Constructing a Prospective Model of Psychosocial Adaptation in Young Adolescents with Spina Bifida: An Application of Optimal Data Analysis

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Objective To examine how individual- and family-level predictors in late childhood and preadolescence relate to psychosocial adaptation (i.e., scholastic success, social acceptance, and positive self-worth) in early adolescence. **Method** This prospective longitudinal study includes 68 families of children with spina bifida and 68 comparison families of healthy children. Multimethod, multiinformant data were evaluated via optimal data analysis (ODA) and classification tree analysis (CTA) techniques. **Results** Factors best predicting psychosocial adaptation in early adolescence included (a) intrinsic motivation, (b) estimated verbal IQ, (c) behavioral conduct, (d) coping style, and (e) physical appearance. There were no significant group (spina bifida vs. able-bodied) effects. **Conclusions** The final classification model correctly classified 77.8% of the total sample, indicating that this model had significant predictive capabilities. Results suggested that processes leading to psychosocial adaptation may be similar for youth with and without chronic illness.

Key words adaptation; adolescence; optimal data analysis; psychosocial; spina bifida.

The transition from childhood to adolescence has been widely studied in the field of psychology. Understanding the integration of individual development, timing of a transition, and the social/emotional context in which a transition takes place is central to our understanding of adolescent development (Graber & Brooks-Gunn, 1996; Steinberg, 2002). Yet there remains limited information regarding how the dimensions of adolescent development combine to foster pathways to psychosocial adaptation. The attainment of psychosocial adaptation during the transition to adolescence may be particularly challenging for children and families who must cope with the presence of a chronic illness or disability, such as spina bifida (SB). The purpose of this study is to identify family- and individual-level characteristics (Table I) that most strongly promote the development of psychosocial adaptation (Table II) during the transition to adolescence in families of children with SB as compared to their able-bodied (AB) counterparts. Optimal data analysis (ODA) procedures and classification tree analyses were used to determine the most salient predictors of psychosocial adaptation for groups and subgroups of this sample (Soltysik & Yarnold, 1993).

This investigation includes a sample of youth with SB, a congenital birth defect caused by failure of the spinal vertebrae to close properly during gestation. SB is one of the most common birth defects, occurring in approximately 1 of every 1,000 births (McLone & Ito, 1998). The severity of this defect varies considerably depending on both where the lesion occurs in the spinal column (e.g., thoracic vs. sacral) and the extent of associated neurological complications (e.g., hydrocephalus; McLone & Ito, 1998). Typically, children with SB have diminished urinary and bowel control and often require the use of leg braces or a wheelchair to ambulate. Research suggests that those who have a physical disability such as SB may develop along different, and often less favorable, psychosocial trajectories than their AB

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Table I. Predictors of Psychosocial Adaptation

Scales and subscales (total number of subscales)	Reporter (total number of reporters)	T1 and T2 combined? (number of time points)	Number of predictors
Demographics (subscales: group, gender, parent marital status, SES, ethnicity) (5)	Mother (1)	Yes (1)	5
Family-level predictors			
Conflict			
PAC: Parent–Adolescent Conflict (subscale: intensity rating) (1)	Mother, father (2)	Yes (1)	2
	Child (1)	No (2)	2
FES: Family Environment Scale (subscale: conflict) (1)	Mother and father combined (1)	No (2)	2
Macro Coding (subscale: conflict composite) (1)	Rater (1)	Yes (1)	1
Cohesion			
FES: Family Environment Scale (subscale: cohesion) (1)	Mother and father combined (1)	No (2)	2
Macro Coding (subscale: cohesion composite) (1)	Rater (1)	Yes (1)	1
Stress			
FILE: Family Inventory of Life Events (subscale: total events score) (1)	Mother and father combined (1)	Yes (1)	1
Individual-level predictors			
Biological or physical development			
Perceived Pubertal Timing (total scale score) (1)	Mother (1)	Yes (1)	1
SPPC (Harter): Self-Perception Profile for Children (subscale: athletic competence) (1)	Mother, father, teacher (3)	Yes (1)	3
SPPC (Harter): Self-Perception Profile for Children (subscale: physical appearance) (1)	Mother, father (2)	Yes (1)	2
	Teacher (1)	No (2)	2
Psychological development			
CBCL/TRF: Child Behavior Checklist (subscales: withdrawn, somatic complaints, anxious/depressed, attention problems, aggressive behavior; internalizing and externalizing) (7)	Mother and father and teacher combined (1)	Yes (1)	7
SPPC (Harter): Self-Perception Profile for Children (subscale: behavioral conduct) (1)	Mother, father, teacher (3)	Yes (1)	3
CDI: Child Depression Inventory (total scale score) (1)	Child (1)	No (2)	2
SRCS: Self-Report Coping Scale (subscales: approach, avoidance) (2)	Child (1)	No (2)	4
PPVT-R: Peabody Picture Vocabulary Test—Revised (subscale: verbal IQ) (1)	Child (1)	N/A	1
Autonomy development			
Intrinsic Versus Extrinsic Orientation in the Classroom-Revised Scale (subscale: total intrinsic motivation) (1)	Teacher (1)	Yes (1)	1
DMQ: Decision-Making Questionnaire (subscale: total behavioral autonomy score) (1)	Mother, father (2)	Yes (1)	2
	Child (1)	No (2)	2
Total predictors			46

counterparts (Kazak, Segal-Andrews, & Johnson, 1995). As will be discussed, the presence of a chronic illness such as SB can be conceptualized as a risk factor that impacts psychosocial adjustment in various domains. This study will also examine the risk and protective influences of demographic factors [e.g., socioeconomic status (SES), ethnicity, and parent marital status], family-level factors (e.g., conflict, cohesion, and stress), and individual-level factors (physical/pubertal characteristics, cognitive and psychological functioning, and autonomy development).

Demographic factors such as the family structure, ethnicity, and financial status have been demonstrated to have both direct and indirect influences on psychosocial adjustment during the transition to adolescence.

Table II. Measures of Psychosocial Adaptation

Measures by domain	Reporter(s)	Normative data (scale mean ± *SD*)	Selection criteria[a]
Scholastic success			
SPPC (Harter): Self-Perception Profile for Children (subscale: scholastic competence)	Child, mother, father, teacher	3 ± 0.5	Combined reports with mean score ≥2.5
TRF (Adaptive Functioning): Teacher Report Form (subscales: working hard, behaving appropriately, learning, happiness)	Teacher	3 ± 0.5	Mean score ≥3.5
TRF (Academic Success): Teacher Report Form (subscale: academic performance)	Teacher	3 ± 1	Mean score ≥2
Social acceptance			
SPPC (Harter): Self-Perception Profile for Children (subscale: social acceptance)	Child, mother, father, teacher	3 ± 0.5	Combined reports with mean score ≥2.5
Positive self-concept			
SPPC (Harter): Self-Perception Profile for Children (subscale: global self-worth)	Child	3 ± 0.5	Mean score ≥2.5

[a]Youth who met or exceeded the criteria listed for all five measures were included in the "positive psychosocial adaptation" group. All others were included in the "nonadaptation" group.

