus is indicative of increased condition severity; individuals with shunts are at risk for poorer social competence (Nassau & Drotar, 1997), among other psychosocial

outcomes (Holmbeck & Faier-Routman, 1995).

Lesion level. Relevant to SB, the level of the lesion on the spinal cord is often regarded as an indicator of SB severity. Higher lesion levels are associated with greater neurocognitive, motor, and sensory impairments (Fletcher et al., 2005; Galli et al., 2002). A greater amount of secondary health problems (e.g., shunt revisions, orthopedic surgery, scoliosis, urinary incontinence, etc.) have also been found in older adolescents and young adults with higher lesions (Verhoef, Barf, Post, van Asbeck, Gooskens, & Prevo, 2004). Of note, lesion level is not a static indicator of severity; levels may change throughout one's lifetime based on secondary complications (e.g., tethered cord) and changes in functional status (Verhoef, Barf, Post, van Asbeck, Gooskens, & Prevo, 2006). During early childhood, lesion level has been found to predict cognitive and motor skill development (Lomax-Bream, Taylor, Landry, Barnes, Fletcher, & Swank, 2007). In adolescence, lesion level has been implicated in functional independence specific to mobility, health-related self-care, and cognition (Heffelfinger et al., 2008; Schoenmakers, Uiterwaal, Gulmans, Gooskens, & Helders, 2005). The influence of a child's level of lesion on outcomes is not always linear. For example, Holmbeck and Faier-Routman (1995) found support for the marginality hypothesis, which maintains that children with lower levels of impairment experience greater psychosocial difficulties because they struggle to fit in with both typically developing peers and more severely disabled children. Specifically, mothers of children with *lower* lesion levels reported less maternal attachment, more parent-child conflict, and less willingness to grant their children autonomy.

The impact of an individual's lesion level is less clear in the domain of social

skills. Higher lesions were associated with poorer social communication skills in a subsample of Latino youth (Fletcher et al., 2005). Similarly, evidence supports the connection between higher lesion levels and poorer social cognition (Verhoef et al., 2006), although not all studies have confirmed this relationship (Roache, 2012). In contrast, lesion level was not related to social competence or frequency of social interaction in other studies of youth and young adults (Wallander et al., 1989; Hetherington et al., 2006). In line with the marginality hypothesis, it is possible that children with lower lesion levels struggle to demonstrate appropriate social skills with peers because they do not identify with a particular peer group (Holmbeck & Faier-Routman, 1995). For instance, a child with a sacral lesion level may appear relatively able-bodied by successfully ambulating with ankle-foot orthotic braces; on the other hand, the same child may lack bowel and bladder control (requiring catheterization and bowel program management) and experience learning difficulties and subtle neurocognitive deficits that set him or her apart from peers.

Gross motor function. Motor function has been studied as a predictor of social functioning in youth with disabilities. For example, children with impaired motor skills may have difficulty physically keeping up with typically developing peers, face limitations in the type of social activities that are both available and accessible, and are less likely to participate in both formal and informal activities (Blum et al., 1991; Rimmer, Rowland, & Yamaki, 2007; Shikako-Thomas, Majnemer, Law, & Lach, 2008). Further, children with impaired motor skills may be teased by peers about visible indicators of their disability, including ambulatory devices such as wheelchairs, braces, and crutches (Horowitz et al., 2004; McMaugh, 2011; Nassau & Drotar, 1997; Wallander

& Hubert, 1987). In fact, children who have difficulty walking or cannot walk at all tend to exhibit poorer social skills compared to their more ambulatory peers (Ammerman, Van Hasselt, Hersen, & Moore, 1989). In multiple samples of pediatric cerebral palsy, children with greater motor impairments were found to have poorer social competence compared to those with less impairment (Lepage, Noreau, & Bernard, 1998; Voorman, Dallmeijer, Van Eck, Schuengel, & Becher, 2010). However, other research in youth with CNS conditions has not found support for the association between poorer motor function and social competence (Voorman, Dallmeijer, Schuengel, Knol, Lankhorst, & Becher, 2006). Although links between motor function and social skills in youth with SB has received little attention, there is evidence that motor skills predict subsequent development of cognitive, language, and daily living skills for these youth (Lomax-Bream, Taylor, et al., 2007).

In youth with SB, condition severity has previously been implicated in health-related quality of life (HRQOL; Bier, Prince, Tremont, & Msall, 2005; Mueller-Godeffroy et al., 2008; Schoenmakers et al., 2005). In the domain of social skills, condition severity has received less attention. It has been suggested that condition severity is indirectly related to subsequent social functioning (Hommeyer et al., 1999). In contrast, lesion level and shunt status did not predict social competence as measured by a symptom checklist in another sample of children with SB (Wallander et al., 1989). Hommeyer and colleagues (1999) suggested that mixed findings regarding the association between condition severity and social function may be attributed to incomplete examination of multiple indicators of condition severity and failure to differentiate between proximal and distal (i.e., indirect) psychosocial outcomes. The

present study includes two indicators of condition severity (i.e., lesion level and motor function) to determine their influences on subsequent social skills relative to other factors that have been implicated in social development. Lesion level and motor function are associated, such that youth with higher lesion levels have greater motor impairments (Fletcher et al., 2005); however, research suggests that lesion level and motor skills have differing influences on developmental outcomes. For instance, Fletcher and colleagues (2005) found that lesion level broadly influenced domains with minimal motor requirements, including cognitive function, adaptive behaviors, and academic achievement.

Weight. Weight is an additional health-related factor with well-established effects on social skills. It is particularly relevant to the current investigation because obesity is frequently cited as a secondary complication of SB (Simeonsson, McMillen, & Huntington, 2002). Estimates of obesity in pediatric samples of SB range from 8% to 58%, with at least two studies yielding results around 35% (Buffart, Roebroek, Rol, Stam, & van den Berg-Emons, 2008; Dosa, Foley, Eckrich, Woodall-Ruff, & Liptak, 2009; Essner et al., 2014; Mita et al., 1993). An additional subset of youth with SB fall within the overweight range. One recent investigation found approximately 41% of youth with SB to be overweight or obese (McPherson et al., 2013). Children and adolescents with SB are at increased risk for unhealthy weights due, in part, to reduced activity levels and biological processes specific to SB (Mita et al., 1993; Shepherd, Roberts, Golding, Thomas, & Shepherd, 1991). Rimmer and colleagues (2007) also propose that children with disabilities who are socially isolated may fill their free time by overeating, although a recent study did not find evidence for a relationship between weight and activity

involvement (Essner et al., 2014). Obesity levels are typically observed to increase as children with SB grow older (Mita et al., 1993).

The study of social skills of obese and overweight youth has received substantial attention. Multiple investigations have concluded that obese children are at risk for social difficulties compared to children of average weight (Banis et al., 1988; Braet, Mervielde, & Vandereycken, 1997; Goldschmidt et al., 2010). Recent findings from a large meta-analysis showed that obese children tend to have more impaired social functioning relative to children of normal weight as well as youth with other chronic health conditions (e.g., cancer, diabetes, blood disorders), with the exception of neurological conditions (SB, epilepsy, etc.; Martinez et al., 2011). Thus, obese youth with SB may be doubly at risk for social skills deficits.

It appears that the social difficulties of obese children are at least partially explained by engagement in more negative peer interactions (Baum & Forehand, 1984). Indeed, compared to normal weight youth, overweight and obese children and adolescents are more likely to be both targets and perpetrators of verbal, physical, and relational bullying (Janssen, Craig, Boyce, & Pickett, 2004; Lumeng et al., 2010; Pearce, Boergers, & Prinstein, 2002). In fact, a majority of obese youth report that they have been teased about their weight by peers and friends within a one-year period (Puhl, Peterson, & Luedicke, 2013). Obese children also tend to be less accepted by others; their peers describe them as being socially withdrawn, less physically attractive, less athletic, more aggressive, and more tired and sick. Further, sociometric data has shown that obese children are less likely to be nominated as a best friend (Zeller, Reiter-Purtill, & Ramey, 2008).

There is little information regarding the influence of weight on subsequent social skills in children with SB. Findings from a recent study by Essner and colleagues (2014) that utilized the same data set as the present study coincide with much of the literature focusing on overweight and obese children who do not have comorbid chronic health conditions. Specifically, overweight children with SB were reported to have limited social acceptance by their mothers, fathers, and teachers. Their mothers also rated them as having fewer friends than children with SB who were of average weight. Another study found a negative association between body mass index (BMI) and social cognition in girls with SB; this relationship was not significant for boys (Simsek, Turkucuoglu, & Tezcan, 2015). Given the high rates of obesity in this population (Mita et al., 1993), it is possible that the established social difficulties experienced by youth with SB can be partially accounted for by a tendency to be overweight. Clearly, more research is necessary to determine the influence of weight on social skills relative to other health-related, neurocognitive, and family variables that are thought to affect social skill development.

The Current Study and Hypotheses

It is evident that social skill development is influenced by several factors across the health-related, neurocognitive, and familial domains. Numerous studies in the developmental and pediatric psychology literatures have examined effects of individual constructs on social adjustment and social skill development. From this strong foundation of knowledge, models of social competence have been created to integrate across multiple variables that may impact social development. In the context of SB, the bio-neuropsychosocial model (Holmbeck & Devine, 2010) serves as a framework for the

conceptualization of social adjustment. Despite this holistic perspective on social development, much of the research continues to examine bivariate relationships between specific constructs and social function. This approach precludes identification of the most salient predictors (by comparing across different predictor domains) of social skill development and fails to consider the multiple contexts required for an accurate understanding of social functioning in youth with SB. The present study attempts to incorporate multiple variables from the health-related, neurocognitive, and social (i.e., family-related) domains to determine the most important contributors to social skill development in youth with SB (see Figure 1). All variables were selected based on evidence in the developmental, pediatric, and SB literatures that suggests that each is related to youth's social adjustment.

The primary outcome of interest, social skills, were measured by both parent report and observation of peer interactions. Indeed, the assessment of social skills using multiple informants (i.e., parents and observers) is particularly critical because different settings provide unique opportunities for demonstration of social skills (La Greca & Lemanek, 1996). In addition, incorporation of observational data captures a unique perspective given the inconsistencies between parent report of children's social skills and observations of other reporters (Lemanek, Horwitz, & Ohene-Frempong, 1994). Independent variables consisted of data acquired through parent report, medical chart review, observation of family interactions, and performance on neurocognitive tests. Taken together, the present study incorporates multiple methods and informants to reduce common method or source variance between independent and dependent variables and to enhance the validity of study findings (Holmbeck, Li, Schurman, Friedman, & Coakley,

2002).

This study utilized hierarchical linear regression analyses to determine which domain (i.e., health-related, neurocognitive, or family-related) is most important in the prediction of social skills in youth with SB. After controlling for covariates, the predictive power of each domain was examined relative to the contributions of the other two domains. Univariate regression analyses were also conducted to determine whether factors (e.g., lesion level, attention, family cohesion, etc.) within each domain were important for later development of social skills. All regressions were conducted according to a longitudinal study design. Specifically, independent variables consisting of data collected at the first wave of data collection predicted children's social skills approximately two years later, after controlling for social skills from the first wave.

Hypothesis 1. Within the neurocognitive domain, it was expected that the neurocognitive domain (i.e., attention and EF) would be positively related to social skills two years later. A previous study using the same dataset has established cross-sectional associations between these constructs (Lennon et al., 2015). In accordance with the literature, children who are better able to attend to stimuli, flexibly adapt to ever-changing situations, maintain information within working memory, and engage in planning and organizing will be more likely to exhibit adaptive social skills that promote healthy social interactions with peers.

Hypothesis 2. Within the family-related domain, it was anticipated that more adaptive family functioning (high family cohesion, low family conflict) would be positively related to children's social skills assessed at the second time point. Consistent with prior research, children with warm, supportive families will be more likely to

develop more adaptive social skills. Similarly, families with lower levels of conflict would be expected to have children with more positive social skills.

Hypothesis 3. Regarding the health-related domain, it was hypothesized that indicators of condition severity (i.e., lesion level and gross motor function) and body weight would be negatively related to social skills in youth with SB. In other words, children with less severe conditions and/or lower weight would be more likely to later demonstrate greater prosocial skills in their peer relationships.

Hypothesis 4. It was anticipated that the neurocognitive variables would be the strongest longitudinal predictors of social skills. Higher order cognitive abilities are thought to be necessary for competent social function (Beauchamp & Anderson, 2010; Crick & Dodge, 1994), particularly for children with CNS conditions (Nassau & Drotar, 1997; Yeates et al., 2007). Although neurocognitive abilities are susceptible to the influence of social, family-related, and biological factors, it has been suggested that they serve as primary building blocks for social skill development. Guralnick (1999) proposes that cognitive deficits may contribute to impaired social skills by interfering with family-related processes that promote social skills in children with disabilities. The neurocognitive deficits inherent to SB therefore put children with this health condition at significant risk for poorer social skills (Holbein et al., 2015). Further, because cognitive deficits in SB are due to congenital brain abnormalities, rather than an injury acquired at a later age, social outcomes may be particularly adversely affected (Yeates et al., 2007). Despite the emphasis in the literature on neurocognitive predictors of social skills, there have been no studies of youth with SB that explicitly compare the relative importance of cognitive functioning with health-related and family factors as predictors. It is

hypothesized that the neurocognitive factors will most strongly predict social skills relative to health-related and family factors in children with SB.

Hypothesis 5. It was expected that family-related variables would be the second strongest predictor of social skills in youth with SB. Thus, measures of family conflict and cohesion were expected to be associated with later social skills beyond health-related variables. Children acquire social skills in part by learning within the context of family (Repetti et al., 2002). In addition to observing the social interactions between family members and others who may be involved with the family (e.g., family friends, neighbors), children also practice social skills within family interactions starting in infancy. Although neurocognitive factors are expected to be the strongest predictors of social skill development, the family context likely has a significant influence on children's social competence. Drawing from results in other health populations, family functioning moderated the association between neurocognitive function and long-term changes in social competence; despite poorer social competence over time in youth with more severe TBI, those from more dysfunctional families tended to experience greater decreases in social competence (Yeates et al. 2004). Additional research found social competence in youth with ADHD to be predicted by parental functioning rather than neurocognitive abilities (Fischer, Barkley, Fletcher, & Smallish, 1993). Thus, while neurocognitive factors may play a more crucial role in social skills development, family function also affects children's social skills in CNS populations, such as spina bifida.

Hypothesis 6. Finally, health-related variables were hypothesized to be the weakest predictors of social skills. Specifically, condition severity variables and BMI are not expected to predict social skills beyond neurocognitive and family-related variables.

In another chronic health condition sample (e.g., epilepsy), health-related variables were poorer predictors of social skills than were neurocognitive and family function variables (Tse et al., 2007). Associations between health-related variables and social skills in youth with SB has been mixed; although some research suggests that greater SB severity is related to poorer social skills (Fletcher et al., 2005; Lomax-Bream, Taylor, et al., 2007), other studies have not supported these associations (Wallander et al., 1989; Hetherington et al., 2006). Moreover, research examining the influence of BMI on social skills is still in preliminary stages.

CHAPTER 2

METHOD

Participants

Participants were recruited to participate in a longitudinal study investigating neurocognitive, family, and social functioning in children with SB. Families of children with SB were recruited from four local hospitals and a statewide SB association in the Midwest. Inclusion criteria for children with SB (“target” children) were: (1) a diagnosis of SB, either myelomeningocele (MM), lipomeningocele, or myelocystocele; (2) age between eight and 15 years at Time 1; (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 to allow for data collection at families’ homes. 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 (i.e., one child with SB was eight years of age and another child did not have a diagnosis of SB), resulting in a sample size of 140 families (57% participation rate). Based on available data, SB characteristics were not significantly different between families who participated and those who did not: type of SB (i.e., MM vs. other), $\chi^2(1)=.0002, p>.05$, shunt status, $\chi^2(1)=.003, p>.05$, and occurrence of shunt infections, $\chi^2(1)=1.08, p>.05$.

Youth with SB in the full sample of 140 ranged in age from eight to 15 years ($M=11.19$ years, $SD=2.40$), and 55.7% were female. Of these children, 60.4% identified as

Caucasian, 22.6% were Latino, 12.3% were African American, and 4.7% identified as an “other” race. SB characteristics of the target children, including type of SB, lesion level, shunt status, number of shunt revisions, number of surgeries unrelated to shunts, and Full-Scale IQ is reported in Table 1.

