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Longitudinal Mediators of Social Problem Solving in Spina Bifida and Typical Development

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Objective: The current study examined the role of early executive functions (EF) and social language (SL) as well as responsive parenting as mediators of the effect of group on social problem-solving skills at 7 years of age for children with spina bifida and typically developing children. ***Method:*** A mediation analysis was used to determine if the effect of having spina bifida on school age social problem-solving skills was mediated through the effect of group on EF/SL at 3 years of age and responsive parenting at 12 and 18 months. As part of a larger longitudinal study, 103 infants (n = 49 with spina bifida; n = 54 typically developing) received measures of EF/SL at 3 years of age and mother-infant play interactions at 12 and 18 months of age were coded for a range of responsive parenting behaviors. Social problem-solving skills were measured with a game-like observational task at 7 years of age. ***Results:*** Group had a direct relation with later social problem-solving as well as an indirect relation through early EF/SL skills that, in turn, had a direct relation with later social problem solving. An indirect effect of responsive parenting on later social skills also was found through a direct effect on EF/SL skills. ***Conclusion:*** Early precursors of school age difficulties with social problem solving observed for children with spina bifida can be explained, in part, by difficulties in the first 3 years of life with EF/SL. Early responsive parenting appears to positively affect the development of these EF/SL skills. Implications for early intervention are an outcome of this study.

Keywords: spina bifida, social problem solving, executive functions, social language parenting, development

Impact and Implications

- This is the first longitudinal study from infancy into childhood in spina bifida and typical development that examines whether early executive functioning (EF) and social language (SL) from 3 years of age and early responsive parenting in infancy mediate social problem solving outcomes at 7 years of age.
- Given the increased difficulties individuals with spina bifida have in social situations in adolescence, identifying early precursors of later social functioning such as EF and SL and responsive parenting is critically important.
- The findings have implications for the types of early interventions that might help support the development of better social problem solving for children with spina bifida.
- By targeting training in early EF and SL and supporting parents to be responsive in their efforts to support these early cognitive processes for their children with spina bifida, later social deficits might be lessened.

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Introduction

Social problem solving is a specific aspect of social competence and includes the ability to read social cues, take others' perspectives, use inferential social reasoning, and alter behavior based on others' feedback (Astington & Jenkins, 1999; de Villiers & Pyers, 2002). In order to achieve social–cognitive autonomy and functional independence (Steinberg & Silverberg, 1986) children and adolescents must increasingly make their own judgments in social situations, take responsibility to work collaboratively with others in joint problem solving situations (Steinberg & Morris, 2001), and pay attention to how their behavior supports and preserves positive social relationships (de Villiers & Pyers, 2002). Many neurodevelopmental disorders are associated with limited autonomy and difficulties in social problem solving (Holmbeck et al., 2003). However, there is little information on the development of social problem-solving skills in neurodevelopmental disorders including information about early developmental precursors of social problem solving and potential protective factors in the child's early environment (Yeates et al., 2007). Understanding early precursors and protective factors associated with social problem solving in neurodevelopmental disorders is important for informing the timing and nature of early intervention. This article examines the early precursors of social problem solving for school-age children with spina bifida, a group at risk for difficulties with this skill (Dennis,

Landry, Barnes, & Fletcher, 2006; Fletcher, Dennis, & Northrup, 2000).

Social Skills Development in Spina Bifida

Spina bifida is a congenital neural tube defect affecting 0.3 to 0.5 per 1,000 live births in the United States (Williams, Rasmussen, Flores, Kirby, & Edmunds, 2005). It is associated with numerous central nervous system malformations including dysmorphologies of the cerebellum, anomalies of the midbrain and tectum, dysgenesis and/or hypoplasia of the corpus callosum, and aberrant development of the cerebral cortex (Juranek et al., 2008; Juranek & Salman, 2010) as well as white matter pathways (Hasan et al., 2008a; Hasan et al., 2008b) in areas of brain associated with processing and integrating information in social, cognitive, and linguistic domains.

Difficulties in social skills development, in psychological adjustment, autonomy, social competence, greater dependence on parents, and fewer friends and lower levels of closeness with best friends have all been reported for children and adolescents with spina bifida (Appleton et al., 1997; Blum, Resnick, Nelson, & St. Germaine, 1991; Devine, Holmbeck, Gayes, & Purnell, 2012; Friedman, DeLucia, Holmbeck, Jandasek, & Zebracki, 2009; Holmbeck et al., 2010; Holmbeck et al., 2003). A meta-analysis found social acceptance (how a child feels about how they get along with their peers) was lower for children with spina bifida (Shields, Taylor, & Dodd, 2008). These studies have either been cross sectional or have followed children across the early school years into adolescence. However, little is known about predictors in infancy and the preschool years that may impact later social functioning in this disorder.