Additionally, youth with a chronic illness such as SB may be at higher risk for maladaptive outcomes as compared to their AB counterparts when considering the impact of factors such as low SES, minority status, and single parent status (Carr, 1991). For example, research has found that risk for poor outcomes is significantly higher in families who have low SES and a child with SB (Holmbeck, Millstein Coakley, Hommeyer, Shapera, & Westhoven, 2002).

Research also suggests that the *family environment* plays a central role in developing psychosocial competencies during the transition to adolescence (Egeland, Carlson, & Sroufe, 1993; Rolf, Masten, Cicchetti, Nuechterlein, & Weintraub, 1990). Generally, literature in this area suggests that although disrupted family environments may impede the development of psychosocial skills, adaptive family relationships are likely to promote positive adjustment and facilitate psychosocial competencies. Specifically, family environments characterized by low conflict, low stress, and high cohesion have been found to protect against maladaptive outcomes in youth who are at-risk (Murch & Cohen, 1989). As with the demographic risk factors, consideration of family-level factors may be especially relevant to families who have a child with a chronic illness or physical disability (Kazak, Rourke, & Crump, 2003; Phipps & Mulhern, 1995; Quittner & DiGirolamo, 1998).

Owing to the way in which illness impacts upon the *individual-level* development of a child with SB, there may be differences related to (a) physical and pubertal characteristics, (b) psychological functioning, and (c) autonomy development, as compared to their AB peers (Holmbeck et al., 2003). Research suggests that these developmental differences may increase the likelihood of psychosocial difficulties for youth with SB. In regards to physical development, many youth with SB may appear different from their peers and limited in their athletic abilities because of their spinal lesions and need for ambulatory aides. Visible signs of disease status such as use of wheelchairs, crutches, or braces have been identified as risk factors for poor psychosocial adaptation (Kleck & DeJong, 1985; Reiter-Putrill, Gerhardt, Vannatta, Passo, & Noll, 2003). The timing of pubertal maturation, which typically occurs earlier for youth with SB as compared to their same age-counterparts (Blum, Resnick, Nelson, & St Germaine, 1991), may also generate physical differences, further increasing risk for psychosocial maladjustment (Boyatzis, Baloff, & Durieux, 1998; Zakin, 1983).

At the individual-level, it is also important to consider the psychological functioning of youth with SB. Research in this area supports evidence suggesting that youth with SB are particularly at increased risk for symptoms that characterize internalizing disorders (e.g., depression, anxiety, attentional problems, and somatic concerns) and externalizing disorders (e.g., oppositional behavior, conduct problems, and aggressiveness). Internalizing symptoms have been shown to occur at higher rates in youth with SB as compared to normative samples (Blum, 1991). Specifically, girls with SB have increased risk for depression and higher levels of suicidal ideation than their AB peers (Wallander, Feldman, & Varni, 1989). Increased rates of somatic concerns and feelings of anxiety have also been documented in youth with chronic illness (Ammerman et al., 1998; Blum et al.,

1991). Youth with SB may also have increased risk for externalizing symptoms (Fletcher et al., 1995). For example, one study demonstrated that 33% of youth with SB met criteria for Attention Deficit Hyperactivity disorder (ADHD) and 13% met full criteria for oppositional defiant disorder (Ammerman et al., 1998). Higher rates of subclinical externalizing symptoms such as oppositionality and aggressiveness have also been documented in youth with SB as compared to AB peers (Wallander et al., 1989). Marginal cognitive impairments, a common feature in the presentation of SB, have been shown to increase the rates of reported internalizing and externalizing symptoms (Holmbeck et al., 2003). Given that youth with SB may be at higher risk for internalizing and externalizing symptoms, research has sought to identify factors that may attenuate the risk for maladjustment. One factor that may buffer against risk and promote psychosocial adaptation is coping style. Specifically, youth with chronic illness or disability who employ active coping styles (as opposed to passive or avoidant coping styles) have been shown to have more successful psychosocial adaptation (Lewis & Kliewer, 1996).

Another individual level factor that may influence psychosocial adaptation is the development of behavioral autonomy. Research suggests that autonomous behavior may emerge more slowly for youth with SB as compared to their AB peers, due in part to the need for parent involvement in ongoing medical care (Blum et al., 1991; Holmbeck et al., 2003; Rait et al., 1992). Behavioral autonomy deficits may have significant implications, impacting ways in which youth engage in the classroom, interact with peers, and function in the family environment. For example, past research has documented that youth with SB were found to demonstrate lower levels of intrinsic motivation in the classroom and to have less responsibility and independence at home as compared to their peers (Holmbeck et al., 2003).

Despite the numerous risk factors identified above, many youth with SB demonstrate high levels of adaptation, making psychosocial gains at the same rate as their AB peers. Moreover, even when there are one or more identified differences between youth with chronic illness and their peers, psychosocial deficits are not always evident (Holmbeck et al., 2003). The outcome construct of psychosocial adaptation in this study is designed to represent the acquisition of competence in three domains of psychosocial functioning: (a) scholastic success, (b) social acceptance, and (c) positive self-concept. In this study, a child must meet inclusion criteria for each measure within each of these three domains to be classified as "adaptive." "Nonadaptation" includes all youth who do not meet criteria for competence in one or more of the above listed domains (Table II).

These three domains (i.e., scholastic success, social acceptance, and positive self-concept) were chosen because they represent developmental goals that are particularly salient for psychosocial adaptation during the transition to adolescence (Masten & Coatsworth, 1988). Moreover, these areas were chosen because youth with SB have potential vulnerabilities within these domains. For example, youth with SB who also have shunted hydrocephalus, are at-risk for poor classroom performance and low levels of perceived academic competence (Holmbeck & Faier-Routman, 1995). The cognitive sequelae of SB, most commonly including lower IQ and attentional deficits (Hommeyer, Holmbeck, Wills, & Coers, 1999), place youth at-risk for academic disadvantage. Academic difficulties are significant not only insofar as they impact grades, but also in the way they impact on a child's self-esteem and feelings of self-worth. The presence of positive peer relationships may buffer feelings of low self-worth; however, incidents of peer rejection and teasing can further contribute to low self-esteem (Blum et al., 1991). There is also research suggesting that the neurological manifestations of SB may lead to impairments in initiating and maintaining socially competent relationships (Holmbeck et al., 2003). By choosing domains in which youth with SB may be most vulnerable, we hope to learn what factors may buffer their psychosocial adaptation, isolating factors and groups of factors that promote resilience (i.e., positive adaptation in the context of risk).