Table 1. Condition-specific characteristics of youth with SB at Time 1

	Percent	N
Type of SB		
Myelomeningocele	87.1%	122
Lipomeningocele	9.3%	13
Unknown or Uncertain	3.6%	5
Lesion Level		
Sacral	29.3%	41
Lumbar	49.3%	69
Thoracic	17.1%	24
Unknown	4.3%	6
Shunt Status (Present)	78.6%	110
	<i>M (SD)</i>	
Number of Shunt Revisions	3.09 (5.04)	105
Number of Non-Shunt Surgeries	2.96 (2.09)	139
FSIQ	85.68 (19.68)	132

Each family was asked to invite a friend of the child with SB to participate. Inclusion criteria for the friends included (1) age between six and 17 years at Time 1 (the target child's age range +/- two years) and (2) ability to speak and read English or Spanish. In addition to these criteria, families were asked to invite friends who were not related to the target child and who were within two years of the target child's age, although friends that were not consistent with these criteria were not excluded from the larger study. One hundred twenty-eight families (86%) were able to recruit a peer within the specified age range (two peers were excluded because they were older than 17 years). Twenty peers (12% of all friends recruited) were related to the target child, but they were included in the present study in an effort to maximize power. Overall, 121 children with SB (76% of the entire sample of 140) and their friends at T1 were eligible for analyses using observational data from coded peer interactions. Friends ranged in age from six to 17 years ($M = 10.98$ years, $SD = 2.75$), and were 55.7% female. Regarding racial background, 64.2% were Caucasian, 17.9% were Hispanic, 8.5% were African American, and 6.6% reported they belonged to an "other" racial background.

Procedures

Prior to data collection, the study was approved by both university and hospital Institutional Review Boards. At Time 1, data were collected via two three-hour home visits by trained research assistants. Informed consent and informed assent were obtained at the first home visit from caregivers and youth, respectively. Informed consent from the friend's guardian was obtained either in person or via mail prior to the second home visit when peer tasks were administered. Assent from the peer was obtained at the start of the second home visit.

During the first home visit, children with SB and their parent(s) or other caregivers completed a battery of questionnaires and engaged in video-taped family interaction tasks. Neurocognitive testing assessing intellectual functioning, attention, and executive functioning of the target child was also performed. At the second home visit, the target child and his or her friend each completed questionnaires and audio-taped interviews about general friendship characteristics, specific characteristics related to their friendship with each other, and problem-solving in social situations. The children with SB and their friends also engaged in structured interaction tasks that were video-taped. Families and participating friends received small gifts (i.e., T-shirts and pens) and monetary compensations (\$150 for families and \$50 for friends) in exchange for their time and effort. T1 data collection occurred between 2006 and 2009.

Approximately two years from the date of the first T1 home visit, all families who participated in the first wave of data collection were contacted to participate in a second home visit. Of the 140 families who were contacted, 17 declined participation (i.e., refused to participate or failed to return study questionnaires), 12 could not be reached, and one child with SB had passed away. The final sample at Time Two (T2) consisted of 112 youth with SB and their families (80% of the sample who participated at T1).

Data collection at T2 was comprised of one home visit during which children and their families participated in modified family interaction tasks and completed questionnaires assessing multiple psychosocial and medical-related domains. A shorter battery of neurocognitive tests was administered to the target child. Youth with SB and their friends participated in modified peer interaction tasks and completed the same friendship interviews and questionnaire batteries used in T1. For both family and peer

interaction tasks, the content of some tasks was altered to provide a more entertaining and developmentally appropriate experience for participants as well as to decrease the repetition of elicited responses over time (specific changes are described below). Similar to T1, families and participating friends received small gifts (i.e., water bottles) and monetary compensations (\$150 for families and \$50 for friends) in exchange for their time and effort. All T2 data were collected between 2008 and 2011.

Data from teachers, medical professionals (i.e., nurses or doctors), and medical charts were collected shortly after T1 and T2 home visits. Permission was granted by families to contact outside providers. Teachers and health professionals received questionnaires via mail and mailed completed questionnaires back to the research team. They were each compensated \$25 for their time and effort. Medical charts were either mailed to the research team or viewed in person at the SB clinic by trained research assistants.

Observational interaction tasks. Children and their parent(s) participated in four videotaped interaction tasks during both waves of data collection. Siblings did not participate in the tasks due to the varying numbers and ages of siblings across families. When possible, both parents participated in the tasks; however, only one parent participated in the case of single-parent households or a second parent's lack of availability or willingness to participate in the study. Tasks were counterbalanced across families at each timepoint. At T1, families completed the following tasks: (a) Family Conflict Task (families select issues that have created conflict within past two weeks and discuss them together; 10 minutes), (b) Interactive Family Game Task (families establish rules and play the game; 10 minutes) and (c) Transfer of Responsibilities Task (discuss at

least 2 SB-related responsibilities that the child with SB will have to take on and plan for successful transfer; 10 minutes), and Vignettes (families read two stories about hypothetical children's social scenarios and discuss several related discussion questions assessing emotions and problem solving; 10 minutes). At T2, a new game was chosen for the Interactive Family Game Task, and new vignettes were written to increase engagement with the task.

Children with SB and their friends completed four interaction tasks at both T1 and T2. All but one of the tasks (i.e., the Conflict Task) was counter-balanced across dyads. During T1, the following tasks were completed: Tasks included (a) Toy Ranking (rank toys based on how much the children enjoyed playing with them; five minutes), (b) Unfamiliar Object Task (develop a commercial advertising an ambiguous object; five minutes), (c) Plan an Adventure (discuss what the pair would do, where they would go, etc.; five minutes), and (d) Conflict Task (discuss previous peer conflicts and brainstorm other problem-solving ideas that could have been used; 10 minutes; this task was always presented last).

At T2, children with SB and their peers participated in interaction tasks that had been modified from T1 in order to provide a more stimulating experience and appeal to the developmentally more mature sample. The following tasks were administered: (1) Game (play a turn-taking commercially available game; five minutes), (b) Plan a News Broadcast Task (select or create a news story and discuss the details necessary for a broadcast; five minutes); (c) Plan a Vacation Task (decide location, activities, transportation, etc. five minutes), and (d) Conflict Task (same as T1; again, always presented last).

For both family and peer interaction data, undergraduate and graduate research assistants were trained for about ten hours before coding the videotapes. Training consisted of discussions of individual item codes, reviewing coding of family or peer interactions by an expert coder, and practicing coding on a standard set of taped interactions. Coders were required to achieve a 90% agreement rate on practice items before they were authorized to code study videotapes (i.e., “agreement” = concordance across coders within one point on the Likert scale).

Measures

All measures were administered at both T1 and T2 data collections, unless otherwise noted. Please see Table 2 for specific descriptive and statistical information about study variables.

Demographics. The Parent Demographic Questionnaire (PDQ) was developed for the larger study to gather demographic data about the child, caregiver(s), and family. Questions about the target child include the child’s ethnicity/race, date of birth, school, grade, and SB tasks that the child performs. Questions about the caregiver include the caregiver’s relationship to the child, marital status, education, employment status, income, hours spent with the child, and SB tasks that the caregiver performs for the child with SB. Questions about the family include the number and relation of people living in the home and the family medical history. Information from this measure was used to calculate each family’s socioeconomic status according to the computational procedure outlined by Hollingshead (1975).

Table 2. Variable descriptions and statistical values.

Variable Name	Reporter	Time	Range	M	SD	Higher Values
Dependent Variables						
PIMS Prosocial Skills	Observer	T1	2.18 – 3.98	3.24	.39	Greater social skills
		T2	2.27 – 4.00	3.26	.36	Greater social skills
SSRS Total Score ^a	Parent	T1	56.5 - 130	91.68	6.39	Greater social skills
		T2	46 – 130	94.06	7.58	Greater social skills
	Teacher	T1	57 – 130	96.70	4.17	Greater social skills
		T2	66-130	97.99	5.02	Greater social skills
Covariates						
Age	N/A		8 – 15	11.43	.46	Older age
Hollingshead SES	Parent		8 – 66	39.44	5.90	Higher SES
Independent Variables						
Attention/EF Performance Tests ^b	Neuro. Tests	T1	1.00 – 13.50	6.77	.64	Greater attention/EF
TEA-Ch Sky Search ^b	Neuro. Tests	T1	1 – 15	5.68	.43	Greater attention
TEA-Ch Score! ^b	Neuro. Tests	T1	1 – 15	7.60	.56	Greater attention
TEA-Ch Sky Search DT ^b	Neuro. Tests	T1	1 – 19	5.97	.57	Greater attention
TEA-Ch Score! DT ^b	Neuro. Tests	T1	1 – 15	7.06	.71	Greater attention
CAS Number Detection ^b	Neuro. Tests	T1	1 – 15	6.13	.33	Greater attention
WISC - DS ^b	Neuro. Tests	T1	1 – 17	7.33	.19	Greater EF
D-KEFS VF Switching ^b	Neuro. Tests	T1	1 – 19	7.66	.83	Greater EF
Attention/EF Impairment-Parent ^c	Parent	T1	-1.85 – 2.40	.00	.92	Poorer attention/EF
BRIEF – Metacognition Index ^d	Parent	T1	36 – 81.50	55.61	.45	Poorer EF
SNAP-IV Total Score	Parent	T1	0 – 1.64	.74	.40	Poorer attention
FIMS-Conflict Scale	Observer	T1	2.28 – 3.30	2.76	.20	Greater conflict
FIMS-Cohesion Scale	Observer	T1	2.24 – 4.19	3.36	.40	Greater cohesion
FES-Parent Report	Parent	T1	1.68 – 3.39	2.59	.30	More adaptive function
FES - Conflict	Parent	T1	1.22 – 3.12	2.05	.36	Greater conflict
FES - Cohesion	Parent	T1	2.22 – 3.89	3.10	.32	Greater cohesion

Variable Name	Reporter	Time	Range	M	SD	Higher Values
Condition Severity ^d	Dr./Parent	T1	-1.70 - 1.83	.01	.88	Higher severity
Lesion Level	Dr./Parent	T1	1 – 16	7.37	.28	Higher lesion level
Gross motor function class	Parent	T1	1 – 4	2.89	.08	Higher severity
BMI ^{d, e}	Parent	T1	1.00 - 2.73	.95	.36	Greater BMI

Note: ^a Standard score; ^b Scaled score; ^c z score; ^d T score; ^e underwent square root transformation.

Outcome variables: 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, & Hommeyer, 2007). This coding system is an adaptation of several previous coding systems (Holmbeck, Belvedere, Gorey-Ferguson, & Schneider, 1995; Johnson & Holmbeck, 1999; Smetana, Yau, Restreppo, & Braeges, 1991) and also draws upon codes used in other systems (Allen et al., 1998; Allen, Porter, & McFarland, 2002; Buhrmester, Camparo, Christiansen, Gonzalez, & Hinshaw, 1992; Julien, Markman, Lindahl, Johnson, & Van Widenfelt, 1987; Levy, 1943; Paikoff, 1992). Each coder viewed an entire peer interaction task before rating the target child and the friend on codes assessing the social skills of the child with SB and the peer individually as well as the dyad as a whole. For all codes, a five-point Likert scale with detailed, descriptive anchors was used by coders. For example, for the item assessing “Dominance,” coders evaluate each child in the dyad for how much he or she has control over the interaction, considering how much time each child spends talking and directing the conversation (5 = Very Often, 4 = Frequently, 3 = Sometimes, 2 = Rarely, 1 = Not at All). Each coder spent approximately 20 to 30 minutes coding each dyad. For each of the four interaction tasks, behaviors and characteristics were rated by two coders, and item-level means across coders for each task were averaged across the tasks to produce a single score for each target child and friend separately (for codes assessing individual constructs) or for each pair (for codes assessing dyadic constructs).

The PIMS scales were created to refine the measurement of social competence using the observational peer interaction data collected at T1 of the larger study (Holbein,

Zebracki, & Holmbeck, 2014). A total of four scales (i.e., Prosocial Skills, Conflict, Control, Positive Affect) demonstrated adequate scale reliability, interrater reliability, content validity, and convergent validity. This study utilizes the PIMS Prosocial Skills scale due to its specific focus on social skills. The Prosocial Skills scale assesses the adaptive social skills exhibited by the child with SB that further the social interaction in a positive manner. The six items that comprise the scale include: (1) confidence in stating opinions; (2) eye contact; (3) listens to others; (4) maturity; (5) promotes dialogue and collaboration; and (6) receptive to statements made by other. When including non-related peers (Holbein et al., 2014), Cronbach's alpha is .84, indicating adequate reliability at the scale level, and interrater reliability as measured by intraclass correlations (ICC) is excellent (ICC = .84; 95% CI = .80 - .91). Unlike previous investigations (Holbein et al., 2014; Holbein et al., 2015), the present study included dyads in which the target child's "close friend" was related (e.g., sibling or cousin) to maximize power.

Peer questionnaire. The Social Skills Rating System (SSRS; Gresham & Elliot, 1990) is a standardized, norm-referenced questionnaire assessing various social skills that are considered important to the development of social competence. Standard scores are only available for the total score; norm-referenced values for subscales are not provided. This study used versions adapted for parents and teachers. Both forms require the respondent to rate, for each item, how often the child demonstrates a specific skill and how important the skill is to the child's development. However, this study asked parents and teachers to only rate the how often the child demonstrates each social skill, from "0 = never" to "1 = sometimes" to "2 = very often." Although alternate forms are provided for different age ranges of the child, the elementary level form (suited for grades K-6) was

used due to the age range of the participants at Time 1. The SSRS has demonstrated adequate to good internal consistency. Coefficient alphas for the social skills subscales (i.e., Cooperation, Self-Control, and Assertion) ranged from .86 to .95 for the teacher forms and .65 to .87 for the parent forms in previous studies (Gresham & Elliot, 1990). In the present investigation, the SSRS total standardized score was used as one of two measures of the primary outcome (i.e., social skills). Standard scores ($M = 100$, $SD = 15$) allow the present sample of youth with SB to be compared to a normative sample and provide more meaningful indicators of children's social skills, although it should be noted that some youth were older than the standardization sample.

Predictor variables: Neurocognitive domain.

Attention: Performance-based tests. The Cognitive Assessment System (CAS; Naglieri & Das, 1997) assesses planning, attention, simultaneous, and successive cognitive processes in children. Two subtests (i.e., Planned Connections and Number Detection) were administered in the larger study, the latter of which was used in the present investigation. In the Number Detection subtest, a measure of focused attention, youth must attend to given stimulus items while ignoring distractor stimuli under the pressure of time. Reliability coefficients for youth between 5 and 17 years of age have ranged from .69 to .89, and test-retest reliabilities for this age group have ranged from .72 to .77 (Naglieri & Das, 1997).

The Test of Everyday Attention – Child (TEA-Ch; Manly, Robertson, Anderson, & Smith, 1999) is a standardized and normed ($N = 293$) clinical battery for children that allows for assessment across different attentional capacities, including selective attention, attentional control/switching, and sustained attention. The TEA-Ch yields age-scaled

scores and percentiles. Four subtests from the TEA-Ch were used in this study. Sky Search assesses selective/focused attention. The child must circle pairs of items where both items are the same, as quickly as possible. The primary attention score indicates how well the child was able to identify visual target stimuli amid distracting visual information while controlling for motor control (number of correct responses and time per response were not included in analyses). Adequate test-retest reliability for the attention score ($r \sim .75$) has been reported (Manly et al., 1999). The Score! subtest captures sustained auditory attention, such that the examinee must count the number of sounds heard in between varying gaps of silence. Test-retest reliability as measured by percentage agreement within one standard deviation (due to ceiling effects) has been reported as 76.2% (Manly et al., 1999). Sky Search DT measures sustained-divided attention. The child must circle pairs of items where both items are the same, while simultaneously counting the number of “scoring sounds” on an audiotape. The manual reports adequate test-retest reliability ($r = .81$). Finally, the Score! DT subtest requires the child to perform simultaneous audio attention tasks. Test-retest reliability as indicated by percentage agreement within one standard deviation has been reported as 71.4% (Manly et al., 1999). Both DT subtests measure sustained and divided attention.

Attention: Questionnaire. The 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. In this study, the 18-item version of the SNAP-IV was used. The items are from the DSM-IV (American Psychiatric Association, 1994) criteria for Attention-Deficit/Hyperactivity Disorder (ADHD), and include two subscales of symptoms: inattention (items 1-9) and

hyperactivity/impulsivity (items 11-19). The SNAP-IV is based on a 0 to 3 rating scale: Not at All = 0, Just A Little = 1, Quite A Bit = 2, and Very Much = 3. Subscale scores are calculated by averaging the item scores within the domains of Inattention and Hyperactivity/Impulsivity. The SNAP-IV total score ($\alpha = .93$) was used as a measure of parent-reported attention in the present study.

EF: Performance-based tests. The Delis Kaplan Executive Function System (D-KEFS; Delis, Kaplan, & Kramer, 2001) is a comprehensive battery of nine individually administered tests that provides normative and qualitative data assessing higher level cognitive functions (reasoning, problem solving, planning, etc.). The D-KEFS Verbal Fluency Test comprises three testing conditions: Letter Fluency, Category Fluency, and Category Switching. For each condition, the examinee is allowed 60 seconds. This test measures the examinee's ability to generate words fluently in an effortful, phonemic format (Letter Fluency), from overlearned concepts (Category Fluency), and while simultaneously shifting between overlearned concepts (Category Switching). In the present study, Category Switching was used as a measure of EF. This indicator of EF captures the individual's cognitive flexibility by assessing the ability to mentally shift between two distinct categories (i.e., fruits and pieces of furniture).

The Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV; Wechsler, 2003) is an individually administered clinical instrument for assessing the cognitive ability of children aged 6 years 0 months through 16 years 11 months. The Digit Span subtest was used to assess working memory, a component of EF. For Digit Span Forward, the child repeats numbers in the same order as presented aloud by the examiner. For Digit Span Backward, the child repeats numbers in the reverse order of

that presented aloud by the examiner.

EF: Questionnaire. The BRIEF (Gioia, Isquith, Gray, & Kenworthy, 2000) is a questionnaire measure of EF that identifies eight sub-domains that are classified within two broader indexes: Behavioral Regulation Index (BRI; i.e., inhibit, shift, emotional control) and Metacognition Index (MI; i.e., initiate, working memory, plan/organize, organization of materials, monitor). The BRI and MI are combined to obtain an overall Global Executive Composite (GEC) score. Internal consistency is satisfactory (0.80-0.98 for parent) within a normative sample. Test-retest reliability correlation across clinical scales for the 85-item Parent Form normative subsample was $r=.81$ (Gioia, et al., 2000). In line with previous research demonstrating the influence of the MI on subsequent social skills (Gilotty et al., 2002) and the relatively greater impairments in metacognitive skills reported in SB (Brown et al., 2008; Zabel et al., 2011), the present study used the MI to capture parent- and teacher-reported EF skills and behaviors. Sums of all items on the MI were computed and converted into norm-referenced T scores ($M = 50$, $SD = 10$) based on age and gender.

Predictor variables: Family domain.

Observational family interaction measure. Family interaction tasks were coded according to the Family Interaction Macro-Coding System (FIMS; Holmbeck et al., 1995; Kaugars et al., 2011). Before rating families on codes assessing family functioning, research assistants viewed each task as a whole. For all codes, a five-point Likert scale with detailed, descriptive anchors was used by coders. For example, the code measuring “warmth” taps indicators of a positive bond between the child with SB and the peer as demonstrated by verbal or nonverbal behaviors (5 = very warm; 4 = fairly warm; 3 =

somewhat warm; 2 = fairly cold; 1 = very cold). Each interaction required approximately 20 to 30 minutes for coding, and two research assistants coded each interaction. Item-level means across both coders were computed and averaged across all tasks completed by families, resulting in a single score for each family member (i.e., father, mother, or child) or the family dyad or triad.

FIMS observational scales have been developed from the individual FIMS items (Kaugars et al., 2011). Specifically, the FIMS scales assess acceptance, behavioral control, and psychological control for mother and fathers individually as well as conflict and cohesion at the family level. The scales have demonstrated acceptable inter-rater and scale reliabilities as well as evidence of convergent validity (i.e., significant correlations between the PIMS scale and similar questionnaire scales and interview items) in samples of families who have a child with either SB or type 1 diabetes. The Family Cohesion and Family Conflict scales were used in the present study. The seven-item Family Cohesion scale includes the following codes: (1) involvement in the task; (2) requests input from other family members; (3) parents present a united front; (4) parental promotion of dialogue and collaboration; (5) disengaged (reverse-scored); (6) openness/warmth; and (7) family is able to reach an agreement/resolution. Regarding scale reliability, previous research with families of youth with SB has demonstrated Cronbach's alphas ranging from .78 to .86 (Kaugars et al., 2011). The two-item Family Conflict scale measures the level of conflict within familial dyads and the ability to reach resolutions (reverse-coded). In a previous study of families of children with SB, Cronbach's alphas assessing reliability at the scale level ranged from .46 to .79 (Kaugars et al., 2011). Please see the Results section for both scales' interrater reliability and internal consistency statistics as

they pertain to the present study.

Family questionnaire. The Family Environment Scale (FES; Moos & Moos, 1994) measures social and environmental characteristics of the family and is completed by parents. The current study uses Form R, which measures people's perceptions of their actual family environments. The FES includes three main dimensions, comprising a total of ten subscales. The subscales are grouped according to domains, including the Relationship dimension (cohesion, expressiveness, and conflict subscales), Personal Growth dimension (independence, achievement orientation, intellectual-cultural orientation, active-recreational orientation, and moral-religious emphasis subscales), and the System Maintenance dimension (organization and control subscales). For the purpose of this study, only the cohesion and conflict subscales were employed. Examples of items on each subscale include "there is a feeling of togetherness in our family" and "we fight a lot in our family," respectively. Because internal consistency has been low in some studies using the original true-false response format (Alderfer et al., 2008), this study used a four-point Likert-type scale to increase internal consistency and gather richer data about the family environment. Anchors ranged from 1 strongly disagree to 4 strongly agree. The FES-R has demonstrated moderate reliability ($\alpha = .61-.78$; Moos & Moos, 1994).

Predictor variables: Health-related domain.

Condition severity. To assess condition severity, a composite comprised of lesion level and gross motor function was used.

Lesion level was obtained from children's medical charts. As lesion levels can change depending on the child's functional status (Verhoef et al., 2006), it is necessary to

consider multiple lesion level reports. First, lesion levels from the three most recent chart entries at the time of T1 were assigned a number on a scale of one through 30 that corresponds to locations on the spinal cord (e.g., 1 = C1; 15 = T7; 30 = S5). The three numbers were then averaged and matched with the corresponding level on the spinal cord. This value was used as an indicator of the child's lesion level at T1. For 15 participants, the exact lesion level was not available, but the general location (e.g., sacral, lumbar, thoracic) was known. In these cases, the middle value for that general spinal region was used. Although an approximation of lesion level, this allowed for a greater sample size for this variable.

The Medical History and Adherence Questionnaire was adapted from the Parent-Report of Medical Adherence in Spina Bifida Scale (PROMASB, Holmbeck et al., 1998), which was developed for a previous study on youth with SB by the same investigator. The measure is designed to obtain disease-specific medical information, including bowel and bladder functioning, ambulation/motor function, medications, providers and frequency of medical care, and surgery history. Regarding motor function, parents are required to indicate the various ways by which their child ambulates, including use of assistive devices (e.g., braces, crutches, walker, wheelchair, etc.). As many children ambulate in multiple ways (e.g., using a wheelchair at school and crutches at home), parents also indicate the percent of time the child engages in each type of ambulation. In this study, motor function was determined from a modified version of the Gross Motor Function Classification System Expanded and Revised (GMFCS-E&R; Palisano, Rosenbaum, Bartlett, & Livingston, 1997). Based on mothers' responses on the PROMASB 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. Thus, higher values indicate greater gross motor impairments.

Weight. Body Mass Index (BMI) values, presented as z -scores (zBMI), were used as an indicator of weight status of the youth with SB. To obtain zBMI, the child's weight is first divided from his or her height squared (i.e., pounds/inches²). The resulting BMI value is then plotted on gender-specific growth charts developed by the Centers for Disease Control (CDC; Kuczmarski et al., 2002). Unlike unadjusted BMI, zBMI scores take into account developmental changes in body composition as well as variations by gender (Kuczmarski et al., 2002). Weight and height were assessed using the average of mothers' and fathers' written estimates of their child's weight and height on the Health Survey, a questionnaire based on national child and adolescent health guidelines (CDC, 1999). Individual parent report was used for children with only one parent participating in the larger study. The zBMI scores were calculated by entering gender, age, height, and weight into the Pediatric Z-Score Calculator, publically available on the website of The Children's Hospital of Philadelphia Research Institute at <http://stokes.chop.edu/web/zscore/index.php> (The Children's Hospital of Philadelphia, n.d.).

Data Analytic Plan

Preliminary analyses. All data were first checked for completeness and data entry errors. Once data were cleaned, continuous variables of interest were checked for outliers and skewness (Tabachnick & Fidell, 2007). Univariate outliers were identified as

those cases within three standard deviations of the variable's mean, which corresponds to a p-value less than .001 in a t-tailed test (Tabachnick & Fidell, 2007). Cases identified as outliers were replaced by a value one unit higher (or lower) than the most extreme value for the variable in order to limit the amount of missing data. Any variable with a skewness z-score value exceeding ± 3.29 was transformed to better fit the assumption of normal distribution held by multiple regression analyses (Tabachnick & Fidell, 2007). A square-root transformation was attempted first; for cases in which square-root transformations failed to adequately correct skewness, a logarithmic transformation was conducted.

Data reduction methods were performed to reduce the likelihood of type 1 error and to increase the power of multiple regression analyses. For measures with multiple informants (i.e., mothers, fathers, and teachers), bivariate Pearson correlations were conducted. In accordance with the recommendation by Holmbeck and colleagues (2002) regarding multi-informant data, reporters on like measures that were correlated at or above a criterion of .40 would be averaged to form a composite for the given variable. Similarly, for the four subtests of performance-based attention, a criterion of Cronbach's $\alpha = .70$ was used to determine whether the variables could be combined to create a single measure of performance-based attention. Additional data reduction was planned to combine related variables (e.g., lesion level and gross motor function, the Conflict and Cohesion subscales of the FES, the Conflict and Cohesion subscales of the PIMS) within each domain. Again, a criterion value of $r = .40$ was established for determining whether like measures were eligible for combination. Assuming that all of the previous plans for data reduction occurred, a total of eight primary predictor variables were planned to be

used in the regression analyses: condition severity, weight, parent report of EF, performance-based EF, parent report of attention, performance-based attention, parent report of family functioning, and observational family functioning.

In the case that data reduction did not occur as outlined above (i.e., measures did not correlate at or above r values of .40 or did not attain alpha values of .70 or higher), only one subscale was to be used for each of neurocognitive performance-based variables. For performance-based attention, the Sky Search DT task would have been the primary measure due to parallels (e.g., attending to simultaneous auditory and visual information) with actual social interactions (Lennon et al., 2015). Regarding performance-based EF, the D-KEFS verbal fluency switching subtest was selected as the primary indicator. This task requires the individual to shift from one category to another while inhibiting non-category responses. Social interactions also necessitate competence in inhibition and shifting (Gilotty et al., 2002; Kiley-Brabeck et al., 2006). Although multiple measures of performance-based neurocognitive functioning and multiple reporters on questionnaire measures are preferred for multiple reasons (i.e., provide more representative measure of the child's or family's functioning, yield a more stable estimate of the construct), it is important to consider the number of predictors included in the regression models. As the number of predictors increases, the power to identify significant effects decreases (Tabachnick & Fidell, 2007). In addition, a larger sample size is required to detect significant effects, which is especially problematic given the higher likelihood of listwise deletion of participants that occurs with each additional predictor.

Covariates. Age was analyzed as a covariate in all analyses. In general, social

skill development increases with age, such that older children have more sophisticated knowledge of social skills and are more consistent in their use of appropriate social skills. As children and adolescents mature, brain development supports acquisition of advanced cognitive skills (e.g., attentional capacity, EF, theory of mind, etc.) that are required for appropriate social interactions with peers (Beauchamp & Anderson, 2010; Crick & Dodge, 1994; Sebastian, Viding, Williams, & Blakemore, 2010). In addition, older youth have more experiences socializing with peers and adults, resulting in increased exposure to novel situations and more knowledge about particular social processes they have experienced (Beauchamp & Anderson, 2010; Crick & Dodge, 1994). As an example, a very young child who becomes angry at a playmate may engage in hitting, name-calling, and temper tantrums. Years later, the same child who perceives a conflict with her peer may recall that hitting and teasing resulted in poor outcomes (e.g., getting hit back, discipline from a parent, etc.), inhibit aggressive behaviors and/or harsh words, mentally organize and plan her actions, and promote a collaborative problem-solving approach with the peer. Controlling for age in regression analyses reduces the likelihood that increases in social skills that tend to occur with age do not confound results.

Gender of the child with SB was included as a covariate in several regression analyses. Gender differences are commonly observed in studies of social competence throughout the lifespan. Overall, females tend to be more socially skilled than their same-aged male peers (Nilsen, Karevold, Roysamb, Gustavson, & Mathieson, 2013; Rose & Rudolph, 2006). Similar findings suggesting greater social skill development in females have been found in pediatric populations as well, including inflammatory bowel disease (Mackner, Vannatta, & Crandall, 2012) and sickle cell disease (Hurtig & Park, 1989). In

fact, a recent study of youth with SB and their close friends found that pairs demonstrating the most adaptive social behaviors (e.g., greater clarity of thought, maturity, dominance) in peer interactions were more likely to consist of two females (Holbein et al., 2015). In contrast, two meta-analyses examining social competence in youth with chronic health conditions failed to find any significant associations between gender and social competence (Martinez et al., 2011; Piquart et al., 2014). Further, social differences between youth with CNS conditions, including SB, and typically developing peers were not found to differ by gender (Cunningham, Thomas, & Warschausky, 2007). Gender was not included as a covariate for analyses that utilized the SSRS-Parent Report or SSRS-Teacher Report as a dependent variable, as these normative scores already took gender into account during the standardization process.

SES was also included as a covariate in the regression models due to evidence for socioeconomic differences in social skills. Lower SES youth tend to be more aggressive in social situations than their middle class counterparts (Iruka, Winn, Kingsley, & Orthodoxou, 2011; Ramsey, 1988). Moreover, both teachers and parents rate children from lower SES backgrounds lower on measures of social competence than children from middle or high SES backgrounds (Holmbeck et al., 2003; Iruka et al., 2011; Newby, Brown, Pawletko, Gold, & Whitt, 2000). Low SES has multiple implications for social skills development, including more exposure to community violence, access to weaker educational institutions, less adaptive parenting, poorer physical health, and so on (Gershoff, Aber, Raver, & Lennon, 2007). Specific to youth with SB, Holmbeck and colleagues (2003) assert that a low SES background is a risk factor for poorer psychosocial development. Therefore, it is crucial to control for SES when testing

hypotheses to rule out the potential for confounding relationships between the predictors, SES, and social skills.

It should be noted that intellectual functioning was not included as a covariate in regression models. In the context of neurodevelopmental conditions, and specifically SB, intellectual functioning cannot be disentangled from the effects of the condition itself (Dennis et al., 2009). Indeed, intellectual functioning has been demonstrated as a key factor in family functioning, autonomy development, and psychosocial adaptation of youth with SB (Coakley et al., 2006; Friedman et al., 2009; Holmbeck, Coakley et al., 2002). Similar to other research (Dennis et al., 2009), a previous study examining the influence of EF and attention on social skills in this population included a proxy for intellectual functioning as a covariate in analyses (Rose & Holmbeck, 2007). However, Dennis and colleagues (2009) caution against controlling for intellectual functioning in research that examines neurocognitive functioning of youth with neurodevelopmental conditions. As the condition itself is associated with decreases in overall ability, it is virtually impossible to fully control for the effects of intellectual ability. Further, they recommend that intellectual functioning only be included in analyses when the sample's intellectual functioning differs greatly from expected values or when explicitly relevant to a conceptual model or research question. Neither of these conditions are met in this study. Therefore, intellectual functioning was not included as a covariate in the regression models.

Regression models with single primary predictors. Hypotheses one through three were tested by investigating the association between each predictor (e.g., parent-report of attention, lesion level, observed family functioning, etc.) at T1 and social skills

at T2 through hierarchical linear regression analyses. Social skills at T1 was entered in the first step to control for baseline values of social function. In the second step, SES, gender, and age (when applicable) were entered as covariates. Finally, the predictor variable of interest was entered in the third step. The resulting statistics reveal whether the predictor accounts for significant variance in T2 social skills after controlling for T1 social skills and covariates. In other words, these analyses determined whether the neurocognitive, health-related, and family-related variables predicted later social skills in youth with SB. Three regression analyses were conducted (one for each domain) for three dependent variables (i.e., observed social skills, parent-reported social skills, and teacher-reported social skills), resulting in a total of 9 regressions. Variables were included in each model using forward entry. To ensure that all variables of interest were included in the model, the criteria for variable selection were modified (probability of F-to-enter [i.e., PIN] = .999, probability of F-to-remove [i.e., POUT] = 1.0). Statistical significance for all regressions was determined by *p*-values less than .05.