Developmental Precursors of Social Problem Solving in Typical Development and in Individuals With Spina Bifida

Effective functioning in social problem-solving situations requires the integration of a range of abilities across social, cognitive, and linguistic areas of development. These include the child's ability to consider others' points of view (Tomasello, Kruger, & Ratner, 1993), evaluate what is required of them, (e.g., Astington & Jenkins, 1999; Hughes, 1998), attentional and working memory skills, and the flexible use of language (Eslinger, Biddle, & Grattan, 1997). To fully capture a child's competence in social problem solving, the use of observational paradigms that place demands on the integration of these abilities in natural social contexts may be preferable to conventional rating scales or questionnaires (Isquith, Gioia, & Epsy, 2004; Yeates et al., 2007).

Executive functions (EFs) are thought to be important developmental precursors of later developing social problem-solving skills although little is known about how specific aspects of EF and many social skills are linked (Rinsky & Hinshaw, 2011). Early EF skills are goal-directed behaviors that allow children to inhibit automatic responses in order to regulate their behavior to solve novel cognitive and social problems (Garon, Bryson, & Smith, 2008) and to formulate goals and sequence their behaviors to achieve these goals (Isquith et al., 2004). Early EF skills, along with pragmatic language abilities have been referred to as foundational for competence in social problem solving (Guralnick, 1999). In early childhood, EF skills can be measured with object search tasks where efficient performance involves searching new locations for a reward on each trial (updating function of working memory) and inhibiting going back to previously searched locations (inhibitory control aspect of working memory; Garon et al., 2008). Social language (SL) tasks often place demands on the child to hold information in memory and communicate it to another person (e.g., story retell tasks) or understand a series of rules or goals needed to carry out a social activity and provide this information to a naïve partner. As the first 5 years are critically important for the development of EF and SL skills, examining these skills during this early period for their relation with later performance on a novel social problem solving task is important.

Problems in the development of skills (e.g., executive functions, social language) considered to be necessary for competency in social problem solving have been documented for children with spina bifida including difficulties identifying and applying rules, difficulties in working memory, and in initiation (Fletcher et al., 1996; Rose & Holmbeck, 2007; Snow, 1999). Children with spina bifida also have difficulties with the regulation of attention and behavior in order to organize and execute complex chains of behavior (Buhrmester & Furman, 1986; Dennis, Landry, Barnes, & Fletcher, 2006) and with the flexible use of language to relay information in social contexts (Barnes & Dennis, 1998; Dennis & Barnes, 1993). In one study comparing adolescents with spina bifida with typically developing adolescents, EF skills mediated the relation between group and parent-reported social skills (Rose & Holmbeck, 2007). Given these findings it is important to examine relations between EF and social functioning longitudinally with measures of EF in early childhood.

Parenting and the Development of Social Problem Solving

The early caregiving environment supports the development of early EF and SL skills. Several studies have shown that when parents provide a specialized form of support, known as "responsiveness" through parental attention to children's signals and interests along with language and gestures tailored to the child's developmental level, children are able to accomplish goals at higher levels than they would be able to on their own (Bornstein & Tamis-LeMonda, 1989; Freund, 1990; Gauvain & Rogoff, 1989). Other studies report significant direct relations between early parental responsiveness with later developing aspects of EF (e.g., Hughes & Ensor, 2005), as well as indirect effects of this form of early parent support on later EF through its effect on language abilities (Landry, Miller-Loncar, Smith, & Swank, 2002). What have not yet been examined are the direct and/or indirect relations of early parental responsiveness on school-age social problem-solving skills and the extent to which early EF and SL skills are important in the process.

During preadolescence, higher levels of parent responsiveness are typically associated with better adaptive coping strategies (McKernon et al., 2001); however, parents of preadolescents and adolescents with spina bifida are found to be more intrusive, use higher levels of psychological control, and have more authoritarian parenting practices (Seefeldt et al., 1997). These types of parenting behaviors are associated with lower levels of decision-making autonomy (Holmbeck & Devine, 2010).

In very young children with spina bifida, higher levels and faster rates of cognitive and language development from early infancy through 3 years of age was observed for children whose mothers showed higher levels of support for their focus of attention in mother–child play interactions (Lomax-Bream et al., 2007). A reciprocal and sensitive parenting environment is known to positively influence the social development of other high risk children (e.g., very low birth weight; Landry, Smith, Swank, Assel, & Vellet, 2001; Landry, Smith, Swank, & Guttentag, 2008), and parenting interventions that increase levels of responsive parenting result in better social skills for these high risk children Landry, Smith, et al., (2008). Thus, it seems particularly important to understand the effect of the early caregiving environment on the development of EF and SL skills and later social problem-solving skills in spina bifida.

