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Role of early parenting and motor skills on development in children with spina bifida

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Abstract

The impact of parenting and motor skills on the development of cognitive, language, and daily living skills was examined in 165 children (91 with spina bifida, SB), from 6–36 months of age. Motor scores significantly influenced cognitive, language, and daily living skills. Higher quality parenting was associated with higher levels of development and faster growth in cognitive and language skills for both groups. However, on daily living skills, an interaction among parenting, motor skills and group revealed that higher quality parenting was associated with higher levels and faster rates of growth only for the typically developing children with better motor skills. Early parenting style was found to have a directional impact (mother to child) on child development by 26 months of age. Results are discussed relative to intervention considerations for children with SB.

Keywords: Spina bifida; Parenting; Motor development; Language; Cognitive

1. Introduction

Spina bifida meningomyelocele (SB), a neural tube defect, is a relatively severe disabling disorder with a post-dietary fortification rate of 0.3–0.6 per 1000 live births (Williams, Rasmussen, Flores, Kirby, & Edmunds, 2005). Although the public perception of SB is focused on the obvious motor difficulties, SB is a disorder of both the spine and brain. The characteristic spinal lesion leads to varying degrees of paraplegia of the lower limbs. Children with SB are also born with congenital brain malformations involving the cerebellum, midbrain, and corpus callosum. About 80–90% experience subsequent hydrocephalus that requires shunt diversion. As a result, children with SB often have difficulties, as well as relative strengths, with the development of cognitive, language, and adaptive behavior skills. While these strengths and weaknesses are well documented in school-age children (Barnes & Dennis, 1992; Barnes et al., 2006; Brewer, Fletcher, Hiscock, & Davidson, 2001; Dennis & Barnes, 1993; Dennis, Landry, Barnes, &

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Fletcher, 2006; Fletcher et al., 1996; Fletcher, Copeland, et al., 2005; Landry, Robinson, Copeland, & Garner, 1993; Snow, 1999; Wills, 1993; Yeates, Fletcher, & Dennis, 2005), their developmental origins are not well understood.

Most of the central nervous system (CNS) manifestations of SB are present at birth, making it likely that the variable impact of these CNS anomalies on learning and social skills could be identified early in development. It has also been proposed that the degree to which children establish skills in one area of development (e.g., motor) may influence the degree to which they develop in other areas (e.g., broader cognitive and language skills; Thelen & Smith, 1994). The impact of environmental factors such as socioeconomic status and the quality of parental interaction experienced by children with SB is also likely to influence these developmental areas, particularly in terms of enhancing strengths and ameliorating the impacts of weaknesses in cognitive development.

Despite the nature and severity of the CNS manifestations, children with SB usually do not experience mental retardation. Nonetheless, they often show domain-specific strengths and weaknesses by the time they reach school age. In attention, children with SB have difficulties with focus and shifting, but not sustaining attention (Brewer et al., 2001; Dennis et al., 2005); action-based visual perception is weak, but the categorical perception is not (Dennis, Fletcher, Rogers, Hetherington, & Francis, 2002). Rule-based problem solving and performance that relies on the assembly of meaning from context is difficult, but rote learning is preserved (Barnes, Faulkner, Wilkinson, & Dennis, 2004; Barnes et al., 2002; Dennis & Barnes, 2002; Fletcher et al., 1996; Snow, 1999). Two-thirds of the children with this disorder develop problems in academic areas such as reading comprehension and math, but problems with word recognition are infrequent (Barnes & Dennis, 1992; Barnes et al., 2006; Fletcher et al., 2005).

The language profile for children with SB is especially striking. Although children with SB often have strengths involving vocabulary and grammar, difficulties with the flexible use of language in context are frequently identified in school-age years (Barnes, Johnston, & Dennis, in press). Children with SB have deficiencies in verbal abilities at the discourse level (Dennis & Barnes, 1993). When re-telling stories, they produced as many clauses as their peers, but were less efficient in their ability to relay information in a concise manner, producing fewer clauses that communicated the content of the story than did typically developing children (Barnes & Dennis, 1998; Dennis, Jacennik, & Barnes, 1994). Furthermore, the conversational responses of individuals with SB seem tangential (Dennis et al., 1994). Although motivated to interact, they have difficulty assembling verbal information to provide appropriate responses in quickly changing situations. Similarly, during discourse and text comprehension they have difficulty using the unfolding context to infer and revise meaning (Barnes et al., in press).

Another skill area that is important for optimal adaptation by the end of early childhood is the acquisition of independent living skills, which are also likely to be impaired in children with SB. Older children with SB tend to have difficulty regulating and organizing their behavior towards the achievement of particular goals, an important skill in the acquisition of daily living skills. For example, findings regarding the performance of school-aged children working on independent problem-solving tasks showed that children with SB had more difficulty maintaining goal-directed activities during play than did the IQ-matched control group (Landry et al., 1993). The two groups did not differ in the number of initiated activities or in the amount of time spent with the materials, but children with SB seemed to have problems sequencing their own behavior in order to reach goals. Their play remained at a simpler level throughout the task. In a study by Snow (1999), children with SB were found to exhibit severe deficits in visual planning and sequencing, compared not only with typically developing children, but also when compared with children with learning disabilities and/or AD/HD. This group of children with SB also demonstrated diminished problem-solving and abstraction ability, with highly perseverative response styles, suggesting a lack of mental flexibility in problem solving above and beyond that expect from general cognitive ability (i.e., IQ) alone.