Specific questions this study sought to address include: what factors promote the successful transition to adolescence in a medically at-risk population?; do these factors systematically differ from those of a "healthy" population?; Lastly, what factors may assist a child with a health-related stressor in maintaining an adaptive transition to adolescence? To address these questions this study utilized a prospective longitudinal design to evaluate the predictive utility of individual- and family-level factors in late childhood (Time 1; ages 8–9) and preadolescence (Time 2; ages 10–11) as they related to psychosocial adaptation in early adolescence (Time 3; ages 12–13). ODA techniques (Soltysik & Yarnold, 1993) were used to identify the most salient predictors of psychosocial adaptation.

Several hypotheses were proposed. First, it was hypothesized that there would be fewer youth with SB and/or low SES included in the psychosocial adaptation group, as compared to their AB and high-SES counterparts. Second, it was anticipated that low to moderate ratings of family-level conflict and stress, and moderate to

high ratings of family-level cohesion would contribute to a classification of psychosocial adaptation. Third, within the domain of individual-level factors, it was anticipated that autonomy seeking behavior, age-congruent pubertal maturation, absence of psychopathology and cognitive deficits, and adaptive coping strategies, would all relate to the attainment of psychosocial adaptation.

Methods

Sample

Data for this study came from a longitudinal investigation following 68 families of children with SB and 68 demographically matched comparison families of healthy children through the transition from childhood to early adolescence. There are three data points in total (Time 1, Time 2, and Time 3) that represent a 4-year time interval in development (e.g., 8- to 9-year olds →10- to 11-year olds →12- to 13-year olds). See Holmbeck et al. (2003) for a more complete description of recruitment, demographics, sample matching, and attrition.

This study classified participants into the two psychosocial adaptation outcome groups using data collected at Time 3. Therefore, families who were lost to attrition prior to Time 3 data collection were eliminated from analyses. Additionally, because the criteria for the psychosocial adaptation outcome variable included teacher reports, those participants for whom teacher report at Time 3 was unavailable were also eliminated from the sample before conducting analyses. Together, these data management strategies reduced the total sample size from 136 to 118 participants. There were no significant differences for group (i.e., SB vs. AB), ethnicity, parental marital status, or SES after the sample was reduced.

Information on physical status variables for the SB group was obtained via maternal report and from the child's medical chart. Eighty-two percent of the participating children had SB myelomeningocele, 12% had lipomeningocele, and 6% had other forms of SB. With respect to lesion level, 32% had sacral, 54% had lumbosacral or lumbar, and 13% had thoracic level lesions. Most youth had a shunt (71%) and used braces (63%) or a wheelchair (18%) for ambulation.

As expected, a significant difference was found between the samples on a measure of receptive language (Peabody Picture Vocabulary Test, Revised; Dunn & Dunn, 1981): $M = 92.49$ ($SD = 18.49$) for the SB sample and $M = 108.97$ ($SD = 15.06$) for the AB sample. This finding parallels results based on verbal IQ test scores, insofar as children with SB typically score in the low average range (Wills, Holmbeck, Dillon, & McLone, 1990). Because lower receptive vocabulary scores were viewed as part of the symptom presentation in children with SB (much like ambulation difficulties, for example) and because children with SB are typically mainstreamed into classrooms with AB children, no attempt was made to match the samples on this variable. Instead, as will later be discussed, Peabody Picture Vocabulary Test—Revised edition (PPVT-R) scores were entered into the predictive model.

Procedure

Graduate- and undergraduate-level research assistants conducted assessments of the participating families during a single home visit at each longitudinal data collection point. During each home visit, parents and their child were asked to complete a set of questionnaires as well as 1 hour of videotaped family interaction tasks. Three tasks from the videotaped family session were coded: an unfamiliar board game task (developed for this study), a conflict task (Smetana, Yau, Restrepo, & Braeges, 1991), and the Structured Family Interaction Task (SFIT) (Ferreira, 1963). For the unfamiliar board game task, families were presented with a board game they had never seen before and asked to establish their own rules, then play the game together. The conflict task was based on a procedure employed by Smetana et al. (1991). The SFIT (Ferreira, 1963) involved family members trying to reach group consensus for responses on a questionnaire each had previously completed individually. With parent and child permission, teachers were contacted and asked to complete a questionnaire packet via mail.

Measures

Measures Assessing the Construct of Psychosocial Adaptation

The following measures were used to categorize youth into the dichotomous outcome variable "psychosocial adaptation" versus "psychosocial nonadaptation." All measures used to generate this outcome variable draw on Time 3 data. To "qualify" for the "psychosocial adaptation" outcome, individuals had to be rated no less than one standard deviation below the normative mean for each measure assessing the following three constructs (a) scholastic success, (b) social acceptance, and (c) positive self-concept (Table II). Youth who were functioning below the normal range (i.e., one standard deviation or more below the established midpoint of the specified measurement) in any one of these areas were included in the "psychosocial nonadaptation" outcome variable (Table II). Cronbach alphas for "Time 3" scale reliabilities were all acceptable, with a mean rating across scales of .87 for the AB sample, and .84 for the SB sample.

Scholastic Success

Mother, father, child, and teacher report on the Harter Self-Perception Profile for Children (SPPC) was used to assess scholastic competence (Harter, 1985). A combined assessment of mother, father, teacher, and child reports from the "Scholastic Competence" subscale of the SPPC was used in the assessment of scholastic success. The construct of scholastic success also included the Achenbach Teacher Report Form (TRF) (Achenbach, 1991b).

Social Acceptance

Peer relations were assessed via child, mother, father, and teacher report on the "Social Acceptance" subscale of the SPPC. As with the "Scholastic Success" subscale of this measure, a combined assessment of all reporters was used.

Positive Self-Concept

Child report of the SPPC was used to assess the degree to which a child has a positive self-concept. Specifically, the "Global Self-Worth" subscale was used for this assessment.