Current Study

The primary objective of this study was to determine whether social problem solving at 7 years of age differed in children with spina bifida (SB) and typically developing (TD) children. We hypothesized there would be group differences (SB vs. TD) in social problem solving at 7 years of age as well as in early executive function and social language (EF/SL) skills at 3 years of age and that these early EF/SL skills and later social problem-solving skills would be strongly related across time. Early EF/SL skills were measured through a construct made up of tasks that required working memory and response inhibition as well as tasks that required the flexible use of language in a social situation where understanding the perspective of another person was necessary for competency. Social problem solving at 7 years of age was assessed with an ecologically sensitive observation task that draws on a range of cognitive, linguistic, and social demands in order to solve a problem with others and which produces a single score representing one underlying behavioral construct (Landry, Smith & Swank, 2009).

We also sought to determine whether the relation of group to social problem solving at 7 years was mediated by the child's early executive function and social language (EF/SL) skills at 3 years of age and whether early parenting quality affected these relations. A schematic of these proposed relations is in Figure 1. We hypothesized that group would have both direct and indirect effects on social problem-solving skills at 7 years of age. Indirect effects were expected to occur through the effect of group on early parenting in infancy, and on EF/SL at 3 years of age that were, in turn, expected to relate to later social problem-solving skills at 7 years of age. Because early responsive parenting supports the development of early EF/SL skills, it was expected to directly relate to early EF/SL skills for both groups of children. It was also hypothesized that early responsive parenting would show an indirect relation to social problem-solving skills through its direct relation with early EF/SL.

Method

Participants

A longitudinal study followed 165 children with and without SB over the course of 10 years. From that sample, 62% (n = 103) completed all assessments necessary to be included in this study on social problem solving (49 with SB and 54 neurologically normal and typically developing (TD) children). Both groups of children included in this report did not differ significantly from the original sample of 165 children on any demographic or medical characteristics, including the percentage of children across the three ethnic groups, gender, and socioeconomic status (see Lomax-Bream, Barnes, Copeland, Taylor, & Landry, 2007). Also, as reported in this same earlier report on this sample, the control and SB groups continue to be comparable with each other on ethnicity and gender. Of the original sample, 85% were shunted for hydrocephalus compared with 82% of the children in the present report. The two samples are also comparable with the percent of those with shunts that required no or one shunt revision (72-original vs. 69-current) and those that required two or more revisions (28-original vs. 30-current). The children with SB were referred to the study at birth by treating neurosurgeons and pediatricians in Houston (Memorial Herman Children's Hospital and Texas Children's Hospital) and southern Ontario (Hospital for Sick Children, McMaster Children's Hospital, Thames Valley Children's Centre). TD children were recruited from well baby clinics and community organizations (e.g., community centers and churches). The sociodemographics of these two sites are different, which enhances the representativeness of the sample. The Houston site included many economically disadvantaged infants of Hispanic origin, in contrast to the predominantly White and middle socioeconomic status (SES) Ontario population.

Exclusionary criteria included uncontrollable seizure disorders, other known congenital anomalies, and significant sensory impairments (blindness, deafness). Typically developing (TD) infants

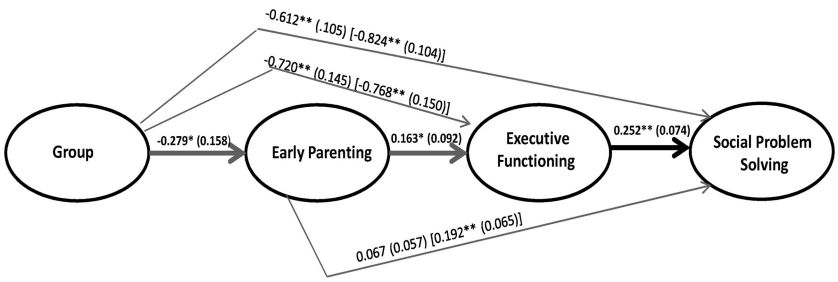

Figure 1. Mediation Model for Social Problem Solving. *Note.* Results are noted as follows: effect with mediators (standard deviation), effect without mediators (standard deviation). * $p \leq .05$. ** $p \leq .001$.

were recruited from well baby clinics, advertisements in newspapers, and local pediatricians. Exclusionary criteria for this group included the above, as well as no gross sensory or motor abnormalities. All of the infants with SB in this study had myelomeningocele. In terms of medical variables commonly used to characterize SB, 40 children were shunted for hydrocephalus (13 with no shunt revisions, 15 requiring one shunt revision, and 12 requiring two or more shunt revisions). Twelve percent of the children had upper level or thoracic spinal lesions (T12 and above) and 88% had lower level spinal lesions involving lumbar/sacral segments of the spinal cord.

Table 1 shows the distributions of gender, ethnicity, and SES, as assessed with the Hollingshead (1975) 4-factor scale. There were no group differences (SB vs. TD) in ethnicity, $\chi^2(103) = 2.83$, $p = .09$ or gender, $\chi^2(103) = 7.33$, $p = .06$. The majority of the participants were White followed by Hispanic, and other ethnicities. The control group had a higher SES than the group with SB, $F(1, 99) = 15.28$, $p < .0002$ reflecting the greater number of economically disadvantaged Hispanic children with SB in Texas.