Given the complex picture of cognitive strengths and weakness documented in school-age years for this group of children, an informative study of their early development requires full investigation of early, broad cognitive development and the factors that influence their various degrees of cognitive skill acquisition. In the absence of longitudinal studies, it has been difficult to establish at what age and via what processes these children begin to exhibit the kinds of later learning and social difficulties described by others. Few studies have examined children with SB less than 5 years of age (Morrow & Wachs, 1992; Nelson, 1980; Spain, 1974; Lomax-Bream, Barnes, Copeland, Taylor, & Landry, in press) and only one has taken a longitudinal perspective across early childhood to assess factors moderating early developmental competence (Lomax-Bream et al., in press). Present studies largely document that children with SB score lower than expected based on published norms and have better development of cognition and language than motor skills.

Despite deficits in cognitive, language, and daily living skills identified for children with SB, additional factors might influence the rate and level of development in these domains. As SB is associated with significant gross and fine motor impairment, the extent of motoric compromise may predict degrees of difficulty in other domains. For example, early motor deficits reduce exploration of the environment and, thus, may be related to cognitive abilities. Restrictions in exploration have been associated with compromised development of visual–spatial skills (Abercrombie, 1968) and problem-solving skills (Thelen & Smith, 1995). This research supports the idea that early motor achievements and motor-dependent experiences facilitate the growth of skills in other crucial areas of development.

1.1. Parenting

Reciprocal and sensitive parenting styles, such as those that involve warmth, accurate perception of young children's interests and needs, and responses that are contingent to those interests and needs consistently are associated with more optimal early development. Mothers who are warm and contingently responsive to their infants' cues presumably help them learn that they can have an effect on their own learning. In typically developing children, problem solving, cooperation, and assertion are facilitated by parenting that promotes autonomy and independence (Crockenberg & Litman, 1990; Weiss, Dodge, Bates, & Pettit, 1992). Some studies suggest that when the child has special needs, the influence of the parenting environment may be even greater than what is seen in typically developing children (Bornstein, 1985; Landry, Smith, Miller-Loncar, & Swank, 1997a,b). For children with SB, who presumably may have difficulty gaining a sense of autonomy over their learning due to motor, visual, and attention problems, this style of parenting may be particularly important because it strikes a balance between supporting their learning while still providing the children with some control over the process.

Studies of school-age children with SB show that parenting moderates the influence of SB on overall adjustment. In one study, parents of children with SB were more likely to be overprotective and attempt to exert more control over the children's emotions and behaviors. This finding may reflect difficulties accepting the child's condition and providing positive support and affection (Greenley, Holmbeck, Zukerman, & Buck, 2006).

While no longitudinal research currently exists that has examined the influence of these aspects of parenting in young children with SB, studies have already examined these parental influences in other medically at-risk children over time. For example, one study of full term versus premature children found that parental warm responsiveness across early development was associated with children's performance on standardized measures of both cognitive and language development (Landry, Smith, Swank, Assel, & Vellet, 2001) through 54 months of age. Relative to the full-term children, the premature children in this study fell even more dramatically behind when parental responsiveness was low. In addition, research on this at-risk population revealed that children whose mothers' early parenting was more responsive, more flexible, communicatively richer, and more attuned to their development, showed faster development of social initiative and better problem solving (Landry et al., 1997a,b) as well as enhanced daily living skills (Dieterich, Hebert, Landry, Swank, & Smith, 2004). Especially important to the goals of the current study, parenting and parental expectations about their children's development predicted children's development of daily living skills above and beyond the children's cognitive ability. This kind of early parenting likely facilitates greater learning because it creates an environment in which children can explore and learn how and why certain objects go together with other objects and actions, and links experiences together for children in ways that support their understanding of concepts and knowledge.

Given indications that children with SB exhibit a variety of developmental difficulties prior to school age, and that both degree of motor impairment and parental behaviors might moderate the expression of such difficulties, the current study had several goals. First, the current study evaluated the relation of early motor development and cognition, language, and daily living skills. We hypothesized that poorer motor skills would impact the development of cognitive, language, and daily living skills among children with SB. Second, the relation between early parenting quality and later development of cognitive, language, and daily living skills was examined. Based on findings with another group of medically at-risk children (Landry et al., 2001; Landry et al., 1997a,b; Dieterich et al., 2004), we anticipated that more responsive parenting that supported the children's goals during unstructured play would be associated with more progress in these domains across the first 3 years. Third, the direction of parent–child influence was evaluated. We anticipated that the direction of influence would be from mother's responsiveness to children's behaviors. Support for this conceptualization is found in previous studies with infants (Barnes, Gutfreund, Satterly, & Wells, 1983; Bloom, Rocissano, & Hood, 1976; Kuczynski, Kochanska, Radke-Yarrow, & Girnius-Brown, 1987; Landry, Garner, Swank, & Baldwin, 1996; Landry, Smith, Swank, & Miller-Loncar, 2000).