To determine the overall validity of the psychosocial adaptation construct, we treated individual scales described above as items in a scale and transformed them to a z-score format, then tested for reliability. Cronbach alphas for the AB and SB samples were strong (.76 and .75, respectively) indicating that the construct of psychosocial adaptation had good internal consistency. With the selection criteria described in Table II, 37.5% of the SB sample and 64.5% of the AB sample were classified in the psychosocial adaptation outcome. There was a relatively equal distribution between outcome groups (i.e., psychosocial adaptation vs. nonadaptation), with 52% of the total sample included in the psychosocial adaptation group, and 48% included in the nonadaptation group.

Predictors of Psychosocial Adaptation

All of the following measures assessed responses at Time 1 and Time 2 data collections. Table I summarizes subscales and reporters for each measure, demonstrating the total number of predictors each measure contributes to this study. All measures were reviewed for item overlap to eliminate the possibility that predictor variables contained items that were also contained within the "psychosocial adaptation" outcome variable. The multisource data described below was aggregated when there was high agreement either between reporters and/or between Time 1 and Time 2 responses. This strategy maintained the integrity of multiple perspectives yet reduced the total number of required analyses. An additional benefit is that the reliability of aggregate variables is typically higher than that of individual scales (Cook & Goldstein, 1993). Therefore, whenever possible, reports that were highly correlated ($r \geq .40$) either across reporter (e.g., mother and father), time (e.g., time 1, and time 2), or both reporter and time, were combined. This particular correlation criterion has been used previously in the pediatric literature (Chassin, Pitts, & Prost, 2002) and is viewed as an effective and meaningful way to combine information from multiple sources and across multiple assessments when sample sizes are small (Holmbeck et al., 2002b).

Demographics

Five demographic variables were used as predictors in this study: (a) gender, (b) group status (AB vs. SB), (c) parent marital status, (d) SES, and (e) ethnicity. Parent marital status was highly correlated at Time 1 and Time 2 for both groups (mean rs > .75), therefore, Time 1 marital status was used as the sole predictor. SES was assessed at Time 1 via Hollingshead scale of SES (Hollingshead, 1975). Ethnicity was coded as a categorical variable including (a) Caucasian, (b) African American, (c) Hispanic/ Latino, (d) Asian, and (e) Other.

Questionnaire Measures of Family Functioning

Conflict

Family-level conflict was assessed with mother and father report on a shortened version of the FES, a 90-item self-report measure that assesses social-environmental characteristics of the family system (Moos & Moos, 1986). The FES was administered in a true or false format at Time 1, and a four-point Likert scale format at Time 2 (the change was made to increase the internal consistency for each subscale). Mean correlations between mother and father report were high ($r \geq .40$); thus, this scale was collapsed across reporters. Cronbach alphas for collapsed reports ranged from .80 to .86 for the AB sample and .74 to .80 for the SB sample. Family-level conflict was also assessed via the 15-item Parent–Adolescent Conflict Scale (PAC), a brief version of the Issues Checklist (Robin & Foster, 1989). The PAC is comprised of a list of potential conflicts that are often discussed in families with preadolescents. It was administered to mothers, fathers, and children. Because mean rs were well correlated at Time 1 and Time 2 for mother and father report, respectively, the PAC was collapsed across time. Child report was not collapsed across time. Combined alphas ranged from .62 to .76 for the AB sample, and .77 to .81 for the SB sample.

Cohesion

A separate subscale of the FES measure described above was used to assess the construct of family-level cohesion. Mother and father reports for this scale were highly

correlated (r > .40); therefore, the cohesion subscale was collapsed across reporter. Combined scales yielded Cronbach alphas ranging from .84 to .85 for the AB sample and .72 to .84 for the SB sample.

Stress

The Family Inventory of Life Events (FILE) is a self-report measure that assesses the frequency of life events over the past 12 months and the degree to which events impact on the family system (Olson et al., 1985). There were high correlations across time and reporter (mean rs > .6); therefore, this measure was collapsed across both time and reporter, generating a single composite scale. Cronbach alphas for this measure were .96 and .89 for the AB and SB samples, respectively.

Observational Measures of Family-Level Functioning

Observational data were coded using a global-coding method developed by Holmbeck, Belvedere, Gorey-Ferguson, and Schneider (1995), based on a system developed by Smetana et al. (1991). For a complete description of the administration and coding of observational data, and interrater reliability, see Holmbeck et al. (2003).

Observed Conflict

Family-level composites were generated to assess levels of conflict and cohesion (Millstein Coakley, Holmbeck, Friedman, Neff Greenley, & Welborn Thill, 2002). For the conflict composite, three dyadic codes (i.e., levels of observed mother–child conflict, father–child conflict, and mother–father conflict) that were highly correlated within both the SB and AB samples were averaged to create a family conflict composite. This scale was then collapsed across time. Cronbach alphas for this composite scale were robust, ranging from .81 to .88.

Observed Cohesion

Similar to the conflict scale, a family cohesion composite was generated assessing the degree to which a family is (a) impaired, (b) disengaged, (c) open or warm, and (d) able to reach a resolution or agreement. The cohesion composite was highly intercorrelated at Time 1 and Time 2 for both the SB and AB sample (mean rs > .70) and was therefore collapsed across time. Cronbach alphas for this composite scale were robust, ranging from .80 to .91.

Questionnaire Measures of Individual-Level Functioning

Pubertal Development and Physical Appearance

Pubertal timing was assessed by means of a validated parent-report measure (Peterson, Corckett, Richards, & Boxer, 1988). Pubertal timing was measured by the item, "Does your son's/daughter's physical development seem to be earlier or later than most other boys/girls his or her own age?" Time 1 and Time 2 ratings of pubertal development were highly correlated for both girls and boys in the AB (rs = .71 and .52, respectively) and SB samples (rs = .74 and .53, respectively). Therefore, these ratings were collapsed across time. Physical development was further assessed via the "Physical Appearance" and "Athletic Competence" subscales from SPPC (Harter, 1985). The physical appearance subscale assesses how children feel about their physical development including perceptions about height, weight, facial appearance, hair, and general presentation. The Athletic Competence subscale assesses how children perceive their abilities and involvement in sports or other physical activities. Cronbach alphas for these two subscales ranged from .68 to .92 in the AB sample, and .73 to .88 in the SB sample.