Regression models investigating all three domains. Three hierarchical regression models including predictors from all three domains were conducted to test Hypotheses 4 through 6 (see Figure 2). Specifically, the predictive power of neurocognitive functioning on subsequent social skills relative to the other two domains was investigated by entering T1 social skills in the first step, covariates (i.e., age, SES, and gender [when applicable]) in the second step, health-related and family-related variables in the third step, and neurocognitive variables in the final step. Statistical significance will provide support for the notion that neurocognitive factors account for the most variance in social skills compared to the health-related and family-related

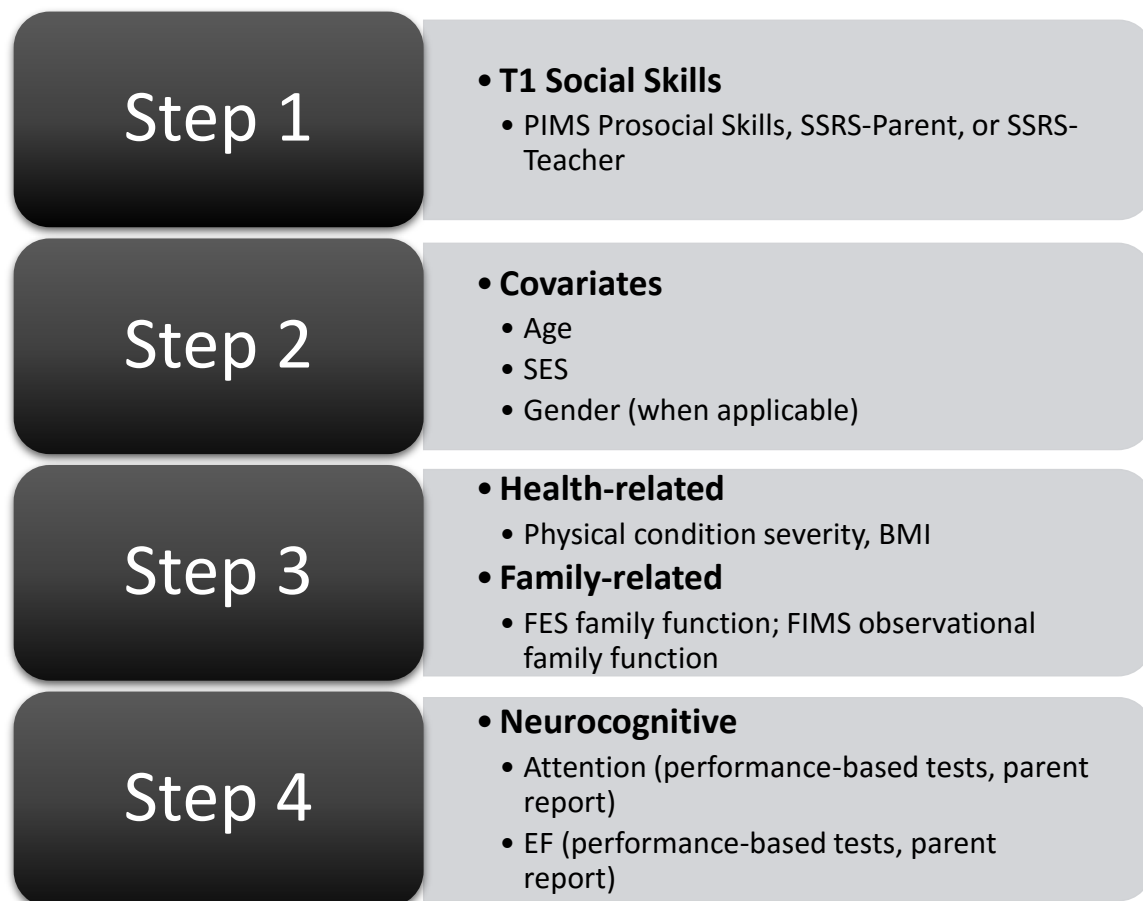
domains after controlling for covariates. Similar regression models were conducted to test the predictive power of the health-related and family-related domains as well; the variables from the domain of interest were entered in the fourth step while variables from the other two domains of comparison were entered together in the third step. The relative predictive power of the three domains was determined by comparing the significance of the R^2 -change values for analyses using the same dependent variable. Regressions were conducted for both observational, parent-reported, and teacher-reported social skills, resulting in a total of nine analyses. Altogether, the aim of these analyses was to determine the most influential predictor of social skills in youth with SB, assuming that one domain was more important than the other two.

Power analysis. A power analysis was conducted using G*Power 3 (Faul, Erdfelder, Lang, & Buchner, 2007) to determine whether the sample size was large enough to detect medium effects. The analysis applies to hypothesis IV because this model required the greatest sample size to detect effects; if the sample size for hypothesis IV is deemed appropriate, it can be assumed that models with fewer predictors (i.e., hypotheses I through III) would satisfy sample size requirements. Cohen's f^2 , a ratio of explained variance and error variance, was selected as a measure of effect size given the multiple regression analyses used in the present study (Faul et al., 2007). The following criteria for effect sizes was employed: $f^2 = .02$ (small effect), $f^2 = .15$ (medium effect) and $f^2 = .35$ (large effect; Cohen, 1992). In addition to the eight predictors listed above, covariates (age, gender, and SES) and T1 values of the DV were included in power analyses, resulting in a total of 11 predictors. For a two-tailed fixed linear multiple regression model, the power analysis indicated that a sample size of 89 is required to

obtain a medium effect size given a type I error probability of .05 (i.e., power = .95).

Thus, the sample of 112 participants (those who participated at both T1 and T2) was found to be sufficient to find medium effects.

Figure 2. Graphical depiction of hierarchical regression model for testing of Hypothesis 4.



Note: Additional models will include: (A) biological variables in Step 4 with family-related and neurocognitive variables included in Step 3; and (B) family-related variables in Step 4 with biological and neurocognitive variables in Step 3. Regression models will be conducted for three separate DVs: SSRS-Parent Report total score, SSRS-Teacher Report total score, and PIMS Prosocial Skills scale.

CHAPTER 3

RESULTS

Preliminary Analyses

Outliers. In accordance with recommendations by Tabachnick and Fidell (2007), outliers were defined as values that were not within three standard deviations of the variable's mean. Two outliers were identified on the T1 PIMS Prosocial Skills scale, while one outlier each was identified on the observational FIMS Conflict scale, FES Conflict scale, performance-based EF composite, and condition severity composite. In all cases, the outlier was replaced by a value 1 unit above (or below) the next highest (or lowest) value for the given variable.

Skewness. To assess for skewed variables, skewness values generated from SPSS were converted into z-scores (Tabachnick & Fidell, 2007). An α value of .001 was used to identify the positive and negative critical values ($z = -3.29$ and 3.29) for identifying deviations from the normal distribution. Using this criterion, one variable, parent report of BMI, was found to be negatively skewed. A square-root transformation was performed and sufficiently corrected for skewness.

Psychometrics of observational measures. Prior to reliability analyses, items were reverse-scored (when applicable; see Table 2). Then, observational items were averaged across all interaction tasks for each of the two coders. Coder ratings on the warm-up game used in family tasks were not used. Next, intraclass correlations (ICCs) were computed to determine interrater reliability at the scale level for the observational

scales. Again, the following criteria specified by Landis and Koch (1977) for ICC values were used: $\leq .40 = \textit{good to fair}$; $.41-.60 = \textit{moderate}$; $.61-.80 = \textit{good}$; $.81-1.00 = \textit{excellent}$ agreement. At both T1 and T2, the PIMS Prosocial Skills scale yielded excellent agreement between raters, with ICC = .89 and .86, respectively. Regarding the observational family measures, both the FIMS Conflict scale (ICC = .66) and Cohesion scale (ICC = .78) produced good interrater reliability.

Internal consistency of each observational scale was also examined. Cronbach's α coefficients were computed to serve as indicators of internal consistency for each of the observational scales used in the present study. Items were collapsed across all raters and all tasks to create means. For items on the FIMS Cohesion scale in which multiple family members were rated (e.g., involvement in the task, requesting input from other family members), item means of the two or three family members were included in reliability analyses. A criterion of Cronbach's $\alpha = .70$ was used to determine acceptable internal consistency. Similar to previous findings (Holbein et al., 2014), the PIMS Prosocial Skills scale yielded adequate internal consistency statistics at both T1 ($\alpha = .86$) and T2 ($\alpha = .86$). Regarding the FIMS scales, the Cohesion scale exhibited adequate internal consistency ($\alpha = .90$) while the Conflict scale ($\alpha = .65$) did not meet the stated criterion. The lower internal consistency found for the Conflict scale may be explained by restricted variability on this scale due to low levels of conflict in families of youth with SB (Holmbeck & Devine, 2010; Holmbeck & Faier-Routman, 1995; Vermaes et al., 2007). Given the close approximation of the Conflict scale's alpha to .70, the inclusion of this variable in subsequent analyses was deemed appropriate. Further, the alpha value could not be improved by dropping scale items. Previous investigations using

observational family data in pediatric populations have deemed similar reliability coefficients to be acceptable (Kaugars et al., 2011).

Data reduction. First, bivariate Pearson correlations were conducted to examine associations across reporters for measures with two (i.e., mother and father report on the BRIEF, SNAP-IV, and FES) or three reporters (mother, father, and teacher report on the SSRS). As all mother and father reports exceeded $r = .40$, parent composites were created for all relevant variables. Correlations between teacher and parent reports on the SSRS total score did not meet the stated criterion at T1 ($r = .24$) or T2 ($r = .25$). Therefore, teacher report on the SSRS was analyzed separately from parent report.

Next, correlations were computed for variables within each conceptual domain to determine whether additional data reduction could occur. In the neurocognitive domain, performance-based measures of EF (i.e., DKEFS Verbal Fluency Category Switching, WISC-IV Digit Span) and attention (TEA-Ch subtests, CAS Number Detection) were expected to be related within their respective subcategories. Correlations between the EF performance-based measures ($r = .41$) exceeded the .40 criterion specified *a priori*, indicating that the two measures could be averaged together after undergoing z-score transformations to create a measure of performance-based EF. Likewise, TEA-Ch subscales and the CAS Number Detection subtest were combined to arrive at a measure of performance-based attention, as a Cronbach's alpha of .75 was attained. This composite of performance-based attention was previously used in another investigation of social skills and cognitive functioning (Holbein et al., 2015). Given previous research that finds substantial differences between performance-based and questionnaire reports of neurocognitive constructs (Anderson et al., 2002; Ganesalingam et al., 2011), the SNAP-

IV and the BRIEF were not expected to be combined with their corresponding performance-based variables. Consistent with past research, both the correlation between the EF performance-based composite and the BRIEF-Parent Report Metacognition Index ($r = -.04$) as well as the correlation between the attention performance-based composite and the SNAP-IV total score ($r = -.10$) failed to meet the specified criterion.

Further data reduction methods were conducted to reduce the number of highly correlated variables entered in the model. Correlations between neurocognitive measures revealed a strong association between the performance-based composites of attention and EF ($r = .66$). Similarly, the parent-reported measures of attention and EF were also highly correlated ($r = .71$). Thus, two composite variables were created: (1) performance-based attention/EF and (2) parent-report of attention/EF. The parent-report measures of attention (SNAP-IV) and EF (BRIEF-Metacognition Index) were transformed according to the z distribution, as both scales are measured on different scales. Higher values for the parent-report neurocognitive composite correspond to weaker attention/EF skills. Transformation for the performance-based composite was unnecessary, as all measures were measured using scaled scores (i.e., $M = 10$, $SD = 3$). Higher values for the performance-based neurocognitive composite indicate better attention/EF skills.

Concerning the family-related predictors, it was anticipated that both observational scales (i.e., FIMS Cohesion and FIMS Conflict) would produce a correlation that exceeded the .40 criterion and would then be averaged. However, the two observational scales produced a lower correlation ($r = -.33$) than expected. Therefore, the FIMS Conflict and Cohesion scales were included separately in the regression models.

Regarding the FES Conflict and Cohesion scales, which were also expected to be eligible

for combination, the correlation ($r = -.58$) exceeded the stated criterion. Prior to averaging the two subscales, the FES Conflict underwent a negative transformation. Thus, higher values of the resulting parent-report variable represented a more positive family environment (i.e., more cohesion, less conflict). The observational and parent-report variables of family function were not significantly correlated (FIMS Conflict and FES composite: $r = -.01$; FIMS Cohesion and FES composite: $r = .11$). Indeed, previous research has shown that FIMS scales and their corresponding FES scales do not correlate at or above .40 (Kaugars et al., 2011), suggesting that both methods produce unique information about family functioning.

Finally, within the health-related domain, it was expected that lesion level and gross motor function would meet the criterion stated above based on previous research demonstrating a strong link between the two constructs (Fletcher et al., 2005). In fact, the correlation ($r = .56$) between the two variables met criteria for data reduction. Due to differing scales of measurement, both variables underwent z-score transformations before being averaged together. The resulting composite variable is an indicator of physical condition severity, with higher values representing greater severity.

Preliminary cross-sectional analyses. Although not included in the hypotheses, analyses were conducted to determine the cross-sectional associations at T1 of neurocognitive, family-related, and health-related variables with social skills while accounting for age, SES, and gender. Correlations between all independent variables, dependent variables, and covariates are presented in Table 3. Regarding dependent variables, peer observational prosocial skills were positively correlated with parent- and teacher-reported social skills; likewise, parent- and teacher-reported social skills were

also related in the positive direction. In addition, youth with SB rated high in observed prosocial skills tended to be older, have higher SES, perform better on attention and EF tests, and were rated higher on family observational conflict and cohesion. When social skills were reported by parents, youth with SB were more likely to have fewer attention problems and EF impairments, perform better on attention and EF tests, have greater adaptive family functioning, and receive higher ratings on observed family cohesion. Greater teacher-reported social skills were related to fewer parent-reported attention problems and EF impairments as well as stronger performance on neurocognitive tests. Further, it should be noted that SES was related to many independent variables. Youth with higher SES also tended to have greater parent-reported neurocognitive impairments, better performance on neurocognitive tests, higher ratings of observed family cohesion, lower BMI, and lower condition severity.

Cross-sectional regressions were run as linear hierarchical analyses using forward entry and accounting for covariates (please refer to Table 4).

Table 3. Bivariate Pearson correlations between continuous dependent and independent variables.

Variable						Neurocog.		Family		Health		
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. T1 Peer Observational Prosocial Skills	-	.23*	.32**	.19*	.22*	.11	.56**	.01	.35**	.22*	.04	.06
2. T1 Social Skills – Parent		-	.24*	.07	.08	-.27**	.22*	.37**	.35**	-.10	.14	.07
3. T1 Social Skills – Teacher			-	.11	.17	-.21*	.29**	.07	.15	-.13	.14	.00
4. Age				-	.06	.01	.14	.04	.15	-.13	.19*	.15
5. Hollingshead SES					-	.22*	.39**	-.02	.34**	-.11	.19*	.17*
6. Attention/EF Impairment – Parent						-	.07	.23*	.10	.09	.09	.03
7. Attention/EF Performance Tests							-	.02	.29**	-.09	.13	.19*
8. Adaptive Family Function – Parent								-	.11	-.01	.06	.10
9. Family Observational Cohesion									-	.33**	.25*	.03
10. Family Observational Conflict										-	.07	.08
11. Body Mass Index											-	.19*
12. Condition Severity												-

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

Table 4. Cross-sectional hierarchical linear regressions at T1.

Step and Variable	Forward Entry		Simultaneous Entry		
	β	t	R	$R^2\Delta$	Step $F\Delta$
DV: T1 Peer Observation Prosocial Skills ($N=114$)					
1 SES	.24	2.61*	.36	.13	5.54**
Age	.24	2.66**			
Sex	.13	1.48			
2 Attention/EF Performance Tests	.59	6.99**	.63	.27	24.27**
Attention/EF Impairment-Parent	-.03	-.37			
DV: T1 Social Skills – Parent ($N=119$)					
1 SES	.08	.85	.09	.01	.44
Age	.04	.41			
2 Attention/EF Impairment-Parent	-.32	-3.51**	.35	.11	7.30**
Attention/EF Performance Tests	.14	1.47			
DV: T1 Social Skills – Teacher ($N=106$)					
1 SES	.17	1.75	.21	.05	2.43
Age	.13	1.33			
2 Attention/EF Impairment-Parent	-.28	-2.96**	.38	.10	6.08**
Attention/EF Performance Tests	.19	1.79			
DV: T1 Peer Observation Prosocial Skills ($N=115$)					
1 SES	.21	2.27*	.33	.11	4.41**
Age	.20	2.23*			
Sex	.15	1.66			
2 Family Observed Cohesion	.36	3.83**	.46	.11	5.01**
Adaptive Family Function-Parent	-.07	-.77			
Family Observed Conflict	.01	.08			
DV: T1 Social Skills – Parent ($N=121$)					
1 SES	.07	.77	.08	.01	.34
Age	.03	.30			
2 Adaptive Family Function-Parent	.36	4.12**	.48	.22	10.87**
Family Observed Cohesion	.33	3.73**			
Family Observed Conflict	.03	.36			

Table 4. (Continued).