Procedures

Infants were first assessed at 6, 12, 18, 26, and 3 years of age (see Lomax-Bream, Barnes et al. 2007 for reports on assessments from 6 to 3 years of age), and were continued to be assessed at 5, 7.5, 8.5, and 9.5 years of age. Assessments involved a number of standardized tests and observational measures. Assessments were conducted in testing rooms at each site, or in parents' homes depending on parent preference. Trained research assistants consented families and conducted the assessments, parent interviews, and other data collection procedures (e.g., coding, scoring). Researchers received close supervision by doctoral level (Ph.D.) research personnel with annual retraining to minimize drift. In addition, weekly research meetings were conducted at each site with monthly meetings conducted between sites by telephone to assure data integrity. All procedures for consenting and data collection were in compliance with the regulations of the institutional review boards located at each site.

Measures

Children in this study completed the following measures. They are described below in order by time point of assessment. Early responsive parenting was collected at 12 and 18 months of age, measures of early executive functioning were collected at 3 years of age, and the social problem-solving measure (Monopoly) was collected at 7 years of age.

Table 1
Means and Standard Deviations by Group

Variable	TD	SB
N	54	49
Ethnicity *n* (%)		
Caucasian	33 (61%)	28 (57%)
Hispanic	14 (26%)	14 (29%)
Other	7 (13%)	7 (14%)
Gender		
Female *n* (%)	23 (43%)	29 (59%)
Socioeconomic status	44.1 (14.0)	32.8 (15.8)

Note. SES reports mean (*SD*) based on Hollingshead Scale (1975). TD = Typically Developing; SB = Spina Bifida

Early parenting (12 and 18 months of age). This videotaped assessment evaluated child and mother interactions during an unstructured free play situation that lasted about 15 min at each visit. The dyads were left alone with a video camera in a room with chairs, a comfortable rug, and a small collection of toys/books selected to be appropriate for the child's age. Mothers were asked to play with their child as they might typically do in their home settings using as many of the toys as they wished. Maternal and child behaviors during play were evaluated for the last 10 minutes in order to allow mothers and their infants to become comfortable in the play context. Mothers were evaluated for the degree to which they accurately interpreted and sensitively responded to their children's social signals. A composite variable was used to represent responsive maternal behavior across time by averaging the mothers' scores on three scales of parenting behavior at 12 and 18 months. This summary variable included maternal warmth, contingent responsiveness, and degree of maintaining the child's chosen focus of attention. The Warmth scale evaluated the degree to which mothers demonstrated affection, praise, and enthusiasm toward their children. The Contingent Responsiveness Scale focused on acknowledging and responding to the child's emotional and social cues in prompt and sensitive ways that were in direct response to the child's needs. For instance, when the child appeared to enjoy a particular behavior (tone of voice, tickling, etc.) and the mother continued or increased that behavior, the mother received higher credit for responsiveness. Mothers who received high scores for Maintaining Attention were those who continued or enhanced the play with a toy in which their child had initiated an interest. Mothers received lower scores on this scale when they repeatedly attempted to draw the child's attention or focus their own attention on toys in which the child has not demonstrated an interest. On these scales, mothers could earn scores from 1 (*almost never*) to 5 (*almost always*) based on their patterns of interaction during each of two 5-min segments of the taped interaction. These measures of parenting have been used extensively in previous research with very low birth weight preterm and full-term infants where we have demonstrated acceptable levels of reliability and validity (Landry, Smith, & Swank, 2006; Landry, Smith, et al., 2008). In the current study, reliabilities were conducted using generalizability theory, which gives intraclass correlation coefficients. These were calculated to determine the reliability of the three parenting scales separately and overall. Interrater reliability for Warmth was .87, for Contingent Responsiveness was .63, and for Maintaining Attention was .89. The overall generalizability coefficient across rater and item (including both item and rater variance) was .86. The overall stability coefficient was calculated to determine stability of mother–child interaction across raters (.80).

Early executive functioning and social language (3 years of age). Three tasks tapped various aspects of executive functioning. Together the skills measured on these tasks were expected to capture the range of abilities hypothesized to be important foundation skills for later social problem solving including working memory/inhibitory control, the ability to develop and sequence behavior to carry out goals, cognitive flexibility in social situations, and pragmatic language skills. A second rationale for in-

cluding them in a composite is that a composite score is more reliable than individual measures as long as they are significantly correlated (see Table 2), as this enhances the variance that is in common among the separate variables.