Psychological Functioning

Mother and father reports from the Child Behavior Checklist (CBCL) were used to measure emotional and behavioral functioning (Achenbach, 1991). Individual subscales as well as the second order internalizing and externalizing composite scales were included in these analyses. In this study, the social problems subscale was eliminated because of item overlap with the outcome construct of psychosocial adaptation, and the thought problems and delinquent behavior subscales were eliminated from the analyses because of poor scale reliabilities (i.e., mean alphas <.40). Raw scores generated from mother, father, and teacher report for each of the remaining subscales were converted to T-score format. Because mean correlations across reporters were high (mean rs > .40), a combined T-score mean of all three reporters was generated. Time 1 and Time 2 composite ratings were highly correlated (mean rs > .40); therefore, this variable was further reduced by collapsing across time. Externalizing behavior problems were further assessed via the "Behavioral Conduct" subscale from SPPC (Harter, 1985). The "Behavioral Conduct" subscale is scored in the direction of positive conduct (i.e., high scores indicate good conduct) and was assessed via teacher, mother, and father report. Scale reliabilities generated from this study were strong ranging from .78 to .96 across reporters and samples. Time 1 and Time 2 ratings were highly correlated (mean rs > .40); therefore, this variable was reduced by collapsing across time.

The Children's Depression Inventory (CDI) was used to assess depressive symptomotology (Kovacs, 1992). Only the mean total scores were used in this study.

Alphas generated from this study at Time 1 were .78 and .81 for the SB and comparison group, respectively. At Time 2, alphas were .79 and .77 for the SB and comparison group, respectively. Coping skills were assessed via child-report on the Self-Report Coping Scale (SRCS) (Causey & Dubow, 1992). The measure assesses five coping strategies that are collapsed into two theoretically derived second order scales, assessing "approach" or "avoidance" coping strategies. Cronbach alphas generated from this study at Time 1 and Time 2 ranged from .68 to .83 in the AB sample and .62 to .87 in the SB sample.

The PPVT-R was used to assess receptive vocabulary skills (Dunn & Dunn, 1981). The PPVT-R is an individually administered, norm-referenced achievement test of receptive vocabulary that is well-correlated with verbal IQ scores. This measure was only administered to participants at Time 1.

Autonomy Development

Autonomy development in the classroom was assessed via a teacher-report of the Intrinsic Versus Extrinsic Orientation in the Classroom-Revised Scale (Harter, 1980). This measure assesses to what degree a child's classroom performance is influenced by intrinsic factors (i.e., interest in learning and mastery, curiosity, and preference for challenge) as compared to extrinsic factors (i.e., teacher approval and obtainment of grades). This measure was highly correlated across Time 1 and Time 2 and was therefore collapsed into a composite variable representing the mean rating across Time. Behavioral autonomy development within a family context was assessed via the 15-item, Self-report Decision-Making Questionnaire (SDMQ) (Steinberg, 1987). Mothers, fathers, and children each completed this measure assessing self-perceptions of who makes decisions within the family. Within this study Time 1 and Time 2 alphas ranged from .57 to .86 in the AB sample and .66 to .90 in the SB sample. This measure was collapsed across parent report (mother and father), but not across time.

Statistical Design

ODA is a statistical technique that maximizes classification accuracy in determining whether a factor (e.g., PPVT) is predictive of a categorical outcome (e.g., psychosocial adaptation vs. nonadaptation). ODA is free from most of the assumptions that must be satisfied with traditional parametric tests, such as linearity, normality, and independence (Yarnold & Soltysik, 2004). It is similar in design to logistic regression, but ODA is unique from all statistical procedures in its ability to identify a "cutpoint," or decision rule, for each predictor. The "cutpoint" is the value at which a predictor can be used to classify, with the greatest accuracy possible, whether observations are in one category or another of the outcome variable. Another particularly valuable feature of the ODA methodology is that it supports the inclusion of a powerful validity assessment technique known as the Leave-One-Out analysis (LOO). With this procedure, classification accuracy is tested for each predictor by holding out a single observation and rerunning analyses on all remaining observations in the data set. This process, termed "an extreme variation of the one-sample jack-knife," protects against bias when estimating the predictive utility of the data (Yarnold & Soltys; 2004). Because the LOO procedure serves to protect against Type I error and improves the cross sample generalizability of the classification model, it is a particularly advantageous strategy for analyzing a large number of predictors in a single sample.

In this study, classifications generated from ODA were used to construct a nonlinear classification tree analysis (CTA) (Yarnold & Soltysik, 2004). This analysis identified the unique contributions of each predictor, or set of predictors, for particular subgroups of the sample. In this way, the classification tree model developed distinct predictive profiles for individual subgroups of the sample.[1] All predictors in this analysis were simultaneously tested using the following iterative process:

1. A uniODA is performed on all attributes. This establishes a cutpoint, or classification rule, for each predictor that can be used to classify observations with optimal accuracy into the levels of the outcome variable (i.e., adaptation or nonadaptation).
2. Among the predictors that emerge as LOO stable, the predictor with the greatest classification accuracy is selected and placed in the tree model. The optimal decision rule for classifying observations is used to divide the sample into two outcome groups (i.e., psychosocial adaptation vs. nonadaptation).
3. After a predictor is selected, univariate ODA is rerun on all predictors for each ascertained outcome group to determine if other predictors

[1]Though use of this statistical methodology has not yet been evident in the pediatric psychology literature, ODA and CTA have been employed in clinical psychology research to predict outcomes such as substance use in hospitalized psychiatric patients (Mueser et al., 2000), sexual debut in at-risk adolescents (Donenberg, Bryant, Emerson, Wilson, & Pasch, 2003), and to assess the diagnostic utility of a questionnaire rating scale (Ostrander, Weinfurt, Yarnold, & August, 1998).

can further contribute to the classification accuracy of the model.

4. The above three steps are repeated until there are either no more LOO stable variables, or variables do not further contribute to the overall classification accuracy of the model.
5. Once the tree model is complete, it is "pruned" using a Bonferroni adjustment for Type I error (Yarnold & Soltysik, 2004). Predictors that are not statistically significant at the Bonferroni-adjusted .05 level are eliminated from the tree model. This procedure increases confidence that the predictors in the tree are not chance occurrences (i.e., are not experimentwise Type I errors) and improves the validity of the statistical conclusions drawn from the analyses.
6. The final step in this statistical analysis is to assess the overall predictive performance of the classification tree model (Yarnold & Soltysik, 2004).

Results

This study analyzed 46 theoretically relevant predictors drawn from Time 1 and Time 2 data. These predictors included 5 demographic characteristics, 11 family-level variables, and 30 individual-level variables (Table I). In this study, variables were selected for the tree model if they were LOO stable and had the greatest effect strength PAC. This strategy ensures that the tree is grown to specifically maximize classification accuracy.