2. Method

2.1. Participants

The sample included 165 children, including 91 with SB and 74 neurologically normal, typically developing children. The children with SB were referred to the study at birth by the treating neurosurgeons and pediatricians in Houston (Memorial Herman Children's Hospital and Texas Children's Hospital), Toronto (Hospital for Sick Children), Hamilton (McMaster Children's Hospital), and London (Thames Valley Children's Centre). The sociodemographics of the Texas and Ontario sites were different, with the Houston site including many more children of Hispanic origins, in contrast to the predominantly Euro-American Ontario population. Although children were generally admitted to the study prior to 7 months of age, an unexplained decline in births of children with SB, which has not persisted, necessitated that infants with this disorder were permitted to enter the study as late as 18 months of age in a limited number of cases. Therefore, eight children began the study at 12 months and 33 entered at 18 months, with the other 50 children with SB all beginning the study at 6 months of age. All the typically developing children began the study at 6 months of age. Exclusionary criteria included uncontrollable seizure disorders, other known congenital anomalies, and significant sensory impairments (blindness, deafness). In addition, all infants in the study had to have gestational ages from 39–41 weeks, birth weight appropriate for gestational age, normal history of pregnancy and birth, Apgar score at 5 min of eight or greater, normal physical examination, and hospital discharge within 5 days of birth. Typically developing children were recruited from well baby clinics, advertisements in newspapers, and local pediatricians. Exclusionary criteria for this group included the above, plus the typical children also had to be free of gross sensory or motor abnormalities.

Table 1 provides descriptive data on participant sex, ethnicity, and socioeconomic (SES) status, assessed with the Hollingshead (1975) 4-factor scale. The demographic profile of this sample was consistent with the epidemiology of SB, including tendencies for more females and a greater representation of children who were Hispanic in the SB group (Northrup & Volick, 2000). Despite this, there were no significant differences by sex, $\chi^2(1, N = 165) = 3.27$, $p = .10$) or ethnicity, $\chi^2(1, N = 165) = 3.77$, $p = .16$, reflecting the separate matching of the SB and comparison groups in the two sites. However, as the Hispanic subgroup was lower in SES, groups differed on this dimension, $t(154) = 5.89$, $p < .0001$.

The children with SB were born with the most common and severe form of SB, meningomyelocele. The majority of the children ($n = 76$) had lower level spinal lesions below T12, with only 13 having upper level lesions (above L1), the differentiation at the thoracic level based on genetic (Northrup & Volick, 2000) and neuropsychological research (Fletcher et al., 2005). As is common with SB, 77 were shunted for hydrocephalus. Of the shunted cases, most (72%) had either no or one shunt revision, 28% had 2–5 revisions. Altogether, the sample is epidemiologically similar to school-aged samples from the same sites (Fletcher et al., 2005), except that the proportion of upper level lesions is somewhat lower.

2.2. Measures and procedures

Children were assessed in a series of laboratory visits, five times over the first three years of life (6, 12, 18, 26, and 36 months). These assessments involved testing the children on a number of standardized tests and other measures. The

Table 1
Descriptive statistics for sociodemographic variables by group

Variable	Control	Spina bifida
N	74	91
Ethnicity *n* (%)		
Caucasian	46 (62)	48 (53)
Hispanic	16 (22)	32 (35)
Other	12 (16)	11 (12)
Gender		
Female *n* (%)	31 (42%)	51 (56%)
Socioeconomic status *M*	44.0	29.7
SD	12.5	14.1

entire testing period tended to last about 2 h at the younger ages and about 3 h by the time the children reached 3 years of age. As part of this assessment, the children were administered the Bayley Scales of Infant Development and the Preschool Language Scale, Third Edition (PLS). The mother was administered the semi-structured interview for the Daily Living Skills subtest of the Vineland. The child and mother participated in a 15-min, videotaped free play with a standard battery of toys. The assessments were conducted in English or Spanish based on the language preference of the child and mother.

2.2.1. Bayley scales of infant development (Bayley, 1993)

The Bayley Scales were used to measure broad domains of motor and cognitive functions. These scales constitute one of the most widely accepted, comprehensive measures of child development from 1 month to 4 years of age. It consists of Mental and Motor Scales that are administered to the child. The Mental Scale evaluates a variety of cognitive, language and social skills. The Motor Scale evaluates skills requiring control of gross and fine motor skills. Bayley scores are typically reported in terms of index scores. These are calculated by comparing the child's raw score to age-appropriate norms. Index scores can vary from 50 to 150, with 100 being exactly average. Because of our interest in growth, mental age scores were analyzed.