The *Tea Party Task* measures cognitive flexibility in a social setting. In this task, the mother and child are seated at a child-sized table with dishes, cutlery, and snack food (i.e., small cookies or crackers). The mother plays at having a tea party with her child alone for 3 minutes. The examiner then asks permission to join and pretends to be naïve about the nature of tea parties and asks the child, "What do I need for the tea party?" The child is coded for the number of items he or she includes (cup, plate, spoon, and napkin). If the child does not include an item, the examiner provides up to three cues to see if the child will respond with the appropriate item [for example, Cue 1: Do I need something to drink from?; Cue 2: Do I maybe need a cup?; Cue 3: I think I need a cup. (examiner gets one his/herself)]. After the examiner has the basic items in place, h/she proceeds with three higher level items (i.e., water in cup, food on plate, napkin appropriate placement) and provides cues if needed and presents absurd situations. For example, the examiner says, "I'm going to do this now," and places the napkin on top of his or her head. She then asks, "Is this right?" If the child says "no" or provides corrective information he or she receives credit for "catching" the error. The task has two scores, (a) number of items provided and (b) proportion of errors. For this study, we used the number of items provided. This score includes the possible items (seven) and required cues. In this way, each of the seven items is scored on a scale from 4 to 0 (4 = *correct with no cues*; 3 = *correct with one cue*; 2 = *correct with two cues*; 1 = *correct with three cues*; and 0 = *incorrect with three cues*). We then applied a Rasch modeling procedure (one parameter, logistic IRT (Item Response Theory) model to generate a total score for each child (child level reliability = .79).

The *Story-Retell Task,* which places demands on attention, memory, and language, uses miniature Winnie the Pooh characters and play scene. First the examiner tells the child a story using 10 core elements (i.e., Pooh gets out of his hammock, he goes across the bridge, and he slides down a trunk . . .). The examiner replaces the characters and then asks the child to retell the story. The variable for this task is the total number of core story elements recalled. Children received credit for retelling story elements whether these elements were communicated orally or by gesture and the use of props. Because the score for this task is the sum of the individual story components, we used internal consistency reliability and determined the value to be .74.

The *Six Boxes Task* is a developmentally appropriate self-ordered pointing task assessing working memory/inhibitory control that requires the child to search for rewards in a group of six boxes. The child and examiner sit across from each other at a table with six boxes on it. First, the child watches the examiner hide a reward (a Cheerio) under each box. Next, a screen is held up to cover the boxes from the child's view for 5 seconds. The screen is removed and the child is then asked to find one Cheerio, representing one trial. Once the child finds a Cheerio, it is removed from the box and given to the child. The screen is again held up to block the child's view of the boxes. After 5 seconds, the screen is removed and the child is then asked to find another Cheerio. In order to do so, the child has to remember where they previously located the Cheerio and not look under the same box again (i.e., they have to inhibit looking under a box in which they previously located a reward). Trials proceed to a maximum of 20. The child's score on this is the total number of searches the child required to locate all of the rewards. Because the number of trials required varied from child to child, we used a split half method to estimate reliability, comparing odd numbered trials with the even numbered trials (reliability = .98).

Social problem solving task (Monopoly game; 7.5 years of age). The first part of this task included a 20-min teaching phase where one examiner acting as a "teacher," ensured that 18 key rules (i.e., items) needed to play Monopoly Jr. were known by the child. Of these, 12 rules had one part, three had two parts (e.g., 1–choose 10 ticket booths, that 2–match the color of your game piece) and three had three parts (e.g., 1–when you land on property you have to buy the property from, 2–the bank, and 3–put a ticket booth on the game board in the appropriate space).

While playing the game, this examiner narrated the key rules required to successfully start and then complete subsequent turns. To assess rule understanding, the child was asked to describe each rule as each came up in play. At the end of this phase, the examiner stated the need to stop and complete paperwork and asked the child to start the game again with a second examiner who "did not know the rules of the game." Children were asked to "teach the game" to this second examiner for an additional 20–25 minutes.

For the second part, the novice examiner did not make a move until the child provided a full explanation for the rule needed for that particular move or the maximum of three queries by the novice examiner was given. This procedure was used for each of the 18 rules. For example, the novice examiner would not place a game piece on the board until the child told her what to do (e.g., "Take one of these," "Pick a color"). For children unable to independently provide a full explanation, a maximum of three queries for each rule was used to elicit the necessary information. The queries increased in the specificity of information regarding the rule in question. Level 1 queries involved a vague question about what was required to move the game forward (e.g., "What do I do now?") and served as a prompt to the child regarding the examiner's need for information. If a full explanation was still not provided, a Level 2 query that oriented the child to an aspect of the rule in question but did not provide all of the necessary information was posed (e.g., "How do I know how many spaces to move?"). Thus, this query served as a "scaffold" to assist children who required more than a general prompt in order to fulfill their

Table 2
Correlations of Parenting, EF/SL, and Social Problem Solving Variables

Variable	1	2	3	4	5	6
1. Early parenting	—					
2. Story retell	0.18	—-				
3. Tea party	0.35**	0.43**	—			
4. Six-boxes	0.33	0.41**	0.39**	—		
5. EF/SL composite	0.23*	0.76**	0.78**	0.70**	—	
6. Social problem solving	0.23*	0.49**	0.43**	0.45**	0.55**	—

Note. EF/SL composite = Executive functioning and social language composite.
* $p \leq .05$. ** $p \leq .001$.

role as provider of information. If the child remained unable to provide a full explanation, a Level 3 query that offered all of the necessary information related to the rule and only required a "yes" or "no" answer was offered (e.g., "Do I move my game piece the same number of spaces that is on the dice?").

