Psychoeducational Assessment of Children with Congenital Heart Disease Undergoing Cardiac Surgery

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Abstract: The physical and psychological development of 48 children (ages 4 to 12) with congenital heart disease who had average intelligence were examined to evaluate their educational performance. Categorization by diagnosis and surgical procedure placed 25 children in Group 1 with acyanotic, correctible cardiac defects and 23 in Group 2 with cyanotic, palliative defects. We found that the children were at risk for learning problems regardless of the severity of the cardiac defect; however, risk factors increased with the severity of the defect. Gross and fine motor and visual motor integration skills were comparable to the norm group for Group 1, but Group 2 exhibited motor delays. When compared by their teachers to their typical peers at school, overall functioning for Group 1 was within the average range, but Group 2 was below average. However, teachers also stated that both groups were more likely than average to have identified learning disabilities and problems with socialization. For the pediatrician, as well as the educator, there needs to be recognition that children with congenital heart disease can have significant school problems even when the operation is successful.

As pediatric cardiac surgical techniques have improved and mortality rates dropped, attention has turned to issues related to morbidity of children with congenital heart disease (CHD) (Savageau, Stanton, Jenkins, & Klein, 1982). Because these children are being operated on at an earlier age and given the expectation of normal development, it becomes important to determine the more subtle adverse outcomes which supervene despite early repair of their cardiopulmonary state (Wright & Nolan, 1995). A significant, but often unrecognized concomitant of childhood illness is poor school performance, a risk that is greatest when the central nervous system is involved (Anderson & Godberg, 1991).

Studies of varied CHD populations suggest a variety of cognitive deficits (Wells, Coghill, Caplan, & Lincoln, 1983), school problems including below average academic achievement (Morris, Krawiecki, Wright, & Walter, 1993; Youseff, 1988) and learning disabilities (O'Dougherty, Wright, Garmezy, Loewenson, & Torres, 1983). Delays in growth and motor development have also been identified (Gonzalez-Pardo, Miles, Taylor, & Mattioli, 1981; Nuutinen, Koivu, & Rantarallio, 1989). Furthermore, growth failure was associated with limited intelligence, low verbal abilities, impaired attention, and low academic achievement (O'Dougherty et al., 1983; Kramer, Awiszus, Sterzel, van Halteren, & Clafsen, 1989).

Studies have generally focused on identifying psychological and physical developmental concerns in relation to specific CHD diagnostic categories, degree of surgical risk or procedure and cyanotic condition (DeMaso, Beardsley, Setbert, & Fyler, 1990; Hesz & Clark, 1988; Iwamoto, Baba, Koga, Uchida, Matsuo, Ishii, Onitsuka, & Shibata, 1990; Kagawa et al., 1987; Oates, Simpson, Cartmill, & Turnbull, 1995). Consequently, these studies have included children with se-

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vere neurologic disorders, genetic syndromes and retardation. Identifying more subtle concerns, such as educational problems including learning disabilities, in populations that include severe developmental problems with those who appear normal, is unlikely.

A number of methodological problems related to the assessment of psychoeducational variables for children with CHD have been identified in the literature. Age of children tested presents a problem because test norms are only available for limited age ranges. Consequently, studies have used more than one test across a sample population even though they are not directly comparable because tests measure different characteristics (Aram, Ekelman, Ben-Shachar, & Levinsohn, 1985; Wright & Nolan, 1995). More valid comparisons of children are likely when the age range of the sample population is commensurate with the assessment instrument. Other studies have not controlled for socioeconomic status (SES) or health status, which are factors known to affect development (Aram et al., 1985). Another variable obscuring results has been the time of assessment relative to surgery. Developmental delays found after surgery may have antedated surgery and therefore cannot be attributed summarily to surgical events (Aram et al., 1985).

Psychometric measures have commonly been used to assess psychological and educational functioning (Iwamoto et al., 1990; Shampaine, Nadelman, Rosenthal, & Behrendt, 1990). However, full scale IQ scores have been used to make judgments about intelligence and the presence of learning disabilities (Hesz & Clark, 1988; Wells et al., 1983); rather than examining patterns of scores, as advocated by educational psychologists (Kaufman & Kaufman, 1983) and outlined by legal mandates. According to the State of California specific learning disability criteria, students are identified as having specific learning disabilities when they have a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written. This includes visual and auditory processing and sensory motor skills. Students must also demonstrate a severe discrepancy between intellectual ability and academic achievement.