Step and Variable	Forward Entry		Simultaneous Entry		
	β	t	R	$R^2\Delta$	Step $F\Delta$
DV: T1 Social Skills-Teacher ($N=108$)					
1 SES	.17	1.72	.20	.04	2.23
Age	.12	1.22			
2 Family Observed Cohesion	.12	1.18	.24	.01	.52
Adaptive Family Function-Parent	.04	.38			
Family Observed Conflict	.02	.18			
DV: T1 Peer Observation Prosocial Skills ($N=103$)					
1 SES	.20	2.03*	.31	.09	3.44*
Age	.19	1.92			
Sex	.15	1.51			
2 Condition Severity	-.05	-.52	.31	.00	.17
Body Mass Index	-.03	-.27			
DV: T1 Social Skills-Parent ($N=109$)					
1 SES	.09	.96	.10	.01	.50
Age	.03	.29			
2 Body Mass Index	-.11	-1.09	.19	.03	1.38
Condition Severity	.13	1.25			
DV: T1 Social Skills-Teacher ($N=97$)					
1 SES	.17	1.66	.25	.06	3.02
Age	.18	1.79			
2 Body Mass Index	.15	1.39	.29	.02	1.07
Condition Severity	-.05	-.49			

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

Neurocognitive variables. Neurocognitive variables as a whole accounted for significant variance after controlling for covariates for all three dependent variables: observed social skills, $R = .63$, $R^2\Delta = .27$, $p < .001$, parent-reported social skills, $R = .35$, $R^2\Delta = .11$, $p < .01$, and teacher-reported social skills, $R = .38$, $R^2\Delta = .10$, $p < .01$. Significant associations between individual neurocognitive variables and T1 social skills varied depending on the method and informant used to measure social skills. Observed

social skills were significantly related in the positive direction to the performance-based composite of EF and attention, $t = 6.99, p < .001, \beta = .59$. In addition, parent-reported attention problems and EF impairments emerged as a significant predictor of social skills reported by parents, $t = -3.5, p < .01, \beta = -.32$, and teachers, $t = -2.95, p < .01, \beta = -.28$. Therefore, youth whose parents reported fewer EF and attention deficits tended to have better parent- and teacher-reported social skills.

Family variables. Associations between family-related variables and social skills also differed by informant and method. First, family-related variables appeared to account for significant variability in observed social skills when controlling for covariates, $R = .46, R^2\Delta = .11, p < .01$. Upon closer inspection, higher levels of observed family cohesion were associated with greater observed social skills, $t = 3.83, p < .001, \beta = .36$; observed family conflict and parent-reported positive family environment did not predict social skills. Family-related variables were also significantly related to parent-reported social skills after accounting for covariates, $R = .48, R^2\Delta = .22, p < .001$. Parents rated their children with SB higher in social skills when the family was observed to demonstrate greater cohesion, $t = 4.12, p < .001, \beta = .36$, and parents reported a more positive family environment, $t = 3.73, p < .001, \beta = .33$. On the other hand, family-related variables were not significantly related to teacher-reported social skills.

Health-related variables. Health-related variables as a whole did not account for variance in any of the three dependent variables after controlling for age, SES, and gender. Similarly, analyses revealed that neither BMI nor condition severity significantly predicted observed, parent-, and teacher-reported social skills.

Exploratory Analyses: Associations between Covariates and T2 Social Skills

Analyses described below apply to regression models that apply to Hypotheses 4 through 6.

Gender. Gender was entered as a covariate only in analyses with observational DVs, as parent- and teacher-reports of social skills had already been adjusted for gender when obtaining standard scores. Results indicated that females exhibited more adaptive social skills at T2 compared to males, $\beta=.24$, $t=2.62$, $p=.010$.

SES. Children's socioeconomic background was positively related to later social skills, such that children with higher SES at T1 were more likely to be rated higher in social skills when observed in peer interactions at T2, $\beta=.23$, $t=2.52$, $p=.014$. Significant associations between SES and social skills were not found for either the parent- or teacher-report on the SSRS.

Age. Age at T1 did not significantly predict later social skills for any of the three DVs after controlling for T1 social skills.

Hypothesis 1: Neurocognitive Variables Predicting Social Skills at T2

Hierarchical linear regressions were conducted to determine whether neurocognitive variables were longitudinally associated with social skills. Specifically, social skills at T1 were entered in the first step, covariates were entered in Step 2, and both neurocognitive variables were entered in the final step. Table 5 includes statistics for all three regressions. Results differed by measurement of social skills. Overall, F-change values for the third step indicated that neurocognitive variables as a whole predicted T2 observed social skills when controlling for T1 social skills and covariates. Upon closer inspection, observed social skills at T2 were significantly predicted by children's

performance on performance-based tests of attention and EF, such that those with stronger attention and EF skills tended to exhibit greater social skills. Parental report of attention and EF skills was not related to observed social skills. Similar results were found for teacher-reported social skills. In contrast, neurocognitive variables did not predict later social skills when reported by parents.

Table 5. Hypothesis 1 hierarchical linear regressions: Neurocognitive variables predicting T2 social skills

Step and Variable	Forward Entry		Simultaneous Entry		
	β	t	R	$R^2\Delta$	Step $F\Delta$
DV: T2 Peer Observation Prosocial Skills ($N=90$)					
1 T1 Peer Observation Prosocial Skills	.55	6.12**	.55	.30	37.42**
2 Sex	.22	2.52*	.62	.09	3.98*
SES	.19	2.12			
Age	-.09	-.93			
3 Attention/EF Performance Tests	.31	2.73**	.66	.05	3.83*
Attention/EF Impairment Parent	-.05	-.52			
DV: T2 Social Skills – Parent ($N=97$)					
1 T1 Social Skills – Parent	.65	8.38**	.65	.43	70.26**
2 Age	.10	1.34	.66	.01	.89
SES	.01	.06			
3 Attention/EF Impairment-Parent	-.15	-1.75	.68	.02	1.74
Attention/EF Performance Tests	.06	.66			
DV: T2 Social Skills – Teacher ($N=77$)					
1 T1 Social Skills – Teacher	.32	2.94**	.32	.10	8.64**
2 SES	-.08	-.68	.33	.01	.25
Age	-.02	-.18			
3 Attention/EF Performance Tests	.42	3.52**	.49	.13	6.22**
Attention/EF Impairment-Parent	-.05	-.44			

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

Hypothesis 2: Family Variables Predicting Social Skills at T2

Hierarchical regressions were conducted in a similar manner as described above, although family-related variables were entered in place of neurocognitive variables in the

third step (refer to Table 6 for statistics). Although the family domain as a whole did not predict T2 social skills beyond covariates in any of the three regressions, the association of individual family-related variables and social skills varied by measurement of the DV. For instance, observed family conflict at T1 was negatively related to observed social skills at T2; in other words, family interactions characterized by less conflict were subsequently associated with greater social skills demonstrated by the child with SB in peer interactions. When social skills were reported by teachers, greater observed family cohesion predicted greater social skills in children with SB. None of the family-related variables were related to parent-reported social skills at T2.

Hypothesis 3: Health-related Variables Predicting Social Skills at T2

Three hierarchical regressions were conducted to determine whether health-related variables assessed at T1 were associated with social skills at T2 after accounting for covariates (refer to Table 7). Contrary to hypotheses, health-related variables did not predict T2 social skills at the step-level when analyzed in all three regressions. Further, neither BMI nor condition severity were individually related to later social skills.

Table 6. Hypothesis 2 hierarchical linear regressions: Family-related variables predicting T2 social skills.

Step and Variable	Forward Entry		Simultaneous Entry		
	β	t	R	$R^2\Delta$	Step $F\Delta$
DV: T2 Peer Observation Prosocial Skills ($N=91$)					
1 T1 Peer Observation Prosocial Skills	.57	6.58**	.57	.33	43.29**
2 Sex	.22	2.61*	.64	.08	4.07**
SES	.16	1.94			
Age	-.11	-1.18			
3 Family Observational Conflict	-.17	-2.01*	.67	.03	1.54
Adaptive Family Function – Parent	.04	.54			
Family Observational Cohesion	-.04	-.42			
DV: T2 Social Skills – Parent ($N=98$)					
1 T1 Social Skills – Parent	.65	8.41**	.65	.42	70.71**
2 Age	.10	1.27	.66	.01	.80
SES	.00	.04			
3 Adaptive Family Function – Parent	-.14	-1.71	.67	.02	1.15
Family Observational Conflict	-.05	-.66			
Family Observational Cohesion	-.04	-.35			
DV: T2 Social Skills – Teacher ($N=79$)					
1 T1 Social Skills – Teacher	.32	2.94**	.32	.10	8.66**
2 SES	-.07	-.60	.33	.00	.18
Age	-.00	-.02			
3 Family Observational Cohesion	.30	2.62*	.44	.09	2.65
Adaptive Family Function – Parent	-.11	-.98			
Family Observational Conflict	-.06	-.48			

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

Table 7. Hypothesis 3 hierarchical linear regressions: Health-related variables predicting T2 social skills.

Step and Variable	Forward Entry		Simultaneous Entry		
	β	t	R	$R^2\Delta$	Step $F\Delta$
DV: T2 Peer Observational Prosocial Skills ($N=81$)					
1 T1 Peer Observational Prosocial Skills	.58	6.29**	.58	.33	39.60**
2 Sex	.24	2.71**	.66	.10	4.47**
SES	.21	2.36*			
Age	-.04	-.44			
3 Body Mass Index	-.05	-.51	.66	.00	.13
Condition Severity	-.01	-.07			
DV: T2 Social Skills – Parent ($N=88$)					
1 T1 Social Skills – Parent	.67	8.44**	.67	.45	71.21**
2 Age	.10	1.30	.68	.01	.87
SES	.02	.25			
3 Body Mass Index	.05	.63	.68	.00	.31
Condition Severity	-.04	-.48			
DV: T2 Social Skills – Teacher ($N=71$)					
1 T1 Social Skills – Teacher	.36	3.16**	.36	.13	9.96**
2 SES	-.06	-.49	.36	.01	.25
Age	-.06	-1.25			
3 Body Mass Index	-.15	-1.25	.41	.03	1.21
Condition Severity	-.11	-.93			

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

Hypothesis 4: Neurocognitive Variables Predicting Social Skills at T2 beyond

Family and Health-related Domains

Hypothesis 4 posited that the neurocognitive domain would be the strongest predictors of social skills at T2 relative to the family- and health-related domains. To investigate this idea, hierarchical regressions were run for each DV of interest (see Table 8 for statistics). Like analyses previously described, social skills measured at T1 were entered in Step 1 and covariates (i.e., age, SES, and gender [when applicable]) were

entered in Step 2. Next, variables from the family- and health-related domains were entered in Step 3. Finally, neurocognitive variables were entered in the fourth step. Investigation of the F-change test for the fourth step revealed whether the neurocognitive domain predicted T2 social skills beyond the other two domains.

In accordance with expectations, the neurocognitive domain was found to significantly predict later observed social skills. A closer inspection of the analysis showed that children's performance on tests of attention and EF accounted for this finding. Children with SB with better attention and EF skills were more likely to demonstrate more adaptive social skills two years later. Similarly, greater performance-based neurocognitive abilities also predicted better social skills when reported by teachers. The final step testing both neurocognitive variables as a block yielded a marginal effect ($p = .051$). Neurocognitive variables were not significantly related to parent-reported social skills of children with SB at T2. Thus, the expectation that neurocognitive variables would predict social skills over and above the family- and health-related domains was partially supported.

Hypothesis 5: Family Variables Predicting Social Skills at T2 beyond Neurocognitive and Health-related Domains

Hypothesis 5 suggested that the family domain would be the second-strongest predictors of social skills. Hierarchical regressions with 4 steps were conducted, with neurocognitive and health-related variables entered in the third step and family variables entered in the fourth step (refer to Table 9 for complete statistics).

Overall, the family domain variables in combination did not significantly account for T2 social skills beyond the neurocognitive and health-related variables for any of the

three DVs. However, observational family variables were individually associated with social skills, similar to the Hypothesis 2 results. Observed family conflict was negatively related to observed social skills, even when controlling for neurocognitive and health-related variables. Children with SB whose families demonstrated less conflict in their T1 parent-child interactions were more likely to exhibit greater social skills at T2. Moreover, observed family cohesion was positively related to T2 teacher-reported social skills. When families were rated higher in cohesion, teachers were more likely to report greater social skills in their students with SB relative to children whose families exhibited less cohesion. When social skills were reported by parents, no associations were found for any of the three family variables.

Hypothesis 6: Health-related Variables Predicting Social Skills at T2 beyond Neurocognitive and Family Domains

It was expected that the health-related domain would be the weakest predictor of social skills at T2. Consistent with the statistical procedures outlined above, hierarchical regressions were run with variables from the neurocognitive and family variables entered in Step 3 and health-related variables were entered last (refer to Table 10 for statistics).

Results from the three regressions indicated that the health-related domain did not predict T2 social skills. In fact, inspection of $R^2\Delta$ and $F\Delta$ tests at the fourth step suggests that the health-related domain accounted for very little variance in social skills after covariates and other domains were included in the model. Further, at the individual variable level, neither BMI nor condition severity predicted T2 social skills in any of the three analyses.

Further Comparisons between Domains

As specified in Hypotheses 4, 5, and 6, it was expected that the neurocognitive domain would be the strongest predictor of social skills, followed by the family and health-related domains, respectively. Comparisons of the results for regressions with the same DV support the order of domains proposed in the hypotheses. Regarding social skills as assessed by direct observation, only the neurocognitive domain significantly predicted T2 social skills as shown by indicators of change in the fourth step of the analyses, $R^2\Delta = .07$, $F\Delta(2,68) = 4.97$, $p = .01$, while both the family, $R^2\Delta = .04$, $F\Delta(3,68) = 1.77$, $p > .05$, and health-related domains, $R^2\Delta = .01$, $F\Delta(2,68) = .39$, $p > .05$, yielded smaller, nonsignificant values (see Tables 8, 9, and 10). As stated previously, individual inspection of the predictor values revealed that the strong association between children's scores on attention and EF performance-based tests and their observed social skills two years later accounts for the significant F-change value at the fourth step. Further, when entered into the model together in a forward manner in Step 3 (see Table 8), attention and EF performance-based test scores, $\beta = .34$, $t = 2.82$, $p = .006$, were entered into the model before observed family conflict, $\beta = -0.21$, $t = -2.43$, $p = .018$. Thus, attention and EF test scores and observed family conflict are the two strongest predictors of observed social skills.

When social skills of children with SB were reported by parents, the relative comparisons across the three domains of interest were less clear. In fact, none of the domains accounted for significant variance in T2 social skills beyond the other two domains entered in the previous (i.e., third) step (see Tables 8, 9, and 10). Analysis of R-square change and F-change statistics suggests that the neurocognitive, $R^2\Delta = .03$,

$F\Delta(2,75) = 1.94, p > .05$, and family domains, $R^2\Delta = .02, F\Delta(3,75) = 1.16, p > .05$, are relatively similar in their association with parent-reported social skills. Health-related variables were clearly the weakest predictor of social skills, $R^2\Delta = .00, F\Delta(2,75) = .05, p > .05$; as a whole, these variables accounted for virtually no additional variance in the DV after the other two domains were entered in the model.

In the case of teacher-reported social skills, the neurocognitive domain again appeared to be the strongest predictor, $R^2\Delta = .07, F\Delta(2,57) = 3.13, p = .051$. Family variables produced the second-strongest association with teacher-reported social skills, $R^2\Delta = .08, F\Delta(3,57) = 2.40, p = .077$, and the health-related variables continued to be the weakest domain, $R^2\Delta = .01, F\Delta(2,57) = .43, p > .05$. Examination of the individual variables revealed that performance-based attention and EF scores as well as observed family cohesion were the only significant predictors of teacher-reported skills when included in Step 4 of their respective regression analyses. Moreover, when entered together in Step 3 of the model in which health-related variables were entered last (see Table 10), performance-based neurocognitive test scores, $\beta = .44, t = 3.57, p = .001$, exhibited a stronger relationship with the DV when compared with observed family cohesion, $\beta = .29, t = 2.58, p = .012$.

Table 8. Hypothesis 4 hierarchical linear regressions: Neurocognitive variables predicting T2 social skills beyond family and health-related variables.