Figure 1 presents the final ODA classification tree model. In this model, ovals represent decision points

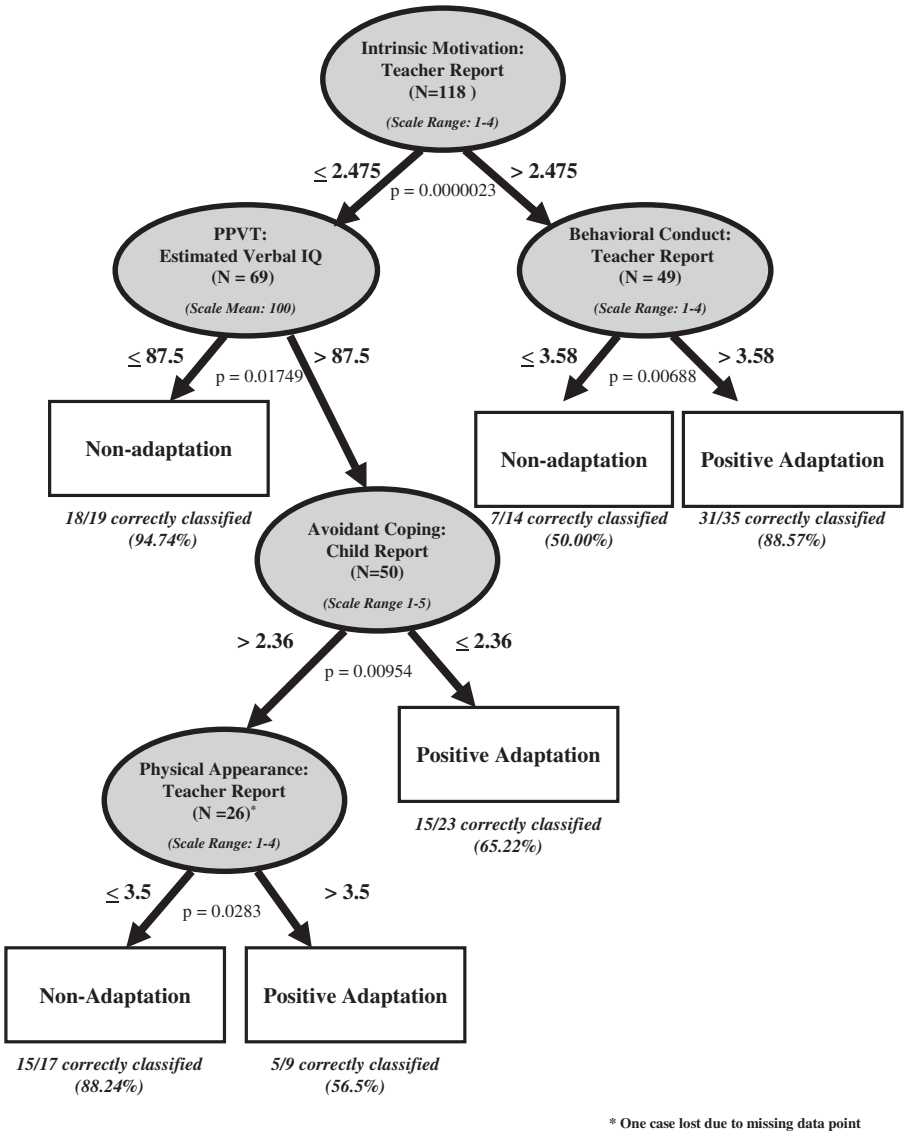

Figure 1. Final optimal data analysis (ODA) classification tree model for predicting positive psychosocial adaptation in early adolescence.

(i.e., the most salient predictor for the sample, or subsample, being analyzed). Within each oval is the name of the scale, the reporter of the scale, and the number of participants who were included at that particular decision point. Additionally, each oval contains information regarding the range of the scale. This facilitates interpretation of the cut-off value (located on either side of each decision point) for optimally classifying observations into categories. Arrows represent predictive pathways, and rectangles represent final classifications. Numbers beneath the decision point ovals are the *p*-value for that particular decision point. Fractions beneath the rectangles represent the number of correct classifications at that endpoint (numerator) and the total number of cases classified at the endpoint (denominator). Numbers in parentheses under the fractions indicate the percentage of correctly classified individuals at that end point.

In this model, the single best predictor of psychosocial adaptation (i.e., the first variable to enter into the tree model) was intrinsic classroom motivation. For the right primary branch, this model indicates that for those with high intrinsic classroom motivation scores (i.e., >2.475), the next variable to enter the model was behavioral conduct. If behavioral conduct was high (i.e., >3.58), then the model predicted psychosocial adaptation with 88.57% accuracy. If behavioral conduct was rated more poorly (i.e., ≤3.58), then the classification tree predicted nonadaptation with 50% accuracy. Thus, for those with high intrinsic classroom motivation (i.e., >2.475) and good behavioral conduct (i.e., >3.58), the classification tree predicted a clear pathway to psychosocial adaptation. The tree model predicted a pathway to nonadaptation if intrinsic classroom motivation was high and behavioral conduct was rated as being poor (i.e., ≤3.58). Overall, the predictive accuracy for the right branch of the classification tree model was 77.6%, correctly classifying outcomes for 38 out of 49 youth. This represents an effect strength of 55.2%, indicating a "strong" predictive accuracy (Yarnold & Soltysik, 2004).

For the left primary branch of the model (i.e., those with intrinsic motivation scores ≤2.475), several factors influenced the final classification outcomes[2]. The second variable to enter the model on the left side was PPVT, a measure of estimated verbal IQ. If PPVT scores were ≤87.5, the model predicted psychosocial nonadaptation with 94.74% accuracy. If PPVT scores were >87.5, then the measure of avoidant coping entered the model. If avoidant coping was ≤2.36, the model predicted psychosocial adaptation with 65.22% accuracy. If avoidant coping was >2.36, then the measure of physical appearance entered the model. Physical appearance scores ≤3.5 resulted in a classification of psychosocial nonadaptation with 88.24% accuracy. Physical appearance scores >3.5 resulted in a classification of psychosocial adaptation with 56.5% accuracy. Thus, for the left branch of the model there are two pathways to psychosocial adaptation: (a) intrinsic motivation ≤ 2.475 + PPVT > 87.5 + avoidant coping ≤ 2.36 and (b) intrinsic motivation ≤ 2.475 + PPVT >87.5 + avoidant coping > 2.36 + physical appearance > 3.5. On the left branch of the model there are two pathways to nonadaptation: (a) intrinsic motivation ≤ 2.475 + PPVT ≤ 87.5 and (b) intrinsic motivation ≤ 2.475 + PPVT > 87.5 + avoidant coping > 2.36 + physical appearance ≤ 3.5. Overall predictive accuracy for the left primary branch of the classification tree model is 91.3% (63/69). This represents an effect strength of 82.62%, indicating a "very strong" predictive pathway (Yarnold & Soltysik, 2004).