2.2.2. Preschool Language Scale-III (PLS; Zimmerman, Steiner, & Pond, 1992)

The PLS-III measures early language development in young children from birth to 83 months of age. It tests a broad range of language skills, laying particular emphasis on Auditory Comprehension (AC, listening and understanding) and Expressive Communication (EC, speech and communication) skills. A scale for AC and one for EC skills are administered to the child by the examiner. A total score is then also calculated that reflects combined performance on both the comprehension and expressive components. Similar to the Bayley, raw scores are compared to age-related norms, yielding an overall index score that can vary from 50 to 150 (100 being exactly average). To assess growth, raw scores were analyzed.

2.2.3. The Vineland Adaptive Behavior Scale, Daily Living Skills subscale (Sparrow, Balla, & Cicchetti, 1984)

The Daily Living Skills subscale from the Vineland Adaptive Behavior Scale was used to assess the children's daily living skills. It includes items that measure cooperation and independence in feeding skills, independence in daily hygiene tasks, understanding value and function of money, communication regarding soiling, understanding which environmental cues signal danger, etc. The Vineland evaluates not only children's capacity to perform such self-care tasks at various levels of independence, but also evaluates the regularity with which the child actually completes the performance of these tasks. For example, items evaluate a range of degrees of independence in feeding skills from inquiry about whether the child indicates anticipation of feeding when a bottle or spoon is presented to whether the child adequately uses a spoon without excessive spilling, a fork, or even a knife. Children do not receive credit for items they perform only rarely, even though they obviously are capable of performing those items. The children can be given 0, 1, or 2 points on most items, so that a child who is beginning to master a task and/or performs it a little more than half the time might receive a 1 whereas a child who performs a task successfully on a very consistent basis might receive a 2. Raw scores were analyzed to assess change over time.

2.2.4. Mother–child coding

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 selected to be appropriate for the child's age, including a storybook, baby doll, bottle, toy truck, toy man to drive the truck, blocks, bucket, and visually engaging spinning. Mothers were asked to play with their child as they might typically do in their home settings using as many or few of the toys as they wished. Maternal and child behaviors during play were evaluated for the last ten 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 maternal behavior across time by averaging the mothers' scores on three scales of parenting behavior at 12 and 18 months in order to emphasize the role of a very early parenting. 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 towards their children. The 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 one (almost never) to five (almost always) based on their patterns of interaction during each of two five-minute 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 et al., 2000).

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 item 1 (Warmth) was .87; for item 2 (Responsiveness) was .63; and for item 3 (Maintaining) was .89. The overall generalizability coefficient of 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).

2.2.5. Data analysis procedures

Given that families were observed five times during the course of the study, a repeated measures type of analysis that assessed growth and level of development was most appropriate. SAS Proc Mixed was the statistical program used for all analyses. In order to examine the growth in child variables over time and to minimize the loss of data due to missing observations, a general linear mixed model analysis was used to model growth. In this model, the outcome is modeled as a function of age (level 1) and the parameter estimates from this function are modeled as functions of the independent variables (level 2). Thus, the primary research question assessed the development of cognitive, language, and daily living skills (level 1) and factors (etiology, motor development, family socioeconomic status, and parenting) that influenced these areas of development (level 2).

The first step was to identify the level 1 model. Because the current study examined natural development with no interventions, a polynomial form was selected over a piecewise linear model to capture what was expected to be a relatively smooth curve. Since the parameters in a polynomial model are interpreted at the point where the time variable is zero, the time variable was centered at 24 months. Thus, the intercept in the model represents the level of development when the children were 2 years old, the slope reflects the rate of change occurring at 2 years, and curvature also was defined at that point. A secondary advantage of choosing a middle time point was the reduction in the likelihood of multicollinearity in the level 1 model when curvature terms are present.

Preliminary examination of individual plots indicated that the data were curvilinear in nature. Therefore, a model was selected that included an intercept, slope (linear term), and curvature (both quadratic and cubic terms). Initially the intercept, slope and quadratic terms were allowed to be random and the cubic term was fixed. If the analysis showed the quadratic term to have minimal variance then it was fixed as well. Once the level 1 model was determined, the level 2 variables were introduced. This included the parenting score as well as the etiology and the interaction between the two. The Bayley motor score was added as a time-varying covariate as the children's scores changed over time. Higher order interaction terms were removed from the model if they were not significant and the final model was interpreted without these nonsignificant terms. The family SES was included in all models as a level 2 covariate. Site differences and age at study entry (6 months or 18 months) were also considered as covariates. However, no site differences were found above and beyond SES and ethnicity on any of the outcome variables, and no age of study entry differences were found. Therefore, models with site and age of entry were not reported. In addition, a cross-lag analysis was conducted to evaluate the relation between mother/child interactions and one of the outcomes being measured, language development.