Step and Variable	Forward Entry		Simultaneous Entry		
	β	t	R	$R^2\Delta$	Step $F\Delta$
DV: T2 Peer Observational Prosocial Skills ($N=80$)					
1 T1 Peer Observational Prosocial Skills	.55	5.82**	.55	.30	33.83**
2 Sex	.24	2.62*	.64	.11	4.52**
SES	.23	2.52*			
Age	-.02	-.18			
3 Family Observational Conflict	-.18	-1.93	.66	.04	.88
Adaptive Family Function-Parent	.05	.59			
Family Observational Cohesion	-.06	-.51			
Body Mass Index	-.04	-.43			
Condition Severity	-.02	-.22			
4 Attention/EF Performance Tests	.40	3.17**	.72	.07	4.97**
Attention/EF Impairment-Parent	-.00	-.04			
DV: T2 Social Skills-Parent ($N=86$)					
1 T1 Social Skills-Parent	.65	7.86**	.65	.42	61.76**
2 Age	.11	1.35	.66	.01	.91
SES	.01	.11			
3 Adaptive Family Function-Parent	-.13	-1.48	.68	.03	.71
Family Observational Conflict	-.08	-.89			
Family Observational Cohesion	-.08	-.71			
Body Mass Index	.04	.39			
Condition Severity	-.01	-.13			
4 Attention/EF Impairment-Parent	-.18	-1.95	.70	.03	2.03
Attention/EF Performance Tests	.05	.53			
DV: T2 SSRS Social Skills-Teacher ($N=68$)					
1 T1 Social Skills-Teacher	.31	2.68**	.31	.10	7.18**
2 SES	-.08	-.67	.33	.01	.49
Age	-.09	-.73			
3 Family Observational Cohesion	.37	3.13**	.54	.18	2.95*
Condition Severity	-.18	-1.59			
Adaptive Family Function-Parent	-.17	-1.51			
Body Mass Index	-.04	-.31			
Family Observational Conflict	-.01	-.09			
4 Attention/EF Performance Tests	.33	2.52*	.60	.07	3.13
Attention/EF Impairment-Parent	-.02	-.14			

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

Table 9. Hypothesis 5 hierarchical linear regressions: Family-related variables predicting T2 social skills beyond neurocognitive and health-related variables.

Step and Variable	Forward Entry		Simultaneous Entry		
	β	t	R	$R^2\Delta$	Step $F\Delta$
DV: T2 Peer Observational Prosocial Skills ($N=80$)					
1 T1 Peer Observational Prosocial Skills	.25	5.82**	.55	.30	33.83**
2 Sex	.24	2.62*	.64	.11	4.52**
SES	.23	2.52*			
Age	-.02	-.18			
3 Attention/EF Performance Tests	.34	2.82**	.69	.07	2.30
Condition Severity	.07	.80			
Body Mass Index	-.04	-.43			
Attention/EF Impairment-Parent	-.03	-.28			
4 Family Observational Conflict	-.20	-2.18*	.72	.04	1.77
Family Observational Cohesion	-.09	-.76			
Adaptive Family Function-Parent	.03	.29			
DV: T2 Social Skills-Parent ($N=86$)					
1 T1 Social Skills-Parent	.65	7.86**	.65	.43	61.76**
2 Age	.11	1.35	.66	.01	.91
SES	.01	.11			
3 Attention/EF Impairment-Parent	-.17	-1.97	.68	.03	1.04
Attention/EF Performance Tests	.05	.55			
Condition Severity	.03	.30			
Body Mass Index	.02	.22			
4 Adaptive Family Function-Parent	-.14	-1.59	.70	.02	1.17
Family Observational Conflict	-.05	-.58			
Family Observational Cohesion	-.10	-.82			
DV: T2 SSRS Social Skills-Teacher ($N=68$)					
1 T1 Social Skills-Teacher	.31	2.68**	.31	.10	7.18**
2 SES	-.08	-.67	.33	.01	.49
Age	-.09	-.73			
3 Attention/EF Performance Tests	.44	3.57**	.53	.17	3.47*
Body Mass Index	-.12	-1.01			
Attention/EF Impairment-Parent	-.08	-.65			
Condition Severity	.02	.16			
4 Family Observational Cohesion	.30	2.36*	.60	.08	2.40
Adaptive Family Function-Parent	-.14	-1.30			
Family Observational Conflict	-.02	-.12			

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

Table 10. Hypothesis 6 hierarchical linear regressions: Health-related variables predicting T2 social skills beyond neurocognitive and family-related variables.

Step and Variable	Forward Entry		Simultaneous Entry		
	β	t	R	$R^2\Delta$	Step $F\Delta$
DV: T2 Peer Observational Prosocial Skills ($N=80$)					
1 T1 Peer Observational Prosocial Skills	.55	5.82**	.55	.30	33.83**
2 Sex	.24	2.62*	.64	.11	4.52**
SES	.23	2.52*			
Age	-.02	-.18			
3 Attention/EF Performance Tests	.34	2.82**	.71	.10	2.86*
Family Observational Conflict	-.21	-2.43*			
Family Observational Cohesion	-.06	-.56			
Adaptive Family Function-Parent	.03	.32			
Attention/EF Impairment-Parent	-.00	-.01			
4 Condition Severity	.05	.55	.72	.01	.39
Body Mass Index	-.06	-.69			
DV: T2 Social Skills-Parent ($N=86$)					
1 T1 Social Skills-Parent	.65	7.86**	.65	.42	61.76**
2 Age	.11	1.35	.66	.01	.91
SES	.01	.11			
3 Attention/EF Impairment-Parent	-.17	-1.97	.70	.05	1.56
Adaptive Family Function-Parent	-.14	-1.67			
Family Observational Conflict	-.05	-.62			
Family Observational Cohesion	-.09	-.78			
Attention/EF Performance Tests	.04	.48			
4 Condition Severity	.03	.30	.70	.00	.05
Body Mass Index	.00	.04			
DV: T2 SSRS Social Skills-Teacher ($N=68$)					
1 T1 Social Skills-Teacher	.31	2.68**	.31	.10	7.18**
2 SES	-.08	-.67	.33	.01	.49
Age	-.09	-.73			
3 Attention/EF Performance-based Tests	.44	3.57**	.59	.24	4.32**
Family Observational Cohesion	.29	2.58*			
Adaptive Family Function-Parent	-.13	-1.23			
Attention/EF Impairment-Parent	-.03	-.24			
Family Observational Conflict	-.02	-.13			
4 Condition Severity	-.10	-.86	.60	.01	.43
Body Mass Index	-.04	-.36			

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

CHAPTER 4

DISCUSSION

The purpose of the present study was to investigate the relative influence of neurocognitive, family, and health-related predictors on social skills in youth with SB. Despite well-known social skills deficits in this population, previous studies have adopted a piecemeal approach by examining associations between social competence and predictors within a single domain. The present study advances the literature by utilizing a developmental framework to provide an organized, comprehensive evaluation of social skills and their predictors in a sample of youth with SB. Further, a longitudinal approach with multi-method, multi-informant methods adds innovation and methodological rigor to this area of research. The current study is one of the first to compare the relative influence of neurocognitive, family, and health-related domains on the development of social skills.

The present study systematically addressed several research questions. First, cross-sectional associations between social skills and variables from all three domains were examined utilizing hierarchical linear regressions. Next, variables from each domain were examined separately as predictors of later social skills. Finally, hierarchical linear regressions were conducted to determine which domain contributed most to social skills in youth with SB. It was hypothesized that neurocognitive variables would be most closely related to social skills, followed by family and health-related domains. Social skills were measured in three different ways: observation of peer interactions, parent

report, and teacher report. Multiple methods and informants in the assessment of social skills allowed for a rich, nuanced examination of social skills in this population.

Overall, this study provides support for the notion that neurocognitive abilities (i.e., attention and EF) and family function significantly contribute to the social skill development of youth with SB. When neurocognitive, family, and health-related domains are compared, it appears that neurocognitive factors are most influential for later social skills, followed by family function and health characteristics. In fact, condition severity and weight status do not seem to have a significant effect on later social skills in this population. Findings differed based on measurement of social skills and independent variables, lending support to the utility of a multi-method, multi-informant methodology. Results from this study have important implications for the development of future research, clinical screening, and intervention.

Preliminary Analyses

Descriptive analyses. To provide a glimpse into the social skills of youth with SB in this sample, scores from parent and teacher report on the SSRS were converted to standard scores. The SSRS was initially normed on a sample of typically developing youth without known CNS complications (Gresham & Elliot, 1990). Therefore, a typically developing child would be expected to achieve a standard score on this measure between 90 and 110. At Time 1, youth with SB in the present study had a mean parent report score of 91.68 (range of 46-130) and a mean teacher report score of 96.70 (range of 57 to 130; see Table 2). Two years later, mean scores were relatively similar, albeit somewhat greater. Thus, children with SB were on the lower end of the average range compared to the normative sample when their parents reported social skills. Teacher

report revealed mean scores that were quite close to the mean score (i.e., 100) of the normative sample. These findings suggest that most children with SB have social skills that meet or exceed developmental expectations. However, closer analysis of the distributions of scores indicates that a subset of youth with SB are likely exhibiting significant social skills deficits. At one standard deviation below the mean value for social skills, scores would fall in the mid-70s and low 80s for parent and teacher report at T1, respectively; these scores are indicative of skills deficits. As the distributions for teacher- and parent-reported social skills were essentially normal, it can be inferred that at least 16% (if not more) of the sample was reported to have below average social skills.

Moreover, it is likely that children with SB may experience variation across social skills, such that they are proficient in some areas (e.g., listening to others, utilizing humor and laughter, tolerating disagreements) and struggle more with others (e.g., expressing ideas clearly, taking charge of an interaction, engaging in a shared task; Holbein et al., 2015). Previous work has also suggested that individuals with SB exhibit social strengths and weaknesses (Devine et al., 2012). Clearly, the social skills of youth with SB are just as heterogeneous as other aspects of the condition, including mobility and neurocognitive abilities.

Cross-sectional correlations. Correlations between study variables revealed several meaningful findings. First, all three dependent variables were found to be modestly associated with each other. Although the three measures of social skills assessed similar social skills and characteristics, coefficients ranging from .23 to .32 imply that each variable captured unique information about children's social functioning. Indeed, social skills may differ based on informants, contexts (e.g., school, community,

home), and interaction partners (e.g., adults, peers, large groups, pairs; Dirks et al., 2007). Children may exhibit different social skills depending on characteristics of the setting; further, others may observe or perceive different social behaviors as well. The use of multiple reporters – parents, teachers, and third-party observers – is certainly a strength of this study.

Second, several demographic characteristics were closely linked with social skills. While older children were observed to exhibit greater prosocial skills in their peer interactions, this association was not found when social skills were reported by parents or teachers. Of note, SSRS scores are not standardized according to age (scores are standardized for the elementary form as a whole); thus, it was somewhat surprising that neither parents nor teachers perceived greater social skills in older youth with SB. Given the brain development that occurs throughout childhood and adolescence, as well as increased socialization and social interaction experiences, older youth would be expected to have greater social skills than their younger counterparts (Beauchamp & Anderson, 2010; Crick & Dodge, 1994). As they age, children are expected to become more sophisticated in their abilities to recognize, organize, and interpret social information (Crick & Dodge, 1994). It is possible that youth with SB do not experience the same growth in social skills that occurs in typically developing youth. Alternatively, the SSRS may not be particularly sensitive to subtle increases in social skills that occur as children age.

Correlations also revealed multiple associations between SES and other study variables. Regarding dependent variables, only observed social skills were related to SES. Previous research with other pediatric populations (e.g., asthma, TBI, osteogenesis

imperfecta) has found similar relationships between social competence and SES (Chen, 2014; Ganesalingam et al., 2011). Parent and teacher reports of social skills were not significantly associated with SES, contradicting previous findings that teachers and parents report lower social competence in low-income youth (Holmbeck et al., 2003; Iruka et al., 2011). As low SES has been linked with greater aggression (Iruka et al., 2011; Martin et al., 2010), and youth with SB are generally more passive than their typically developing peers (Holmbeck et al., 2003), the effects of SES on social skills may be attenuated in this population. It is also possible that parent and teacher reports of social skills did not capture social characteristics that are highly correlated with SES.

Children raised by families with greater socioeconomic resources tended to have higher neurocognitive test scores and observed family cohesion, lower weight, and less severe conditions. Indeed, it is well-established that SES affects many cognitive, environmental, and health-related factors. Associations between SES and independent variables are generally consistent with the literature (Bradley & Corwyn, 2002; Chen, Matthews, & Boyce, 2002; Ganesalingam et al., 2007; Holmbeck et al., 2003; Wang & Beydoun, 2007). Yet, the positive correlation between SES and parent-reported impairments in attention and EF was unexpected. Caregivers with higher education levels and incomes may be more attuned to cognitive deficits in their children. In fact, mothers from lower income households tend to have less stimulating parent-child interactions and monitor their children for less time (Crane & Heaton, 2007). Perhaps they are less aware of their children's subtle deficits in attention and EF. It is less likely that this correlation reflects a true link between SES and cognitive abilities, as performance on cognitive tests was more strongly associated with SES in the positive direction.

Dependent variables (i.e., social skills measured by observation, parent-report, and teacher-report) were also associated with numerous neurocognitive and family variables; health-related factors were not associated with any measures of social skills. Performance-based attention and EF was related to all three dependent variables. When correlated with observed social skills, effects were large; small-to-medium effects were found for teacher- and parent-report of social skills. Huang-Pollack and colleagues (2009) also demonstrated stronger links between performance-based EF and social skills rated by a third-party observer compared to parents or teachers. It has been suggested that parent and teacher measures of social adjustment may capture social traits that are less reliant on cognitive ability (Huang-Pollack et al., 2009). Trained research assistants may be particularly sensitive to the interactions between cognitive abilities and social skills, and they are less biased than parents or teachers who inherently draw on their experiences and perceptions of the child they are rating (De Los Reyes & Kazdin, 2005). Parent-reported attention and EF impairments were also related to parent and teacher report of social skills, such that children with greater social skills tended to have fewer cognitive difficulties. This finding is in line with research establishing the importance of attention and EF for effective social function (Mikami et al., 2007; Kiley-Brabeck et al., 2006; Rose & Holmbeck, 2007).

Family functioning measures were also cross-sectionally related to social skills in children with SB. Observed family cohesion and conflict were both positively related to observed social skills. It is not surprising that children from more cohesive families were also rated as more socially skilled, given previous findings in the literature (McDowell & Parke, 2009; Varni et al., 1996). However, it is interesting that youth with greater social

skills also tended to have families rated higher in conflict. Family conflict may help children with SB to develop skills that allow them to better manage conflicts encountered with peers (Floyd et al., 2009). Given the lower levels of family conflict in this population (Holmbeck & Devine, 2010; Holmbeck & Faier-Routman, 1995), families in this study with greater levels of conflict may actually experience conflict at similar levels to families of typically developing youth (Floyd et al., 2009). As bivariate correlational analyses did not allow for controlling other variables, it is possible that confounding variables partially account for this finding. For example, children with higher cognitive abilities or less severe conditions may be more likely to engage in conflict with their parents, which in turn could be related to greater social skills; however, in this study, neither neurocognitive nor health-related variables were related to family conflict.

Parent-reported social skills were also closely linked to family function. Children reported to have greater social skills tended to have families with greater observed cohesion and parent-reported adaptive family functioning. While consistent with the literature (Haven et al., 2014; McDowell & Parke, 2009; Varni et al., 1996), the correlation between parent-report measures is not surprising given the common method and informant for both variables. Parents who consider their family to function with more cohesion and less conflict could also be expected to rate their children as more socially skilled; indeed, parent perspectives and biases (e.g., negative, optimistic) likely permeate their ratings on both measures. However, the association between observed family function and parent-reported social skills suggests that children with SB with greater social skills are likely to come from more cohesive families.

Cross-sectional hierarchical linear regressions. Hierarchical linear regressions

were conducted using T1 data in order to control for covariates (SES, age, and sex). Both neurocognitive and family functioning domains were associated with children's social skills when covariates were controlled. Although relationships between individual independent variables and the dependent variables differed as a function of the measurement of social skills, it is clear that both neurocognitive and family function were related to children's social skills. Irrespective of age, sex, and SES, children with greater observed or parent-reported social skills tended to have better attention and EF skills and more adaptive, cohesive families. When teachers provided ratings on social skills, only neurocognitive variables were associated to children's social function. Teachers may be more aware of their students' cognitive abilities and may inherently consider them in their ratings of social skills. It is also possible that the social opportunities provided in the school setting are more closely related to cognitive abilities than family function.

Even when controlling for age, sex, and SES, health-related variables continued to show no significant association with social skills. In other words, condition severity and BMI were unrelated to children's social skills. In the SB population, weight status may not influence social function in the same manner as in typically developing youth (Goldschmidt et al., 2010). The CNS-component of SB may also undermine the effect of weight on social skills, as youth with neurological conditions have been found to experience the greatest social difficulties, even when compared to obese youth (Martinez et al., 2010). Similarly, condition severity does not appear to be related to social function either. Previous studies in this population have also failed to find links between condition severity and psychosocial outcomes (Hetherington et al., 2006; Holbein, Bechtel, Papadakis, Bruno, Zebracki, & Holmbeck, under review; Roache, 2012). It is also

possible that associations between condition severity and social skills are obscured by a marginality mechanism (Holmbeck & Faier-Routman, 1995). That is, youth with SB with more severe conditions may struggle socially due to mobility impairments, more health complications, and reduced opportunities for social interaction; at the same time, youth with less severe SB may also experience lower social skills if they feel they do not quite fit in with either typically developing peers or more disabled children. This curvilinear relationship would appear as a nonsignificant result in a linear regression analysis.