When a rule was inaccurately taught, the novice examiner played according to the rules the child provided irrespective of the number of queries given. If children were unable to explain four basic rules necessary to start the game (e.g., choosing a game piece, where to start on the game board, etc.) even when provided the maximum number of queries, the procedure was discontinued and these children were not included in data analyses. This resulted in the exclusion of four children.

Coding of observed behaviors in social problem solving task. For each of the 18 rules described above, three aspects of the child's provision of information was coded: (a) completeness of information (full, partial); (b) number of queries required (0, 1, 2, or 3); and (c) answer to Level 3 queries when required (agreed, denied). The scores for these three behaviors over the 18 rules for each child were used to obtain a single social problem score based on a Rasch modeling approach (child level reliability = .79). An item response theory 1-parameter logistic (Rasch) model was used to derive one score for children's performance on the social problem solving task that represented an underlying unidimensional continuum of skills (Andrich, 1998; Landry et al., 2009). A competency score from this task incorporated children's ability to take initiative, respond to verbal and nonverbal cues, and alter strategies given feedback from their partner such as when their partner appeared confused or hesitant, and provide such information in a clear and coherent manner. In previous studies, significant concurrent relations were found between this social problem solving task and the Tower of London and with a verbal reasoning task (Landry et al., 2009). Also, scores on this task at 8 years of age for children born very premature and for those born term have been associated at 13 years of age with peer-related social negotiation competence and with social problem solving with parents in a conflict resolution task (Landry et al., 2009).

Data Analyses and Results

Overview of Analysis Approach

To control for Type I error, a composite score was created for early EF/SL skills based on theoretical consideration of the underlying construct, relationship with the outcome, and significant correlations with each other. Six Boxes, Story Retell, and Tea Party were combined to create the EF/SL composite on the basis that they were significantly correlated with the social problem-solving task to the same degree, and were significantly intercorrelated (see Table 2). In addition, they each tapped into aspects of early EF/SL skills such as social language, working memory/inhibitory control, and rule-based problem solving. The early EF/SL composite was created by taking the average of the three individual variable components and the reliability of the composite is .65, with all three scores contributing to the reliability. The early parenting composite was created by taking the average responsive parenting ratings from the 12 and 18 month of age assessment time point (see Table 3 for means and standard deviations).

Table 3
Means and Standard Deviations of Measured Variables by Group

	Spina bifida (n = 49)	Comparison (n = 54)
Social problem solving	−0.46 (0.57)	0.37 (0.47)
Early EF/SL	0.58 (0.79)	1.35 (0.71)
Early parenting	3.55 (0.83)	3.83 (0.78)

Note. Early EF/SL = Early Executive Functioning and Social Language Skills. Ranges (early parenting scale from 1.00–5.00).

As is the case in our previous reports of development in children with spina bifida (e.g., Barnes et al., 2011), the analyses do not covary for IQ because (a) IQ does not meet the requirements for a covariate when applied to neurodevelopmental disorders in which IQ differences between groups are part of the disorder rather than due to problems in sampling (Dennis et al., 2009); and (b) IQ is not an explanatory variable in models of social cognition or development. The analyses also do not covary for socioeconomic status (SES) because historically SES is significantly related to parenting and is considered a marker for the quality of the caregiving environment rather than an explanatory factor. The inclusion of SES as a covariate would mask the role of parenting in understanding the relation between the parenting environment with the child cognitive processes being examined in the model (e.g., Elder & Caspi, 1988; McLoyd, 1990).

Mediation Analyses for Social Problem Solving

The purpose of mediation analysis is to determine if there is evidence of an indirect effect of some precursor variable on an outcome through its impact on an intervening variable. The goal of this analysis was to examine potential mediators for the effect of group (SB or TD) and parenting on social problem-solving skills as measured by the social problem-solving task. Our primary interest for an intervening variable was early EF/SL executive functioning and social language skills, which we have measured by creating a composite (described above).

To test for mediation, one must estimate the effect of the precursor on the mediator and (a) the effect of the mediator on the outcome with (b) the precursor variable in the model. The product of these effects (a * b) is the indirect effect. There are two basic ways of testing indirect effects: using normal theory or bootstrapping. We used a data resampling technique, bootstrapping, since our sample was small (e.g., 103 cases) and it does not require that the variables be normally distributed, which is often a problem when dealing with product terms. This also provides better power than some other methods, such as the Sobel test (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002), which is based on normal theory.