3. Results

Tables 2 and 3 provide means and standard deviations by group and time for all outcome assessments and for parenting. Table 2 provides standard scores of mental and motor development for descriptive purposes as well as age

Table 2
Descriptive statistics for the mental scores by group and time (months)

		Bayley Mental Scale					
Etiology	Time	*n*	Mean *SS*	*SD*	*n*	Mean AE	*SD*
C	6	73	95.95	7.18	72	5.86	0.77
C	12	68	101.13	9.72	68	11.43	2.90
C	18	66	99.42	12.06	66	18.02	1.93
C	26	65	101.88	11.96	65	26.86	2.21
C	36	62	101.76	12.32	62	35.85	3.23
SB	6	45	85.38	16.26	45	5.04	1.41
SB	12	47	84.06	14.11	47	10.23	1.64
SB	18	83	78.60	17.09	83	14.71	4.22
SB	26	66	78.89	20.78	65	22.05	5.28
SB	36	54	80.57	18.61	54	29.46	7.19

Note. *SS* = standard score; AE = age equivalent; SB = spina bifida; C = control.

scores that were analyzed to avoid masking the true form of change with norm-referenced standard scores. Table 3 shows standard scores and age equivalents for the language and daily living skills measures and maternal ratings at 12 and 18 months. Whereas standard scores for typically developing children seem stable or slightly increasing, standard scores for those with SB tend to decline and appear less stable. This implies that the rate of growth in the group with SB is less than the average of each of the successive age-based cohorts, a hypothesis that was directly evaluated in the mixed model analyses. Specific results are presented separately for each outcome variable.

3.1. Bayley Mental Scores — cognition

In the level 1 model for the mental scores, the quadratic term variance was not significant, so this term was fixed. Both the quadratic and cubic term means differed from zero, however, so both terms were retained. When the Bayley motor score was entered as a time-varying covariate, it was also significant, $t(277) = 15.44$; $p < .0001$, and all the other parameters

Table 3
Descriptive statistics for language, daily living, and parenting by group and time (months)

		Preschool Language Scale-III					
Etiology	Time	*n*	Mean *SS*	*SD*	*n*	Mean AE	*SD*
C	12	66	99.83	13.83	66	6.34	5.86
C	18	67	99.64	17.73	67	9.63	8.09
C	26	62	106.94	14.71	63	22.76	11.29
C	36	60	108.33	17.77	61	38.50	9.69
SB	12	49	94.16	15.72	48	7.44	4.54
SB	18	79	85.81	17.53	78	9.32	6.48
SB	26	65	85.29	17.65	65	14.42	9.20
SB	36	59	84.81	20.83	59	21.94	13.81
		Vineland Daily Living Skills			Parenting		
Etiology	Time	*n*	Mean	*SD*	*n*	Mean	*SD*
C	6	61	7.23	2.19	69	3.82	0.71
C	12	66	14.38	3.56	68	3.81	0.71
C	18	66	21.35	5.87	67	3.82	0.72
C	26	62	25.21	8.00	65	3.83	0.70
C	36	62	38.39	11.55	63	3.83	0.70
SB	6	42	6.83	2.36	43	3.53	0.91
SB	12	48	12.17	4.36	47	3.60	0.93
SB	18	75	16.63	5.96	67	3.61	0.90
SB	26	66	22.42	8.18	54	3.67	0.93
SB	36	63	23.97	11.62	48	3.64	0.92

Note. *SS* = standard score; AE = age equivalent; SB = spina bifida; C = control.

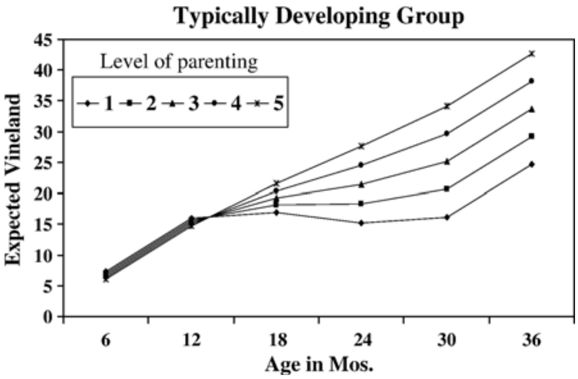

Fig. 1. Estimated growth in daily living skills by group in relation to quality of parenting.

remained significant. No interactions involving the parenting variable and etiology were significant, but several other results were significant. The level of mental age scores at 24 months did not differ between groups when the motor scores were controlled, and the rate at which the mental ages were increasing did not vary by etiology, $t(277) = 2.17$; $p = .14$, when family SES was in the model. Differences in family SES were associated with differences in growth rates with children from families of higher SES showing faster rates of growth in mental development, $t(277) = 3.59$; $p = .0004$. Thus, the mental development of the children was more highly associated with their family SES background and their motor skill development than etiology. This is probably due to the strong association between motor development and SB so that the presence of SB does not explain further variance when the motor scores are in the model. Differences in etiology for the cubic term were significant, $t(277) = 2.38$; $p = .02$. This means that while the typically developing children's mental scores are increasing somewhat faster at 2 years than the children with SB, the rate of increase is slowing.