After the tree model was constructed, all nodes on the tree were evaluated to determine if their Type I error exceeded the allowable *p*-value as determined by the sequentially rejective Sidak Bonferroni-type multiple comparison procedure. This process, known as "pruning the tree," safeguards against spurious findings and greatly increases confidence that the variables included

[2]As previously described, the heuristic for selecting variables as decision points in the tree model was to select the LOO stable variable that had the greatest effect strength (i.e., predicted the greatest classification accuracy) for a particular subsample. This strategy is well-supported in the literature as an optimal way to attain predictive accuracy using this statistical method (Yarnold, Michelson, Thompson, & Adams, 1998). However, for the initial decision point on the left primary branch of the ODA model, there was a "tie" between two LOO stable variables. The PPVT variable and FES Conflict variable (mother report) were both LOO stable and had the identical percent effect strength (34.75%). Therefore, it was necessary to adopt an additional heuristic to select the decision point for this node in the model. As the goal of this project was to most accurately classify predictive pathways to psychosocial adaptation (as opposed to nonadaptation), the variable that had the greatest classification accuracy for psychosocial adaptation was chosen as the appropriate decision point. In this case, the PPVT variable classified psychosocial adaptation with 95.65% accuracy and the FES conflict variable classified psychosocial adaptation with 91.3% accuracy. Therefore, as PPVT had the highest classification accuracy for psychosocial adaptation it was selected as the decision point at this branch of the model. This strategy is viewed as consistent with the overall theoretical goal of the analysis. Additionally, it was endorsed as a viable secondary heuristic for selecting a decision point in this study by an expert in the use of this statistical method (Paul R. Yarnold, personal communication, October 20, 2003). However, given that these variables were so close in their predictive utility of this sample, this particular finding may not cross validate in independent samples.

in the tree are statistically significant. In this tree model, the Sidak Bonferroni test was conducted on *p*-values attained from nondirectional Fisher's exact tests, and an experimentwise alpha of $p < .05$ was selected. All variables in the tree model maintained statistical significance after the Bonferroni test; therefore, no pruning was necessary.

Classification Performance of the ODA Model

There are five indices used to characterize the overall performance of the ODA model. These indices produce summary statistics used to describe how well the model differentiates between participants who met criteria for "psychosocial adaptation" and those who met criteria for "psychosocial nonadaptation." Indices also highlight the predictive utility of the model (Soltysik & Yarnold, 1993). The first model index, overall classification accuracy, is a measure of the percent of the total sample correctly classified by the tree model. Overall, this model correctly classified 77.8% of the sample. The second model characteristic, sensitivity, indicates the percent of correctly classified participants for each class category (i.e., psychosocial adaptation vs. nonadaptation). Overall, this model classified participants with 78.1% accuracy. The third model characteristic, predictive value, is defined as the percentage of predicted classifications in a given category that are correct. In this case, overall, the model predicted correct classification (as either psychosocial adaptation or nonadaptation) with 77.5% accuracy. The fourth model characteristic, effect strength, indicates the predictive performance of the model relative to chance. This index has a maximum value of 100% (identifying perfect classification accuracy) and a minimum value of 0% (identifying performance equal to chance). Effect strength is a particularly helpful index when comparing classification models because it is not biased by sample size, number of classification categories, or number of attributes included in the model (Soltysik & Yarnold, 1993). Effect strength values of 25% or less are considered weak, values between 25 and 50% are considered moderate, and those above 50% are considered strong (Yarnold & Soltysik, 2004). In this model, the sensitivity effect strength is 56.2%, and the predictive value effect strength is 55%. The mean of these two indices provides the value for the fifth and final model characteristic, overall effect strength. This model's overall effect strength is 55.6%, suggesting that relative to chance (i.e., 0%) this model has a robust ability to (a) discriminate between participants who fit the category of psychosocial adaptation and those who fit the category of nonadaptation and (b) predict accurate classifications based on the attributes included in the model.

Discussion

The purpose of this prospective longitudinal study was to evaluate the predictive utility of individual- and family-level variables in late childhood and preadolescence as they relate to psychosocial adaptation in early adolescence for youth with and without SB. ODA was used to construct a hierarchically optimal classification tree model illustrating the predictive profiles determining an outcome of either psychosocial adaptation or nonadaptation. This study also served to identify the clinical and research utility of an ODA and classification tree strategy in a pediatric sample. The findings of this investigation indicated that the constellation of factors best predicting psychosocial adaptation in early adolescence included (a) intrinsic motivation, (b) estimated verbal IQ, (c) behavioral conduct, (d) coping style, and (e) physical appearance. The final classification model correctly classified 77.8% of the total sample, indicating that the factors in the tree model have strong predictive capabilities when evaluating the pathways by which youth attain psychosocial adaptation in early adolescence.

The first variable to enter the classification tree was intrinsic motivation in the classroom. This variable maps onto the larger construct of autonomy development (Harter, 1980). For example, high levels of intrinsic motivation indicate a preference for challenge, working to satisfy personal interest and curiosity, and having a desire to figure out problems on one's own (Harter, 1981; Skinner, Wellborn, & Connell, 1990). The presence of intrinsic motivation at the top of the classification tree signifies the developmental importance of autonomy seeking behaviors in the context of attaining psychosocial adaptation.

The emergence of PPVT in the model suggests that verbal IQ is an important factor for the attainment of psychosocial adaptation. Indeed, research has shown that verbal skills relate to both academic achievement and social competence (Masten et al., 1999). As might be expected, participants with low intrinsic motivation in the classroom and low IQ were classified in the nonadaptation category. This profile identifies a group of youth who have limited IQ (≤87.5) and do not exert autonomy seeking behaviors in the classroom. These youth may be conceptualized as being intellectually slow and not conveying an interest in school and/or learning. The tree model classified this profile with 94.74% accuracy,

suggesting that this is a particularly high-risk profile for moderate to poor adjustment during the transition to early adolescence.