Longitudinal Analyses (Hypotheses)

Individual domains: Hypotheses 1-3. According to *Hypothesis 1*, greater attention and EF skills were expected to predict later social skills; this hypothesis was supported for two of three dependent variables. Considered together, these longitudinal findings extend previous research identifying cross-sectional associations between attention, EF, and social function (Jandasek 2008; Kelly et al., 2012; Rose & Holmbeck, 2007). The present study provides evidence for the notion that attention and EF influence social skill development in children with SB. As youth mature within the social context, it is apparent that their abilities to concentrate and perform higher-order cognitive functions facilitate greater acquisition of social skills.

Parent-reported social skills provided the only exception to the finding that neurocognitive abilities are longitudinal predictors of social skills. To identify potential reasons for this result, it is important to consider measurement characteristics. For both observational and teacher-reported ratings of social skills, T2 ratings are derived from different reporters than those at T1. In the case of parent ratings, informants at T1 and T2 (i.e., children's mothers and/or fathers) generally did not differ. Shared method variance

is partialled out in longitudinal analyses that include parent-report as the dependent variable. As such, there is little variance remaining after T1 parent social skills are entered, resulting in great difficulties actually finding the presence of an existing relationship between independent variables and T2 social skills. Informant characteristics may also be partially responsible for this discrepancy (De Los Reyes & Kazdin, 2005). For instance, parents may be less aware of or sensitive to changes in social functioning over time due to the day-to-day time spent with their children. As teachers and observational raters observed children in different contexts than parents, it is also important to acknowledge the possibility that informants based their ratings on perceived social characteristics rather than contextualized qualities associated with specific social skills (Gresham, Elliott, Cook, Vance, & Kettler, 2010). As discussed above, parent measures may also capture social skills that depend less on attention and EF skills (Huang-Pollack et al., 2009). Therefore, neurocognitive abilities may appear to show no relation to changes in parent-reported social skills over time.

Hypothesis 2 anticipated that family function at T1 would significantly predict later social skills. Results examining family variables altogether as a block did not support this expectation. Despite cross-sectional associations between family factors and social skills, family function did not appear to predict variability in social skills over time. Family function may be more important for short-term, rather than long-term, social adjustment. Improvements in family function may have more immediate effects on social skills. It is also possible that as children age and develop increasing autonomy, their family environments have less influence on their social skills (Kang et al., 2010). As children reach middle childhood and adolescence, their social circles become essential

determinants of their social skills and adjustment (Viner et al., 2012). A previous study by Ehrlich and colleagues (2012) found that adolescents with poorer social functioning were more likely to experience conflict in their relationships with *both* parents and close friends. Thus, family conflict may have differential effects on youth's social development, depending on both family and individual characteristics; some children may be more or less susceptible to the effects of family conflict.

Although the family domain as a whole did not predict social skills at T2, investigation of individual family variables demonstrated associations with later social skills in youth with SB. In line with previous research in typically developing samples (Barber & Erickson, 2001) and youth with SB (Jandasek, 2008), lower levels of observed family conflict at T1 predicted greater observed social skills at T2. It is plausible that children with SB growing up in conflictual family environments had few positive models of adaptive social behaviors, infrequent social opportunities (Repetti et al., 2002), poor conflict management skills (Herrera & Dunn, 1997), and a predisposition to conflict and hostile attributions (Ramani et al., 2010). Within the SB population, it appears that higher levels of family conflict have detrimental effects on multiple outcomes, including social skills, medical adherence (Stepansky et al., 2010), depression (Murch & Cohen, 1989), and adaptive parenting (Greenley et al., 2006).

Moreover, observed family cohesion predicted subsequent teacher-reported social skills. Similar to previous findings (Haven et al., 2014; Leidy et al., 2010; Sijtsema, Nederhof, Veenstra, Ormel, Oldehinkel, & Ellis, 2013), this relationship was in the expected direction, such that children with SB from more cohesive families were rated higher in social skills by their teachers. Consistent with developmental literature, children

with SB from more cohesive families may have had more opportunities to observe and practice adaptive social behaviors (Haven et al., 2014; Paterson & Sanson, 1999). It is also possible that family cohesion has an indirect effect on social skill development. For example, children with SB with more cohesive families may be at less risk for depression (Essner & Holmbeck, 2010), which is then linked to more prosocial skills and greater time spent socializing with peers (Segrin, 2000). Although the exact mechanisms underlying this association remain unclear, it is clear that family function is an important underlying factor of social skill growth in this population.

Per *Hypothesis 3*, it was expected that lower BMI and condition severity at T1 would be related to greater prosocial skills at T2; analyses did not confirm this hypothesis. Indeed, the literature contains numerous examples of research that has not found health-related variables to predict subsequent social function (Hetherington et al., 2006; Voorman et al., 2006; Wallander et al., 1989). Overall, it appears that health-related aspects of SB may be less important factors in the determination of social skills. Neither parents, teachers, nor third-party observer ratings of social skills were predicted by children's earlier BMI or condition severity (i.e., gross motor function and level level). Clearly, given significant findings for neurocognitive and family variables, the physical differences and variations in youth with SB play a much smaller role in their development of social skills.

All domains: Hypotheses 4-6. Again, the present study is perhaps the first to compare the influence of neurocognitive, family, and health-related domains on social skill development in youth with SB. In accordance with *Hypothesis 4*, analyses revealed that neurocognitive variables contribute most to social skills over time, although this was

not demonstrated for all dependent variables (i.e., parent-reported social skills). Indeed, neurocognitive function has been highlighted as a primary determinant of social development (Beauchamp & Anderson, 2010; Crick & Dodge, 1994; Yeates et al., 2007). Beyond the cross-sectional findings supporting the connection between attention, EF, and social skills (Jandasek, 2008; Lennon et al., 2015; Rose & Holmbeck, 2007), the present findings provide evidence for the influential role of cognitive abilities in the subsequent maturation of social skills in youth with SB. In this population, cognitive abilities appear to be a significant determinant of children's social skills. In order to interact competently in social interactions at home and at school, it is important for youth with SB to possess strong attention and EF skills. Given deficits in these cognitive skills in individuals with SB (Burmeister et al., 2005; Dennis et al., 2006; Hampton et al., 2011; Snow, 1999), it is not surprising then that social competence has also been identified as a concern (Devine et al., 2011; Holbein et al., 2015; Landry et al., 2013). As children grow, their cognitive strengths and weaknesses may shape their opportunities for socialization. For example, children who struggle with EF and attention may interact more with cognitively similar youth, resulting in fewer experiences with socially skilled peers. Further, specific social skills, such as clear expression of ideas, cooperation, and attending to a shared task, require strong attentional and EF skills (Holbein et al., 2015).

Attention and EF skills assessed via performance-based tests accounted for the associations between the neurocognitive domain and social skills after both the family and health-related domains were included in the model. It is well established that cognitive tests and parent-report of cognitive abilities offer unique information (Anderson et al., 2002; Ganesalingam et al., 2011). Performance-based tests allow for a more

objective measurement of cognitive abilities relative to parent report and may provide a glimpse at basic cognitive processes (Barkley & Murphy, 2010). Of note, many tests of attention and EF generally reflect cognitive self-regulation (e.g., abilities to inhibit behaviors, attend to a task), which is an important skill to utilize in peer interactions (Ganesalingam et al., 2006). Additional scrutiny of the neurocognitive tests utilized in this study reveal other parallels to social skills. Attention tasks assessed selective (TEA-Ch Sky Search, CAS Number Detection), sustained (TEA-Ch Score!), and divided attention (TEA-Ch Sky Search DT and Score DT). EF tasks measured working memory (WISC-IV Digit Span) and cognitive flexibility (D-KEFS Verbal Fluency). Social interactions require individuals to simultaneously focus on dynamic auditory (e.g., conversation, tone of voice) and visual information (e.g., facial expressions, gestures; Andrade et al., 2009; Kiley-Brabeck & Sobin, 2006). Successful social interactions also involve adaptable responses to changing situations and management of thoughts and emotions (Ganesalingam et al., 2011; Gilotty et al., 2002; Shields & Cicchetti, 1998). With regard to working memory, individuals must mentally keep track of social cues, ongoing events, and conversation details (Kofler, Rapport, Bolden, Sarver, Raiker, & Alderson, 2011).

The expectation that family variables would be the second best predictors of social skills over time (i.e., *Hypothesis 5*) was partially supported when comparing R-square change and F-change statistics across domains. Closer analysis revealed that observational characteristics of family function were predictive of subsequent social skills. First, parent-child interactions rated lower in conflict were related to greater observed social skills two years later, even when demographic, neurocognitive, and

health-related variables were controlled. Again, this result supports the notion that higher levels of family conflict are risk factors for social skill development in youth with SB (Jandasek, 2008). Regardless of SES, gender, age, neurocognitive ability (EF and attention), and health-related factors (condition severity, BMI), argumentative families appear to disadvantage children with SB in the context of their social skill growth. Although family conflict has been noted to provide opportunities for children to learn conflict resolution skills (Adams & Laursen, 2007; Floyd et al., 2009), the overall effects of family conflict in this population are somewhat detrimental.

Additional support for the importance of family function as a foundation for social skill growth is evident in the finding that greater observed family cohesion was predictive of greater teacher-reported social skills. Although this finding mirrors results from domain-specific analyses (i.e., Hypothesis 2), it is notable that this effect was found even after all covariates and other predictor domains were controlled. It is clear that family function, especially when observed in parent-child interactions, has major implications for children's future social successes. Indeed, the family context provides children with opportunities to observe and learn the fundamentals of social competence (Bennett & Hay, 2007; Repetti et al., 2002). While neurocognitive traits are essential for competent social interactions, family characteristics also play a key role in the acquisition of social skills in this population.

Consistent with *Hypothesis 6*, health-related factors contributed least to long-term social skill development. In fact, neither condition severity nor weight status was related to social skills over time. For youth with SB, physical characteristics of their health condition are far less influential for social competencies when compared to

neurocognitive and family functioning. Additional research also suggests that cognitive abilities, rather than markers of physical condition severity (e.g., lesion level), in this population have greater effects on outcomes (Holbein, Zebracki, Bechtel, Papadakis, Bruno, & Holmbeck, under review). As social skills are distinct concepts that are learned (Crick & Dodge, 1994), it makes sense that a child's cognitive abilities may supersede his or her physical limitations. Further, although weight has previously been found to affect social acceptance in this population (Essner et al., 2014), the perception of others (i.e., social acceptance) is quite different than the presence of specific skills. The process of acquiring and implementing specific social skills (e.g., defending opinions, making eye contact, tolerating disagreements) is dependent on cognitive abilities and a child's exposure to social skills within the family; physical characteristics do not seem to affect social skill acquisition in SB.

Findings must be interpreted with consideration to common method variance. Common rater effects (i.e., when informants provide data for both the independent and dependent variable) and measurement context effects (e.g., when different constructs are measured by the same medium, such as direct observation) contribute to systematic measurement error that may compromise the validity of study conclusions (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Parents' responses in this study may have been affected by social desirability, negative affectivity, or other biases (Spector, 2006). Results inherently influenced by shared method variance include: (1) cross-sectional correlations between observed family and social interaction characteristics; (2) cross-sectional correlations between parent-reported social skills and parent reports of family and neurocognitive function; (3) cross-sectional regression associations between parent-

reported family function, neurocognitive dysfunction, and SSRS-Parent report; (4) cross-sectional regression between observed family cohesion (FIMS) and prosocial skills (PIMS); and (5) longitudinal associations between observed family conflict (FIMS) and prosocial skills (PIMS; i.e., Hypotheses 2 and 5). Common method variance varies across research studies (Podsakoff et al., 2003), thus it is possible that the above findings indeed reflect true associations between constructs. In fact, it has been argued that common method variance does not automatically affect the legitimacy of conclusions as is often proposed (Spector, 2006). However, the potential for type 1 error cannot be ignored.

Of note, none of the results in support of a longitudinal relationship between neurocognitive abilities and social skills could be accounted for by common method biases. For instance, cognitive abilities were directly assessed via cognitive testing while social skills were either observed or reported by teachers. The conclusion that children's attention and EF skills are crucial to their development of social skills appears to be clear. Further, findings that observed family function predicted later teacher-reported social skills are also independent of shared method variance. The multiple informants and/or methods involved in these analyses certainly strengthen the validity of these findings.

Research Implications

The present study provides excellent support for continued integration of theoretical frameworks in psychosocial research. The social development of youth with SB is not attributed to any one domain. Rather, a child's social skills are the product of interacting influences of social (i.e., family), neurocognitive, health-related, and demographic factors (Holmbeck & Devine, 2010). In 2010, Holmbeck and Devine called for theory-driven models to drive the selection of hypotheses, methodologies, and

statistical analyses. Others have also advocated for integrative biopsychosocial models to drive research hypotheses (Beauchamp & Anderson, 2010; Yeates et al., 2007). Instead of focusing on isolated domains, the consideration and comparison of multiple conceptual domains allows for identification of the most salient predictors of social skills in this population. Although studies that hone in on specific predictors (e.g., attention, family conflict) yield important information, adopting a more global, comprehensive investigation of predictors provides helpful insight into predictors as they relate to each other. This determination of the most influential contributors to social skill development informs future directions for more focused research. For example, future studies may examine the interactions between neurocognitive abilities and family function in the development of social skills over time while fewer resources may be devoted to health-related variables.

Utilization of multiple methods and informants is a significant strength of the present study. Inclusion of observational, parent-report, teacher-report, and performance-based test measures provides a comprehensive view of neurocognitive, family, and health-related factors in youth with SB and their families. Each informant and method introduces valuable and unique information about the given construct, thereby enhancing validity of study findings (Noll & Bukowski, 2012; Renk, 2005). For instance, parent reports of attention provide a glimpse at children's attention in everyday life while cognitive testing illustrates concrete attention skills in the context of a fixed task. This approach also reduces the likelihood that shared method and informant variance can account for study findings (Holmbeck et al., 2002; Poksakoff et al., 2003). Reliance on a single reporter inherently incorporates bias into measurements, which is limited when

multiple informants are included in analyses (Gardner, 2000). The study also highlights the importance of observational measures of family and peer interactions. Despite the significant labor and cost (Matson & Wilkins, 2009), direct observation of interpersonal interactions captures valuable information that is often not otherwise assessed by questionnaire measures (Noll & Bukowski, 2012). Findings demonstrating the importance of neurocognitive and family functioning on subsequent social skills may not have emerged if a single method (e.g., parent report) had been used. In fact, observational and performance-based test data yielded more significant findings compared to questionnaire data on corresponding variables. Future psychosocial research in pediatric psychology must consider designs that incorporate innovative methodological approaches with a diversity of informants and methods.

Similarly, this study demonstrates the value of examining a given dependent variable (i.e., social skills) as measured by different methods and informants. Teachers, parents, and other observers often provide differing ratings of children's social competence (Renk, 2005). Reporters' ratings are infused by their own biases and observations of children's social skills in distinct contexts (e.g., school, home, community; Dirks et al., 2007; Gifford-Smith & Brownell, 2003). Study findings were relatively similar for teacher-reported and observed social skills; in contrast, social skills reported by parents were largely unrelated to independent variables. As Lennon and colleagues (2015) posited, parents may focus more on their child's physical health with less attention devoted to psychosocial functioning. Although all three dependent variables measured social skills, the specific social behaviors and characteristics assessed by each method were likely distinctive from one another. Correlations between all three

dependent variables support this notion. Again, it is also critical to acknowledge the role of shared informant variance for parent reports as well, as parent report at T1 partialled out significant variability of T2 social skills in longitudinal analyses. Social skills research requires multiple assessments of social skills to bolster the validity of study conclusions.

Closer examination of the observational peer interaction measure (i.e., PIMS Prosocial Skills scale) is warranted given its significant associations with multiple independent variables over time. This scale assesses both verbal (e.g., confidence in stating opinions, promotion of dialogue and collaboration, receptive to statements made by a peer) and nonverbal social skills (i.e., eye contact, shows maturity, listens to a peer). Children with poor verbal skills or those who are hesitant to speak may have deflated scores on this measure. Previous work has established significant correlations with other validated measures of social skills, including the Adaptive Behavior Assessment System (ABAS)-Social Skills scale, the Social Skills Rating System (SSRS) Cooperation and Self-Control scales; inverse associations were found between the PIMS Prosocial Skills scale and the CBCL Externalizing and Social Problems scales and the Children's Depression Inventory (CDI; Holbein et al., 2014). Despite these findings, it is important to acknowledge that the PIMS Prosocial Skills scale does not capture all facets of social competence. Further, the behaviors and characteristics included in this scale inherently require strong neuropsychological function. A prior investigation found that two scale items (i.e., maturity and promotion of dialogue and collaboration) were significantly related to performance-based attention skills (Holbein et al., 2015). However, parent- and teacher-reported outcomes (i.e., SSRS scores) have also been linked with attention and

EF (Rose & Holmbeck, 2007). Although the observational outcome variable may be a nuanced, or even imperfect, glimpse of children's social skills, it certainly offers valuable information via direct observation that is lacking in parent- and teacher-report measures.