Parenting, even with SES in the model, was positively related to the level of mental age scores at 2 years, $t(277) = 2.05$; $p = .04$, and positively related to the rate of growth as well, $t(277) = 2.29$; $p = .02$. The parenting variable also was inversely related to the cubic term, $t(277) = 2.02$; $p = .04$. Thus, higher quality parenting was associated with higher mental age scores at 2 years and faster rates of growth for both groups. However, those higher rates of growth are slowing more for those with better parenting. The lack of interaction effects means that these results are consistent for both the children with SB as well as the typically developing comparison group.

3.2. PLS scores — language

The smaller degrees of freedom in this analysis reflect that the PLS was not administered at 6 months. Language ages as measured by the PLS showed some curvilinearity. The mean of the quadratic term was significantly greater than 0, $t(146) = 5.34$; $p < .0001$, indicating that the slope was accelerating.

The Bayley motor score, when added as a time-varying covariate, was significant, $t(61) = 5.32$; $p < .0001$, and the remaining parameters retained their significance as well. Family SES also significantly predicted levels of language development $t(61) = 3.18$, $p = .002$. There were no interactions with etiology and parenting, indicating that any effects of either of these variables were consistent over the levels of the other. The final model revealed significantly higher levels of language scores for typically developing children as compared to those with SB, $t(61) = 2.77$; $p = .007$, as well as higher slopes, $t(61) = 2.90$; $p = .005$. As before, the typically developing children's language growth was accelerating faster, $t(61) = 2.75$; $p = .01$, but the rate of acceleration was slowing more, $t(61) = 2.06$; $p < .05$. Higher quality parenting predicted level differences $t(61) = 3.22$; $p = .002$ and faster rates of growth in language scores as well, $t(61) = 3.83$; $p = .0003$, and this finding was consistent for both groups (with or without SB).

3.3. Vineland Daily Living Skills scores

Vineland scores demonstrated substantial curvilinearity. While the quadratic term mean did not differ from zero, its variance did, $Z = 3.22$; $p = .0006$, and the mean of the cubic term was significant, $t(132) = 2.44$; $p = .02$. Thus, both terms were retained in the model.

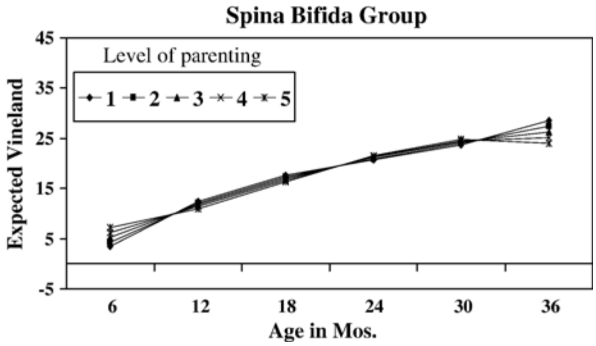

Fig. 2. Parent–child interaction on language outcomes.

Family SES did not predict the Vineland scores. There was a significant difference in the level of daily living skills between children with SB and normal children, $t(134) = 2.36$; $p = .02$. However, a 3-way interaction between the motor scores, quality of parenting, and etiology showed that for the typically developing children with higher motor scores, quality of parenting had the strongest predictiveness, $t(134) = 2.50$; $p < .02$.

In addition, this group had growth rates on the Vineland that were accelerating, $t(138) = 4.62$; $p < .0001$, as compared to children with SB. Finally, the rate of acceleration was increasing more for typically developing children, $t(138) = 4.34$; $p < .0001$.

These results can be seen in Figs. 1 and 2, with estimated growth of daily living skills across time points. While higher quality parenting predicted better daily living skills for the normal children there was relatively little difference between levels of parenting behavior and Vineland scores for the children with SB.

3.4. Bidirectional influence of child and maternal behaviors

The assumptions in these models have been that the maternal variables affect the child variables rather than the other way around. One way to investigate this assumption was through a cross-lagged analysis. Such a model tests paths from earlier assessments of the maternal variables to later assessments of the child variables and vice versa. This was done across three time points while allowing the constructs at the same time point to be correlated, that is not specifying a directional relation when the observations take place at the same time. The language measure was chosen as the outcome since it may be more amenable to maternal impact and was not subject to maternal report.

The results of the path model showed that the model was a good fit to the data, $\chi^2(4) = 2.29$; $p = .6819$; CFI = 1.0; TLI = 1.049; RMSEA = 0.00. Both the 12-month language assessment ($Z = 7.997$; $p < .0001$) and 12-month maternal parent–child rating (PCR) average ($Z = 2.803$; $p = .0025$) were significantly related to 18-month language. In addition,

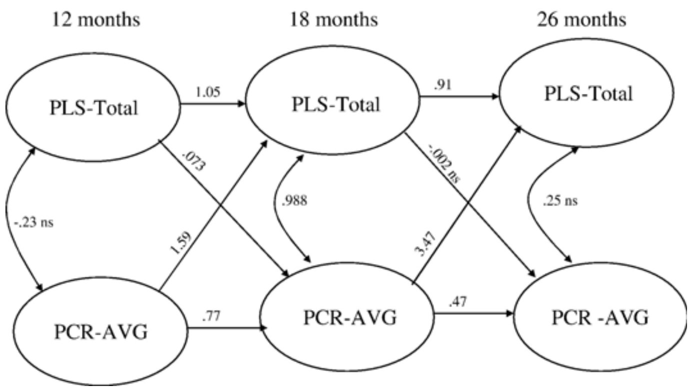

Fig. 3. Bidirectional impact of parent–child interaction on language.