The purposes of this study were (a) to determine whether subtle psychoeducational and physical problems can be identified before and after surgery in children of average intelligence with CHD; (b) to determine whether psychoeducational/physical differences exist between cyanotic and acyanotic children with CHD when age, SES, level of intellectual functioning and health status are controlled; and (c) to measure associations previously identified between educational and growth factors in a sample CHD population with average intelligence. It was hypothesized that (a) children of average intelligence with CHD would have a higher incidence of educational and growth problems than found in the general population and (b) cyanotic children with average intelligence would demonstrate a higher incidence of educational and growth problems than acyanotic children with average intelligence.

METHOD

Participants

Participants were 48 children (19 male, 29 female; 38 Caucasian, 8 Hispanic, 2 black) with CHD (ages 4 to 12, $M = 7$, $SD = 3$; preschool ages 4 to 5, $n = 24$; school ages 6 to 9, $n = 14$ and ages 10 to 12, $n = 10$) who were scheduled for elective cardiac surgery at a metropolitan children's hospital. Mean SES was middle class (Hollingshead, 1975). Twenty-five patients were classified by the cardiologist and surgeon as acyanotic with surgically correctable cardiac defects (Group 1) and 23 patients were classified as cyanotic with surgically palliative cardiac defects (Group 2). All participants met the following criteria: (a), at least average intelligence, estimated by cardiologist and later confirmed by psychometric assessment, (b) fluent in English, (c) no identifiable syndromes, (d) lived within the metropolitan area, and (e) agreed to participate in the study. Of 52 patients solicited for the study, two declined and two who initially agreed to participate did not complete the longitudinal assessment due to scheduling problems.

Measures

Approximately three weeks before the electively scheduled surgery, the cardiologist asked the primary caregivers and their children to participate in a year-long study of their psychological and physical development. After the informed consent forms, approved by the hospital IRB, were signed, baseline measures were completed under standardized conditions. Parents provided information including parental education, occupation and pertinent medical history, which was verified by hospital records. Standardized measures with established reliability and validity that have been used extensively in schools were selected to assess psychoeducational functioning and physical development. Height and weight were recorded at the time of test administration.

Intelligence and academic achievement were assessed by a school psychologist at baseline and one year after surgery using the *Kaufman Assessment Battery for*

Children (K-ABC; Kaufman & Kaufman, 1983). This test was selected because test norms are provided for children ages 3 to 12 which includes all of the participants in our sample population. More importantly, the K-ABC includes both intelligence and achievement scales in a single battery, which provides the ideal circumstance for comparing ability to achievement for children suspected of having learning disabilities. In addition, the K-ABC has often been included in neuropsychological evaluations and its development comes from neuropsychological theory. The Sequential (serial) processing versus Simultaneous (spatial) processing dichotomy stresses the relationship of the processing distinction to specific areas of brain function. The finding of a significant discrepancy between these processes is interpreted as evidence for the child's superiority and greater efficiency in processing information by one style rather than the other. Although the comparison of Sequential and Simultaneous processing scores was anticipated by the authors as a potential diagnostic indicator of learning disabilities, research has not robustly supported this position. However, Kaufman and Kaufman (1983) cite studies of learning disabled children where significant processing discrepancies were demonstrated and suggest that some learning disabled children have difficulty with integrated as well as sequential tasks.

Piaget and others have demonstrated the basic validity of sensory-motor bases for intelligence and achievement (Beery, 1989). Poor handwriting is frequently a sign of a learning disability, as defined in the California Education Code and factor analytic studies have indicated that visual-motor integration was the underlying, key factor for handwriting performance. Therefore our assessment included the *Developmental Test of Visual Motor Integration* (VMI; Beery, 1989), administered by an occupational therapist and a physical therapist at preop (baseline), one, four, and twelve months after hospital discharge. Gross and fine motor skills were assessed at the same time on the *Bruininks-Oseretsky Test of Motor Proficiency* (BOMP; Bruininks, 1978). The BOMP has previously been used to assess fine and gross motor skills in children with CHD (Wright & Nolan, 1995).