The use of standardized scores for several study variables allows for comparison of youth with SB with typically developing samples. Parent-reported social skills of youth with SB tended to be slightly lower, although still in the average range, compared to normative samples. When teachers reported social skills, mean values were quite similar to typically developing youth. It is likely that these results provide evidence for subtle social difficulties in this population, in line with previous findings (Fletcher et al., 2004; Holbein et al., 2015; Landry et al., 2014). Parents may be particularly aware of their children's social difficulties. Although many youth with SB exhibit multiple adaptive social traits, standard deviation values indicate that a subset of youth also experience significant social deficits. These individuals may require increased support to achieve social milestones throughout development.

Further, standardized neurocognitive variables reveal sizable neurocognitive deficits. Mean scores on tests of EF and attention yielded values in the borderline to low average ranges. Parent-report on the BRIEF revealed slightly higher than average scores of EF dysfunction relative to normative samples, with standard deviation values indicating a subset of youth experiencing more significant EF problems. Study participants clearly possessed many of the EF difficulties characteristic of SB (Burmeister et al., 2005; Hampton et al., 2011; Rose & Holmbeck, 2007). These results support the generalizability of the study sample to the larger population of individuals with SB.

Clinical Implications

Study results can inform clinical practice in the medical and mental health fields. First, screening practices occurring within multidisciplinary medical clinics for individuals with SB may need to be adapted to account for information gleaned from the present study. Longitudinal associations between neurocognitive abilities (i.e., attention and EF), family function, and social skills reinforce the necessity of identifying children with SB most at risk for social deficits. When individuals with SB are noted to experience attention and EF deficits or problematic family function, it is important that medical and mental health providers assess and monitor social skills. Youth with SB who are identified as having difficulties with social skills can then be referred to appropriate therapeutic interventions, including social skills groups and outpatient therapy provided by a mental health professional.

Medical and mental health professionals are encouraged to assess their patients' social skills. Evaluation of social skills can be accomplished through validated behavior checklist questionnaires, clinical interviews, and behavioral observations (Dirks et al., 2007). There are a variety of parent- and self-report measures with subtests that measure social skills, including the Behavior Assessment System for Children, Third Edition (BASC-3; Reynolds & Kamphaus, 2015) and Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001), and Adaptive Behavior Assessment System, Third Edition (ABAS-3; Harrison & Oakland, 2015). A thorough clinical interview can also capture social skill proficiency. Providers are encouraged to inquire about both general social adjustment (e.g., friendships, getting along with peers, bullying) and social skills (e.g., conversational skills, immaturity, entering a social situation, social passivity; Holbein et

al., 2015). Moreover, providers can gain valuable information about a patient's social skills by carefully observing interactions between the patient, the clinician, and family members.

Treating youth with SB for inattention and EF deficits may have a positive influence on social skills as well. Children who receive behavioral treatment and/or stimulant medication in childhood may develop better social skills over time (Holbein et al., 2015). It is notable that treatment of core symptoms of ADHD has been shown to be related to greater social skills (Hoza, 2007; Pelham et al., 2014). Behavioral interventions for attention and EF skills are especially encouraged, given poorer responses to stimulant medications in SB relative to ADHD (Davidovitch, Manning-Courtney, Hartmann, Watson, Lutkenhoff, & Oppenheimer, 1999). Future research may examine potential links between pharmacological and behavioral treatment of cognitive deficits and social skills in this population.

In addition, this study emphasizes the need to select 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, it is important to implement social skills interventions that best fit the neurocognitive function in youth with SB. Social skills training programs validated in youth with attention and EF deficits may be particularly helpful for youth with SB. Indeed, multiple social skills interventions have been found to be effective for youth with ADHD (de Boo & Prins, 2007; Hannesdottir, Ingvarsdottir, & Bjornsson, 2014; Pfiffner et al., 2014) and autism spectrum disorder (DeRosier, Swick, Davis, McMillen, & Matthews, 2011; Laugeson, Frankel, Gantman, Dillon, & Mogil, 2012). Social skills interventions that are

implemented with little consideration to the unique needs of the population often produce less than ideal results (Gresham, Sugai, & Horner, 2001). To maximize intervention effects, care must be taken in the implementation of social skills programs that best fit the characteristics of youth with SB.

Study results also demonstrate the need to address family functioning for families of youth with SB. Again, less family conflict and greater family cohesion were linked with better social skills over time. Families of youth with chronic health conditions, such as SB, experience greater stress relative to families of typically developing youth (Bennet & Hay, 2007). In fact, families of youth with SB have been found to be less cohesive (Holmbeck et al., 2002). Although conflict tends to be lower in these families (Holmbeck & Devine, 2010; Holmbeck & Faier-Routman, 1995; Vermaes et al., 2007), identification of families in which conflict is exhibited at higher levels is important; these families can then be guided toward appropriate family interventions. Improving family relationships may have positive effects on children's development of social skills, as well as a multitude of other psychosocial factors, including psychosocial coping strategies (McKernon et al., 2001), externalizing behaviors (Lavigne et al., 1988), medical adherence (Stepanksy et al., 2010), and depressive symptoms (Murch & Cohen, 1989). Realistically, multiple outcomes could be combined into one family intervention package (Holmbeck, Greenley, Coakley, Greco, & Hagstrom, 2006).

There is very little, if any information, about the effectiveness of family-based interventions for families of youth with SB (Holmbeck et al., 2006). Stand-alone family therapy interventions have been shown to improve family functioning in families of youth with mental health concerns (Hogue, Dauber, Samuolis, & Liddle, 2006; Kumpfer,

Whiteside, Greene, & Allen, 2010) and chronic illness (Harris, Freeman, & Beers, 2009; Meyler, Guerin, Kiernan, & Breatnach, 2010; St. George, Wilson, Schneider, & Alia, 2013). Social skills interventions with parent or family components provide an additional avenue for targeting both family and social functioning. There is promising evidence for the effectiveness of parent involvement in social skills interventions (Karst, Van Hecke, Carson, Stevens, Schohl, & Dolan, 2015; Mikami, Lerner, Griggs, McGrath, & Calhoun, 2010). Further research is required to determine the optimal treatment methods specific for families of youth with SB.

Results from the present study also suggest that it is not useful to distinguish between certain health-related variables, such as condition severity or BMI, when screening for and treating social skills deficits in youth with SB. Interventions need not be delivered separately to families of children with varying levels of SB severity. Social skills development does not appear to be related to the SB-specific factors studied here. As social skills interventions are frequently delivered via group therapy modalities (Laugeson et al., 2012; Reichow, Steiner, & Volkmar, 2013), this conclusion maintains that there do not need to be separate groups for children with SB of varying condition severity (e.g., one group for children ambulating with wheelchairs versus a group for those who can walk). Youth with SB and their families, regardless of lesion level, gross motor function, or weight status, may experience similar levels of social problems and stand to benefit equally from interventions. Other SB-specific variables not studied here, such as secondary complications (e.g., urinary tract infections, pressure sores) and urinary and bowel continence, may affect social skills; additional research is needed to investigate other potential predictors of social skills that are unique to SB.

Limitations

The results of the present study must be interpreted in the context of its limitations. First, although efforts were made to examine multiple neurocognitive, family, and health-related predictors of social skills in SB, the variables included in this study are a small subset of relevant predictors; there are other variables associated with social skill development that were not analyzed in this research. For example, in addition to attention and EF, social cognition (e.g., theory of mind, social problem-solving, language pragmatics) and emotion recognition have been shown to significantly predict social skills (Beauchamp & Anderson, 2010; Izard, Fine, Schultz, Mostow, Ackerman, & Youngstrom, 2001; Roache, 2012; Yeates et al., 2007). Additional family variables that have previously been linked with children's social skills include parenting style (Takahashi, Okada, Hoshino, & Anme, 2015; Yeates et al., 2007), parenting acceptance (Putnick et al., 2015), and parental mental health (DeRose, Shiyko, Levey, Helm, & Hastings, 2014). In the health-related domain, negative effects of pain, sleep, and pubertal development on social development are well-known (Essner et al., 2014; May, Cornish, Conduit, Rajaratnam, & Rinehart, 2015; Mensah, Bayer, Wake, Carlin, Allen, & Patton, 2013; Palermo, 2000; Rosen, Storfer-Isser, Taylor, Kirchner, Emancipator, & Redline, 2004; Westling, Andrews, & Peterson, 2012). While it would have been interesting and informative to investigate additional factors, the number of variables was limited by power considerations and sample size. Future research with larger samples of youth with SB can examine associations between additional neurocognitive, family, and health-related predictors and social skills.

Measurement and methodological issues must also be noted. First, children's

height and weight were reported by their parents rather than collected via anthropometric measurement. Obtaining accurate height and weight data presents considerable challenges in a home visit setting for this population. A large specialized scale is required to weigh individuals in wheelchairs who are unable to stand on a standard scale. Further, precise measurement of height is complicated by abnormal spine curvatures (i.e., scoliosis, kyphosis). The literature on parent-reported height and weight data is mixed, with some studies demonstrating that parents are relatively accurate (Banach, Wade, Cairney, Hay, Faught, & O’Leary, 2007; Goodman, Hinden, & Khandelwal, 2000) and others finding errors that affect subsequent analyses (O’Connor & Gugenheim, 2011; Shields, Gorber, Janssen, & Tremblay, 2011; Weden, Brownell, Rendall, Lau, Fernandes, & Nazarov, 2013). However, given the differences in body composition and physical development inherent to SB, it is possible that parents in the present sample were less accurate. In an effort to maximize the validity of parent report, mother and father report of height and weight were averaged for each child (when available).

An additional measurement issue concerns the use of a social skills measure – the SSRS – developed for use in elementary-level children (i.e., those in grades kindergarten through sixth grade). Adolescents in this study were older than those intended for the measure. Examination of the items for both the parent and teacher versions suggests that the majority of items continue to be relevant to young adolescents, although one or two items may have appeared more appropriate for younger children (e.g., “accepts friends’ ideas for playing”). As standardized scores were used in this study, it must be acknowledged that adolescents were not included in the original normative sample for the elementary form (Gresham & Elliott, 1990). Therefore, higher ratings of social skills for

adolescents may have misrepresented actual social abilities. Correlations indicate that age was not significantly related to social skills assessed by either parent- or teacher-report on the SSRS (see Table 3), suggesting that adolescents may not have benefited from being older than the standardization sample. In an effort to reduce age effects, age was included as a covariate in analyses in which the SSRS was a dependent variable.

The aim of the present study was to examine global associations between predictors and social skills. While multi-method, multi-informant data collection is a strength of the study, data reduction procedures were required to maximize power. By combining several variables into larger composites (e.g., as with neurocognitive performance-based tests), it becomes impossible to disentangle associations between more specific constructs (e.g., shifting attention, sustained attention, working memory) or informants (e.g., mothers, fathers) and study outcomes. Research focused on specific domains is needed to further investigate relationships investigated here at a more detailed level. Nonetheless, a nuanced examination of very specific predictors of social skills was beyond the scope of the present study.

The lack of a comparison sample of typically developing youth and their parents precludes the ability to compare models of social skill development in youth with and without SB. Given the unique role of SB on psychosocial development, findings may be unique to children with SB and their families. On the other hand, the importance of neurocognitive and family functioning for social skill development may simply mirror normative developmental processes. It is likely that similar influences on social skills are present across multiple groups of children, as variables were selected based on the developmental and pediatric literature. In the future, research with other samples (either

typically developing or other pediatric populations) may attempt to replicate the findings presented here.

The wide age range of children in the present study (i.e., 8-15 years old at Time 1) is an additional limitation. Social skill development is a dynamic process that occurs over time. Therefore, it is likely that transactional processes arise with age, with different predictors and interactions influencing social skills depending on the child's age. It may be useful to examine age as a moderator in future social skills research. Alternatively, studies with larger samples sizes may be able to examine separate subgroups (e.g., pre-adolescents 10-12 years of age, early adolescents 13-15 years age, late adolescents 16-18 years of age) of youth with SB.

Future Directions

In addition to the suggestions for exploration noted above, additional considerations for future research are notable. Examination of interactions between demographic and predictor variables would provide rich information about the development of social skills over time. Potential moderators (e.g., age, gender, family conflict and cohesion) of the associations found in the current study may be a focus of future research. For example, given the role of neurocognitive and family function for social skills development, it may be of interest to examine an interaction between the two constructs. Family function could serve as a buffer for cognitive difficulties, such that children with poorer neurocognitive skills that are raised in cohesive, warm families may fair relatively well compared to youth with similar neurocognitive profiles and distant, conflictual families. In fact, Guralnick (1999) proposed similar interactions between cognitive and family factors. It may also be beneficial to identify profiles of children,

using cluster or discriminant analyses, across the continuum of social skill development. In other words, future research may address questions such as, “what combinations of characteristics are needed for a child to demonstrate proficient social skills?” and “are neurocognitive variables most influential for social skill development in some children with SB while family factors are most important for others?”

The current study examined social skill development over the span of two years (i.e., from Time 1 to Time 2 of the larger study). Prospective research may examine social skills over a longer interval of development. Building blocks of social skills, such as joint attention and social responsiveness, can be observed as young as infancy (Krog-Jespersen, Liberman, & Woodward, 2015; Valentino, Cicchetti, Toth, & Rogosch, 2011). Additional study of very young children with SB may help to identify the very beginnings of social skill development. Preliminary work suggests that preschoolers with SB experience subtle differences in social competence (Fletcher et al., 2004; Landry et al., 2013). Moreover, there is a considerable dearth of information about the social function of adults with SB. While the literature suggests that social difficulties remain in adulthood (Castree & Walker, 1981), adults with SB have also been found to report similar levels of social adjustment to their typically developing peers (Hetherington et al., 2006; Zukerman et al., 2011). Much is still unknown about the social competence of individuals with SB and related health conditions. Clearly, additional research is required to fully understand social skills and develop associated recommendations for intervention in this population.

Summary

Despite research documenting social dysfunction in youth with SB, little is known

about the etiology of these social difficulties. Most investigations identifying predictors of social deficits have concentrated exclusively on one domain. Utilizing a bioneuropsychosocial framework, this multi-method longitudinal study examines the relative predictive power of neurocognitive (i.e., attention and EF), family (i.e., family cohesion and conflict), and health-related variables (i.e., condition severity, weight status) on later social skills in youth with SB. It was hypothesized that neurocognitive variables would be the strongest predictors of social skills, followed by family and health-related variables. Results partially supported hypotheses. The neurocognitive domain significantly predicted observed social skills at T2 after controlling for covariates, family variables, and health-related variables. Further, analysis of F-change values also demonstrates the predictive power (in descending order) of neurocognitive, family, and health-related variables. Closer investigation indicated that performance-based tests of attention and EF, family conflict, and family cohesion have a key influence on social skill development in youth with SB. Weight status and condition severity were not significantly associated with social skills. Results differed based on the method and reporter used to assess social skills. To maximize effectiveness, social skills interventions must address attention and executive function as well as family interactions. Future research may investigate moderators of social skill development in this population. Examination of social skills into adulthood is also an area of prospective study.

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VITA

Dr. Christina Holbein graduated from The Ohio State University with honors and distinction in Psychology in 2008. Prior to graduate school at Loyola University Chicago, she worked at Nationwide Children's Hospital (Columbus, OH) as a research assistant and program coordinator on a study investigating social adjustment in youth with inflammatory bowel disease under the supervision of Laura Mackner, Ph.D. In addition, she served as a counselor at Dr. William Pelham's Summer Treatment Program at the University at Buffalo. Dr. Holbein is currently a Ph.D. student in the Clinical Psychology program at Loyola University Chicago. As a graduate student, she completed a psychotherapy practica at Loyola's undergraduate psychological Wellness Center and a pediatric neuropsychological assessment practica at Alexian Brothers Hospital – Center for the Pediatric Brain. In the area of pediatric psychology, she completed practica at Shriner's Hospitals for Children – Chicago and University of Illinois Hospital & Health Sciences System. Dr. Holbein also enjoyed training experiences as a neuropsychological assessment technician with Jacqueline Rea, Ph.D., of NeuroBehavioral Associates, and a research assistant under the supervision of Lisa Sorensen, Ph.D. of Ann and Robert H. Lurie Hospital for Children. Dr. Holbein completed her pre-doctoral internship at Nemours/A. I. duPont Hospital for Children in Wilmington, DE. Dr. Holbein's research with Loyola faculty advisor Grayson Holmbeck includes the investigation of social adjustment in youth with SB and measure development. She has published in the *Journal of Pediatric Psychology* and *Psychological Assessment*. Dr. Holbein graduated from

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