both the 12-month maternal parent–child ratings (PCR) average, $Z = 6.121$; $p < .0001$, and the 12 month language assessment, $Z = 2.494$; $p = .0063$, were related to the 18-month maternal behavior. However, while the 18-month language assessment, $Z = 4.451$; $p < .0001$, and the 18-month maternal PCR average, $Z = 3.296$; $p = .0005$, were significantly related to child language, only the 18-month maternal PCR average, $Z = 3.504$; $p = .0002$, was significantly related to the 26-month maternal PCR average. Language and maternal behavior was not correlated at 12 months and the disturbance terms were not related at 26 months but the disturbance terms at 18 months did show significant covariation, $Z = 2.656$; $p = .0040$; $r = .46$. Thus, there is some indication that while maternal and child behaviors may impact each other early, as the child gets older, this relation becomes one of mother effects on the child (see Fig. 3).

4. Discussion

This study adds to the sparse research on early development of children with SB by considering the impact of parenting style and motor skills on the early development of cognitive, language, and daily living skills in children with and without SB. The results show that difficulties with these broad areas of development are measurable in all these domains and persist across early childhood. Moreover, parenting style was a significant moderator and motor functioning was a significant time-varying covariate in all three domains. Socioeconomic status, the other time-varying covariate, was significantly related only to cognitive and language skills. Interestingly, although motor functioning accounted for significant variability in cognitive, language, and daily living skills development, the parenting variable predicted important aspects of these developmental domains even when motor skills were controlled in the models. Thus, these results support Dennis et al. (2006) in identifying environmental factors that moderate cognitive outcomes.

The analysis of parent–child interaction was conducted using language as an outcome since this variable was believed to be more amenable to maternal impact and was not subject to maternal report. Our findings suggested that the interaction between parent and child is bidirectional early in development (12–18 months), but by 26 months, the direction of this relation becomes one of mother to child. Overall, these results help to strengthen the findings related to parenting style as a moderator for developmental outcomes across several high risk conditions.

In regard to cognitive development, motor functioning entirely accounted for any group differences by virtue of etiology, with motor functioning significantly relating to cognition in both groups. This finding demonstrates that motor skills help to explain cognitive skills similarly for typically developing children and those with SB, and having SB does not contribute to the variance in cognitive skills above and beyond motor skills. It is difficult to fully interpret these findings and tease apart the differences in mental and motor functioning in infancy, especially with mental measures that often rely on motoric abilities at this age. Despite this limitation, this finding is consistent with the emphasis other researchers have placed on the influence of early motor development on emerging cognitive skills (Bushnell & Boudreau, 1993; Gibson, 1982; Thelen & Smith, 1995). For example, the timing of the crucial motor milestone of self-generated locomotion (crawling, walking) affects the development of perceptual cognitive skills, such as the shift toward coding locations in reference to landmarks rather than to the self (Bertenthal, Campos, & Barreto, 1984). The present findings, with the inclusion of a group of children with severe motor delays, further establish the importance of early motor development for different aspects of cognitive development.

When looking at the influence of motor skills on language development, children with SB exhibited lower levels and slower growth even when motor functioning was included in the model, although the effect of motor skills was also significant. Thus, in contrast to cognitive skills, information about both a child's etiology and motor development explains more of the variance in language development than knowledge about motor development only. A similar finding was found for daily living skills, as the significant group differences also were apparent when level of motor skills was in the model, showing that the typically developing children demonstrated higher levels and more acceleration in their growth. Thus, while motor development was a significant time-varying covariate in all three of the outcomes measured, it appeared to account for group differences in cognitive development, but not in language or daily living skill development.

The role of parenting as an influence on cognitive development also appeared to be similar for children with and without SB. This finding is somewhat different from research on other medically at-risk groups, which has shown that children at medical risk are often even more developmentally responsive to the quality of parenting they receive (Landry et al., 2001). Nonetheless, the present research found that both groups showed higher levels and faster rates of growth with higher quality parenting even when level of motor functioning was already statistically controlled for in the model. Furthermore, the role of parenting is especially impressive here given that SES, often viewed as a distal marker for quality of parenting, was also significant in the model. For a sample that included children with SB, who often have profound motor difficulties, the potential of parenting to improve child cognitive outcomes above the level predicted by motor impairment and families' economic backgrounds is encouraging.

Parenting quality also had an impact on the development of early language skills in both groups of children, relative to motor functioning and family SES. In addition to family SES, the quality of early parenting provided further information about individual differences in the level and rate of language development, with higher levels and faster rates found among the children receiving higher quality early parenting. Again, the lack of interactions between the parenting and etiology variables suggests that higher quality parenting at early ages was comparably predictive of faster rates of growth for both children with and without SB.