The interactive relationship between low intrinsic motivation and moderate to high PPVT scores is further moderated by coping style. For those with low intrinsic motivation and moderate to high verbal IQ scores, it was found that limiting the use of avoidant coping strategies (e.g., trying to forget problems) led to psychosocial adaptation. Previous research in pediatric populations has found that there is a direct link between the use of avoidant coping strategies and psychosocial difficulties (Lewis & Kliewer, 1996). This profile (i.e., low motivation + high IQ + low avoidant coping) also suggests that higher IQ and low avoidant coping may buffer against the effects of low intrinsic motivation. For example, youth who demonstrate low motivation in the classroom may still do well psychosocially if they have the intellect to understand the academic material and can actively cope with challenging situations that may arise from low motivation.

The last variable to enter the model on the left side was physical appearance. This teacher report variable assesses how a particular child compares to others in terms of his or her physical attractiveness and general presentation. Those who were rated as being physically attractive were categorized as having psychosocial adaptation, whereas those who were rated as less attractive were categorized in the nonadaptation group. This finding supports research suggesting that the physical manifestations of a disability such as SB can greatly influence psychosocial functioning.

Moving now to the right side of the tree model, the only variable that interacted with intrinsic motivation in the prediction of psychosocial adaptation was behavioral conduct. It was not surprising that those who demonstrated both high motivation and high levels of positive behavioral conduct were classified as having psychosocial adaptation with 88.6% accuracy. These two factors in combination suggest a clear means by which youth may attain psychosocial adaptation. Those with high motivation, but who had moderate to poor behavior in the classroom were classified as nonadaptive.

There were several unexpected outcomes in this study. Most notably, neither group (AB vs. SB) nor SES differences emerged as significant predictors in the classification tree model. That no significant group or SES differences were found in this study is particularly interesting given that past research in pediatric psychology, as well as past research conducted on this particular sample (Holmbeck et al., 2003; Millstein Coakley et al., 2002), has demonstrated robust group difference effects. However, a lack of group differences is congruent with a line of research in pediatric psychology suggesting that although youth with chronic pediatric conditions may have certain identifiable stressors in their life (i.e., medication adherence and hospital visits), they are not necessarily different or deviant from their AB peers (Kazak et al., 2003). Although group (SB vs. AB) is an important variable in this study, it does not account for as much between subject variance as compared to the variables that entered into the model when predicting psychosocial adaptation.

It was hypothesized that family-level factors would have a significant impact in this study given past research findings (e.g., Holmbeck et al., 2002). A lack of robust effects for family-level predictors may be in part related to the measures used in the study, which included almost three times as many individual-level predictors as compared to family-level variables. This may have biased the study toward identifying individual-level predictors. Similarly, it is also interesting to note that all factors that entered into the model were based on either teacher or participant ratings. Neither parent report nor observational predictors emerged in the final model. This may also be an artifact of the study design, reflecting a problem of common method variance. Given that the outcome construct of psychosocial adaptation included four teacher report measures, three child report measures, and two parent report measures, the construct of psychosocial adaptation may have been biased towards eliciting predictors based on teacher and child report.

This study has several limitations that have bearing on future research in this field. The sample in this study was primarily white middle class families. Therefore, the external validity and cross-cultural generalizability of these findings is limited. Also, it is possible that the findings in this study, relating to youth with SB, may not apply to other pediatric samples. As such, similar phenomenon should be explored with other chronic illness or disability groups. This study also included a relatively small sample. With the added power of a larger sample it is possible that the overall classification accuracy of the tree would increase. Moreover, a larger sample may have led to the identification of additional predictors in the classification of psychosocial adaptation.

It is important to note that the use of ODA and CTA methodology required the use of a dichotomous outcome variable (i.e., psychosocial adaptation vs. nonadaptation). This design limitation ruled out the possibility of identifying multiple outcome groups representing various levels of adaptation (e.g., excellent

adaptation, moderate adaptation, and maladaptation). Working within the ODA and CTA framework also made it necessary to generate an algorithm determining how youth would be classified. A great deal of care was taken to ensure that the classification categories were reliable, incorporated support from existing empirical research, and possessed theoretical relevance to the population under investigation. The validity of this model is also clearly dependent on the validity of the measures in the model. For example, although PPVT scores are typically well-correlated with verbal IQ, future research in this area would be strengthened by the inclusion of more comprehensive cognitive and neuropsychological assessments.

Lastly, it is important to note that the results reported in this study are correlational. Although this study was designed in a prospective fashion (i.e., Time 1 and Time 2 data points predicted Time 3 outcomes), a variable's position within the classification tree does not necessarily indicate a temporal relationship. Additionally, the order of the variables in the model do not indicate a sequence of cause and effect. The tree model only serves as a tool for clarifying the linkages between the factors that most accurately predict psychosocial adaptation. Future research will be needed to further elucidate more intricate relationships between the variables in the tree model.

This study provides promising evidence that the presence of a chronic illness may not be the most salient factor influencing psychosocial adaptation during the transition to adolescence. However, the particular set of risk and resource factors identified in this study represent areas of development that are often influenced by chronic illness. For example, previous research has shown that: (a) compared to AB youth, those with SB are at risk for not developing autonomous behavior at the same rate as their peers (Holmbeck et al., 2002; Millstein Coakley et al., 2002); (b) the ambulatory complications associated with SB often generate physical differences between youth with SB and their peers (Blum, 1991; Varni & Wallander, 1988); and (c) the presence of hydrocephalus, a common correlate of SB, put youth at risk for cognitive deficits (Brookshire, Fletcher, Bohan, & Landry, 1995; Horn, Lorch, Lorch, & Culatta, 1985). Thus, many of the factors that previously have identified youth with SB as being at risk for difficulty during the transition to adolescence (i.e., autonomy development, cognitive ability, and physical appearance) are evident in this study. This suggests that clinicians should continue to assess for difficulties in these areas of functioning.

This study furthers the APA goal and general shift in the field of child and developmental psychology to identify factors that promote psychosocial adaptation (Masten, 2001; Newman, 2003). Focusing on pathways to psychosocial adaptation serves to inform prevention programs and provides direction for problem-focused interventions. Findings from this study indicate the need for psychosocial interventions that target strategies for increasing intrinsic motivation, improving behavioral conduct in the classroom, and teaching adaptive coping strategies. From a clinical perspective it is also interesting to consider the cutpoints that were established for predictors in this study. These cutpoints may be applied as clinical guidelines when considering the extent to which a child may be a risk for psychosocial difficulties. As this is the first known application of ODA and CTA in pediatric psychology, it is hoped that this study will provide new directions for future research. Given that ODA can be used on small samples, has the power to manage numerous predictors, and increases the ability to generalize to other samples (i.e., with the LOO analysis), it may be an important statistical tool for future research in the field of pediatric psychology.

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