The process proceeds by taking samples of size n (where n is the sample size of the data) *with replacement* a large number of times (we use 5,000 replications) and estimating the parameters of the proposed model in each replicate. By considering confidence bands about the parameter using the estimates from 5,000 replications, it is possible to test whether the direct or indirect effects are un*likely* to occur assuming they are in fact zero (Preacher &

Hayes, 2004, 2008). If the confidence interval about the indirect effect does not contain zero, then there is evidence supporting a mediation effect. By examining the direct effect of the precursor etiology) on the outcome (social problem solving) while including the mediator (was early EF/SL executive functioning and social language skills) we can also determine if the mediation is partial or total. By dividing the mean parameters of the 5,000 bootstrap samples by the standard deviations of those estimates, we can determine an effect size similar to Cohen's *d*.

To test for the mediation of early parenting and early EF/SL, there had to be a relation between group and the potential mediators (parenting and EF/SL) and between group and the social problem-solving task. There also had to be a relation between the potential mediators and social problem solving (Baron & Kenny, 1986). The criteria delineated by Baron and Kenny (1986) regarding possible mediation were met for the relationship between the variables. Group (99% CI 2-tail [−1.071, −0.553]; Effect Size (ES) = −8.05) and parenting (99% CI 2-tail [0.020, 0.355]; ES = 3.02, $p = .01$) were both significantly related to scores on the social problem solving task when no mediators were in the model and early EF/SL skills [99% CI 2-tail (0.066, 0.435); ES = 3.50] also related to social problem-solving scores. The model that included the mediators showed group (99% CI 2-tail [−0.870, −0.337]; ES = −5.85) was still significant but parenting (ES = 1.44; $p > .05$) was not. Group had a significant indirect effect on social problem solving through its effect on early EF/SL (99% CI 2-tail [−0.395, −0.042]; ES = −2.65) but not through parenting (ES = −0.92, −0.86, both p values $> .05$) or parenting and EF/SL (ES = −0.92, $p > .05$). The total indirect effect size was −3.37 ($p < .05$, two-tailed). Parenting also had a significant indirect effect on social problem solving through early EF/SL (99% CI 2-tail [−0.006, 0.197]; ES = 2.05), but group did not have a significant indirect effect on early EF/SL through parenting (ES = −0.92; $p > .05$). In conclusion, both group and parenting had indirect effects on social problem-solving scores through their unique prediction of EF/SL, and group also had a direct effect.

Discussion

This study examined a key area of social development, social problem solving, that has received limited attention in neurodevelopmental disorders, including children with spina bifida (SB). A major objective was to determine whether SB, a common congenital disorder, explained variability in school-aged social problem-solving skills, when groups of children with and without spina bifida were included in a predictive model that also included early executive functioning and social language skills from 3 years of age and early responsive parenting.

The results show that group had a direct relation with the social problem-solving Monopoly task, even when early parenting and early EF/SL skills were included in the model. Specifically, children with SB had lower scores, and thus, had more difficulty on the task at 7 years of age. Higher scores on the social problem-solving task required integration across a range of social, cognitive, and linguistic skills, including goal-directed behavior, memory, flexible use of verbal skills, and perspective taking. Lower scores on this task were expected for children with SB given previous behavioral findings of difficulties in aspects of executive function and social language as well as regionally-specific aberrant brain development (Juranek et al., 2008; Juranek & Salman, 2010) and reduced integrity of fiber tracts associated with problems in the integration of information across social, cognitive, and linguistic domains (Hasan et al., 2008a; Hasan et al., 2008b).

The results also show that group had an indirect effect on ability levels on the Monopoly task through a direct effect on early EF/SL skills assessed at 3 years of age. Early EF/SL skills, in turn, had a direct effect on the Monopoly task. Thus, children's skills in the toddler period on tasks measuring working memory, social language, planning, and cognitive flexibility were found to be precursors to a task that required integration of these foundation skills at a later age. The model also showed that children with SB evidence measureable difficulties with these precursor EF/SL skills as early as 3 years of age. The EF/SL construct included three related tasks. One of these, the Six Boxes task was a search task that required attention, working memory, and response inhibition, and the Tea Party task placed demands on taking another's perspective, remembering a sequence of steps, understanding when rules were broken, and relaying the correct information to a "novice" partner. The final task, Story Retell, required attention, memory, and sequencing of events in a narrative. Identifying problems with these early precursor skills for young children with SB has implications for early interventions. Facilitation for the skills targeted in the early EF tasks might be implemented during early childhood when brain plasticity is primed for adapting structure and function in order to strengthen early on, some of the skills required for later more complex social tasks.