In contrast, parenting quality had a varied impact on daily living skills as evidenced by the significant interaction involving parenting, group, and motor abilities. Interestingly, higher quality parenting at 12 to 18 months of age was associated with significantly higher levels of daily living skills only for the typically developing children with the strongest motor skills. This interaction suggests a finding in the opposite direction of the study of premature children by Landry et al. (2001). It is possible that the motoric complications indicative of SB are harder to influence at this early age. Evaluating these same children as they get older may produce different results. It is important to note that several of the daily living items from the Vineland are especially difficult to master for children with SB. For example, there are several items in the set administered by 3 years of age that inquire about the child's independent toileting skills. Because of the spinal lesion, children with SB are extremely unlikely to acquire bowel and bladder control regardless of any parenting experiences at any age, much less take care of all their toileting needs independently. It is possible that other parenting factors aside from those measured here may be more sensitive to changes and growth in skills such as toileting. For example, items that can be quite difficult to master for children with SB may be more related to parents making accommodations in their homes that would be necessary to permit independent and regular execution of the skills evaluated. For instance, families living in very small apartments that are not accessible for people with physical disabilities often use wheelchairs only when they leave their homes. It is often easier for these families to let their children sit or scoot/crawl on the floor while at home, but tasks such as getting one's own drink of water, helping in simple food preparation, or setting the table are difficult to complete from the floor level.

The finding that parental style impacted daily living in typically developing children but not those with SB has important implications for intervention, and suggests that it is important to educate parents, evaluate the physical environment, and help parents modify expectations to accommodate these physical and environmental barriers. Even for families that are able to make more accommodations to support their children's growing ability to care for their own basic daily needs, some sensitive parents may find it emotionally difficult to push children with SB to persist at acquiring skills that are difficult and perhaps distressing for them. Furthermore, the parenting styles measured in the current study are those that tend to occur naturally, without any special parent training. The acquisition of daily living skills for children with SB may be so challenging that parents need special training to help clarify appropriate expectations for independent self-care abilities and further support to effectively guide their children to reach such expectations.

The parenting variable measured here involves the degree to which mothers accurately inferred and sensitively, promptly responded to the social and emotional signals of their children, as well as to their children's visual foci of attention. To score high on this scale, mothers must be adequately attuned to the wants, needs, and interests of their very young children and must also relate to their children's perspectives in order to respond patiently and warmly even when the children's signals are inconsistent with their own wishes or concerns. Children who experience this kind of parenting early in development may feel more confident that their internal experiences and indicated interests are valid and will be accepted and positively responded to by adults. Such experiences may help the children see themselves as active learners, encourage more exploration, and support more mutual conversation with adults from which the children can learn more language. Thus, it is not surprising that this kind of parenting would support high levels and/or faster rates of growth in areas such as cognitive and language development. In fact, this style of parenting may even permit these children to make stronger assumptions about their own capacity for independence and take more risks towards independence.

The current study has limitations. The parenting style measure is based on a highly overt (videotaped) short term (15 min) observation of mother–child interaction. While this is a procedure that is often used in the literature it has problems, a major one being the question of how representative mother–child interactions assessed with this procedure are of naturally occurring interactions in the home. It is possible that the types of interactions observed would not generalize to interactions assessed at home. Another limitation is that only early parenting was used in the models. It is possible that parenting during the toddler–preschool period could be more important, especially for the development of daily living skills in children with SB, than parenting during infancy and early toddlerhood. In addition, these children have not yet been followed into school years and the study therefore cannot speak to whether early parenting predicts the kinds of outcomes in children's development that might emerge in early school years. The persistence of these problems was therefore beyond the scope of the current study.

Nonetheless, this is a diverse prospective sample of children with and without a relatively common birth defect that has been established to have broad-reaching consequences for children's motor, cognitive, and social development by the time they are established in the school system (Dennis et al., 2006). Very little work to date has focused on the early developmental experiences of this group of children, let alone how their well-established motor difficulties might influence other areas of development, or how early parenting experiences might or might not compensate for these motor difficulties. Most importantly, the current study would suggest that early warm and responsive parenting can influence mental and language development in children with (or without) SB even when the influence of motor skills and family SES are statistically controlled.

The current study supports particular directions for parent training that could benefit many children, but particularly children with SB. The warm, responsive parenting style measured here appeared to be quite valuable for the cognitive and language development of both groups of children evaluated. However, this style was associated with enhanced outcomes in the independent, regular performance of daily living skills only for typically developing children with strong motor skills. It is likely that children with SB may benefit when their parents receive not only general training to correctly identify the interests, support the feelings, and respond to the communications of their infants and children, but also specific training to coach their children through the acquisition of daily living skills. Both early childhood intervention specialists and parents may need to give careful, individually appropriate attention to which kinds of tasks a particular child with SB can and should attempt to master at ages comparable to his or her peers. However, even when appropriate daily living skills are identified for mastery, parents of children with SB may need extra instruction, support and encouragement regarding the process of teaching and ongoing support their children will need to actually achieve such goals.

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