Approximately two months after returning to school, classroom teachers were contacted by phone by a medical social worker who asked them to compare the school functioning of their students with CHD to their typical peers by completing and returning *The Deasy-Spinetta Behavior Questionnaire* (DSBQ; Deasy-Spinetta & Spinetta, 1980), which was sent by mail. Length of time after returning to school, rather than length of time after surgery, was used for the teachers' reports to control for health status since recovery varied depending on severity of surgical procedures. Only one teacher did not complete the DSBQ after follow-up phone calls by the social worker. This questionnaire was selected for our study because it provides a comparison of the child with CHD to a typical classroom peer rather than require comparison to a norm group; teacher reports of academic achievement in reading, math, spelling and handwriting and information about special education placement for learning disabilities. The DSBQ is a well-validated 49-item "yes/no" checklist which rates adaptive functioning at school (learning abilities, rate of absenteeism, feelings and coping skills). The DSBQ was standardized on normal school children and children with cancer. It has also been used for CHD students to assess their school performance (Fowler, Johnson, Welshimer, Atkinson, & Frank, 1987). Research suggests that the educational performance of children with a variety of life-threatening illnesses can be assessed noncategorically, as done on the DSBQ, because students face common life experiences and problems based on generic dimensions of their conditions, rather than on idiosyncratic characteristics of any specific disease entity (Stein & Jessop, 1984).

RESULTS

In order to verify that there were clinical differences between groups, as categorized by the cardiologist and surgeon, medical/surgical experiences were analyzed using t-tests. Table 1 shows that Group 2 (cyanotic, palliative) experienced significantly more problems than Group 1 (acyanotic, correctible), reflected by percent operative risk estimated by the surgeon, number of prior hospitalizations, hours on ventilator, hours in ICU, post operative complications, days hospitalized and postoperative clinic visits ($p < .01$). Chi-square was used to analyze associations between categorical variables. There were no differences between the two diagnostic groups for age, sex, ethnicity or socioeconomic status (SES).

Children in both groups were significantly below height and weight compared to their healthy peers pre- and post surgery using national normative tables. Table 1 compares percentile means and standard deviations for the two groups derived from the National Center for Health Statistics (1976). Mann Whitney *U* tests were used to compare group differences in height and weight. Group 1 children were significantly heavier at preop than those in Group 2 ($p < .05$), but this weight difference was not found one year post operatively. Group differ-

Table 1 Medical Surgical Experiences/Growth Percentiles.

Group Comparisons: Mean Scores and Standard Deviations

	Group 1(n = 25) (Acyanotic)		Group 2(n = 23) (Cyanotic)		
Medical and Surgical Experiences	***M***	***SD***	***M***	***SD***	***t* score**
% Operative risk	1.9	1.6	7.5	5.3	-5.06**
# Prior hospitalizations	0.7	1.2	5.2	4.3	-5.01**
# Hours on ventilator	7.5	8.4	26.1	26.9	-3.27**
# Hours in ICU	38.2	14.6	68.1	49.3	-2.90**
# Postop complications	0.04	0.02	0.52	0.5	-5.93**
# Days hospitalized	4.5	2.2	9.7	7.5	-3.31**
# Postop clinic visits	3.4	1.3	4.7	2.0	-2.45**
Growth Percentiles - National Center for Health Statistics	***M***	***SD***	***M***	***SD***	***z* score**
Preop Height %tile	40	34	29	28	-1.13
Postop Height %tile	34	26	31	28	-0.42
Preop Weight %tile	37	29	21	25	-1.94*
Postop Weight %tile	44	32	33	26	-1.17

* $p < .05$
** $p < .01$

ences in height were not significant at either time. There was a significant percentile increase in weight for both groups from preop to one year postop ($p < .002$). Height did not change.

Intelligence (Sequential, Simultaneous and Mental Processing Composites) and academic achievement (reading, math, general level of information and language concepts) were assessed by the K-ABC. Table 2 provides pre- and one-year post operative mean scores and standard deviations.

Differences between Mental Processing Composite (MPC) standard scores and academic achievement standard scores were calculated for each participant to determine whether there was a discrepancy at the 95% confidence level ($p < .05$). Tables, provided in the K-ABC manual, were used to determine if the discrepancy was

significant for identifying a learning disability (Kaufman & Kaufman, 1983). MPC was significantly greater than achievement composite at pretest for 40% of Group 1 and 38% of Group 2. MPC was significantly greater than achievement at posttest for 38% of Group 1 and 44% of Group 2.

Differences between scores were calculated to determine whether the participant's Sequential and Simultaneous processing scores differed significantly from each other at the 95 percent confidence ($p < .05$) level, as outlined by Kaufman and Kaufman (1983). Sequential processing was significantly greater than Simultaneous processing at pretest for 40% of Group 1 and 52% of Group 2. A similar profile was found at posttest for 54% of Group 1 and 66% of Group 2.