More recently there has been some attention to implementing interventions in early childhood that target EF skills, including self regulation, where teachers are trained to provide a range of scaffolds (e.g., language that supports regulation of attention and behavior) for young children's development of EF skills (*Tools of the Mind*, Barnett et al., 2008). Also, good efficacy has been demonstrated through responsive parenting interventions to increase high risk infants' and young children's attentional, social, and language skills (Landry, Smith, & Swank, 2006; Landry, Smith, et al., 2008). Additionally, a classroom-based prekindergarten intervention, Providing Alternative Thinking Strategies (PATHS), has shown effectiveness in supporting young children to inhibit automatic responses to difficulties in interactions with others (anger, hitting, withdrawal) by using strategies that help children implement more appropriate behaviors in social problem-solving situations (Greenberg, Kusche, Cook, & Quamnia, 1995). An important challenge for young children is to understand their own and others' behavior in order to learn to manage social situations. Therefore, early childhood is an ideal time for the implementation of interventions that facilitate early EF and social language skills, particularly for children that are known to have difficulties with later complex social situations.

The model also showed an indirect effect of early responsive parenting on the social problem solving task and this occurred through the direct effect of parenting on early EF/SL skills. This finding suggests the potential for responsive parenting to support very young children's development of the range of skills required in the early EF/SL construct. Higher scores on early responsive parenting required parents to respond promptly and sensitively to their child's signals and interests in ways that were contingent to what the child signaled they needed. This form of responsiveness is thought to support children's cognitive and social development

because it is tailored to each child's individual needs in ways that allow them to internalize their learning and then to generalize this learning to different situations. Although responsive parenting was important in understanding later social problem-solving skills, it did not mediate the relation of group on these later skills. That is group did not have a significant indirect effect on the social problem solving task through responsive parenting.

The model did show that parenting was at lower levels of responsiveness for parents of children with spina bifida. The increased challenge of parenting a young child with a disability and/or developmental problems is well documented (Landry, Taylor, Guttentag, & Smith, 2008). Specific problems reported for children with spina bifida in early childhood include motor problems (e.g., trunk control, locomotion, reaching/grasping) as well as deficiencies in visual perceptual and attention skills. These types of problems make it more difficult for a child to clearly signal their needs (e.g., interests, request for help) and, in turn, parents may not be able to interpret their child's signals accurately. When parents have more trouble reading children's signals the process of providing a prompt and sensitive response that is contingent on what the child signals may be disrupted.

It is important to emphasize that the variability in early EF/SL skills, which is related to social problem-solving scores and that is explained by early parenting is different from the variability in EF/SL skills that is related to social problem solving but which is due to group. In other words, although having a child with SB is associated with poorer parenting, higher quality parenting has an independent and positive effect on later social development through its impact on early EF/SL skills. The negative effect of SB on responsive parenting does not override the positive impact of good parenting on later social development. This would indicate that a responsive parenting intervention for parents with young children with SB could lead to better EF/SL outcomes and, in turn, better social problem-solving skills at later ages.

Together these results demonstrate the need for longitudinal information beginning in early childhood on groups of children with neurodevelopmental disorders such as those with spina bifida. These findings, based on studying children with spina bifida inform our understanding of the developmental processes associated with brain dysfunction and social development. Given the increased difficulties individuals with SB have in social situations in adolescence, including fewer friends than their peers and dysfunctional interactions with family members (e.g., Blum et al., 1991), identifying early precursors of later social functioning such as executive functions, social language, and early environmental factors, which can be targets for early intervention, is critically important.

There are several limitations to the current investigation. Although our sample size provided adequate power to test a mediation model that included early parenting and EF/SL, a larger sample would have allowed for examination of additional variables that may be important in understanding early predictors of social problem-solving skills in both groups. Also, although we examined factors in early childhood that mediate the effect of SB on social skills in middle childhood, further research is needed to examine whether these early factors and/or social problem solving in middle childhood are important for understanding social outcomes in adolescence. It will also be important to understand the role of parenting on social problem-solving abilities beyond the early childhood period. Given reports of slower trajectories of behavioral autonomy development from 8 years of age into early adolescence for children with SB, compared with their typically developing peers (Friedman et al., 2009), parental support for more social and behavioral autonomy during the transition into adolescence may help explain a more successful transition across these developmental periods. Another potential limitation was the use of a composite score for the three early tasks that assessed executive function and social language skills. They were combined, as this approach provides a more reliable score for correlated measures than including them separately, as it enhances the variance that is in common between the measures. However, a limitation of this approach is that a composite score does not allow the model to determine the unique contribution of each of the three tasks. As the analyses were longitudinal, a possible limitation includes the absence of a measure of each construct at earlier time points.

The findings of this study highlight the critical nature of factors in early childhood for understanding school age social difficulties reported for children with SB. Although interventions targeting social and behavioral difficulties in middle childhood and adolescence may be effective, there is a growing body of research demonstrating the importance of the first 3 to 4 years of life for programs that support cognitive and social development and the potential for parents and teachers in these early years to better assure normal trajectories of development that extend to later ages (Elman et al., 1996). Levels of behavioral autonomy and social skills are already at lower levels by 8 years of age for children with SB as demonstrated by the findings in the current study and those of Friedman and colleagues (Friedman et al., 2009). The current findings suggest the need to put programs in place for parents of children with SB during the very early childhood period to train them in specialized techniques that support the development of the range of skills associated with early executive functions and social language.

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