Associations between continuous variables (i.e., ability scores) were assessed using regression analysis and their means compared (ANOVA). Although there were no significant differences between the two groups' intelligence test scores, Group 1 intelligence scores improved over time (Sequential, $p < .01$, Simultaneous, $p < .03$, MPC, $p < .001$), whereas Group 2 scores did not change. Group 1 academic achievement also improved over time ($p < .002$) and was significantly higher than Group 2 achievement one year after discharge ($p < .05$).

In order to determine if visual motor integration problems were a risk factor for learning disabilities in this sample population, individual VMI test scores completed at the same time as the K-ABC (baseline and one-year post operative) were examined. VMI scores were greater than one standard deviation below the mean at pretest for 28% of Group 1 and 38% of Group 2. Similar scores were found at posttest (23% of Group 1 and 33% of Group 2). When individual scores were examined for the pres-

Table 2 Intelligence and Academic Achievement (Pre-Post).
Group 1 and 2: Mean Scores and Standard Deviations

Kaufman Assessment Battery for Children (Mean = 100 SD = 15)

Pre-operative	**Group 1 (n = 25) (Acyanotic)**		**Group 2 (n = 21) (Cyanotic)**	
K-ABC Scales	***M***	***SD***	***M***	***SD***
Sequential Processing	110	13	111	13
Simultaneous Processing	103	10	101	10
Mental Processing Composite	107	11	106	11
Academic Achievement	102	11	100	15
One Year Post-operative	**Group 1 (n = 22) (Acyanotic)**		**Group 2 (n = 16) (Cyanotic)**	
K-ABC Scales	***M***	***SD***	***M***	***SD***
Sequential Processing	117	12	114	18
Simultaneous Processing	108	13	102	10
Mental Processing Composite	113	13	108	14
Academic Achievement	107	11	99	11

ence of a severe discrepancy between intellectual ability and achievement, as well as significantly below average visual motor integration, 12% of Group 1 at pre- and one-year posttests and 33% at pretest and 29% at posttest of Group 2 had a pattern of scores commensurate with a learning disabilities profile.

Multivariate analysis of variance (MANOVA) was used to determine if visual motor integration changed after surgery. Grouping factor was severity (Group 1 — acyanotic, correctible; Group 2 — cyanotic, palliative). Repeated factors were time (baseline at preop, one, four and twelve months postop) and VMI scores. There were no effects of time measured on the VMI. To compare Group 1 and 2 scores with published norms, 95% confidence intervals were calculated. Those confidence intervals which did not overlap with the means for the norm groups ($M = 100$) were interpreted as indicating significant difference. Table 3 provides VMI mean scores, standard deviations and confidence intervals. Univariate analysis showed that the mean score for Group 1 across time was significantly higher than for Group 2 ($p = .04$). One sample t-tests were used to compare Group 1 and 2 to the norm group. There were no differences between Group 1 mean scores and the norm. Group 2 mean scores were significantly lower than the norm ($p < .01$).

MANOVA was also used to determine if gross and fine motor skills changed after surgery. Grouping factor was severity and repeated factors were time and gross and fine motor composites. The 95% confidence intervals were calculated to compare Group 1 and 2 scores with published norms (Bruinicks, 1978). Those confidence intervals which did not overlap with the means for the norm groups ($M = 50$) were interpreted as indicating significant difference. There was a highly significant Group X Composite interaction effect ($p < .001$). Univariate analysis showed that the gross motor composite mean score for Group 1 across time was significantly higher than for Group 2 ($p = .004$), but there was no significant difference for the fine motor composite. There was no significant effect of Time, Group X Time or Composite X Time interaction. There were no gross or fine motor differences between Group 1 mean score and the norm group. Group 2 mean score was below the norm (-1 *SD*) Table 3 provides gross and fine motor composite and visual motor integration means, standard deviations and confidence intervals. Participant number varied due to scheduling and logistical problems.

School functioning as measured by the DSBQ was analyzed using the Wilcoxon Signed Rank test. The questions were scored under the author's guidelines (Deasy-Spinetta, 1981), whereby a total discrepancy score is derived (CHD children's mean composite score minus typical peers' mean composite score). Group 2 adaptive functioning at school was significantly below their typical peers ($p < .005$); whereas, Group 1 was functioning in the average range.

When answering specific questions on the DSBQ, teachers reported that students in both groups were more likely to have been labeled learning disabled than their typical peers ($p < .01$). Group 2 students had higher rates of absenteeism than Group 1 students ($p < .01$), who were not absent any more often than their typical peers. Teachers' responses on specific questions of the DSBQ indicated that the more complex the diagnosis, the more likely the child was to have problems at school ($r = .36$, $p < .04$).

In order to examine associations previously identified with educational and growth factors in children with CHD, Spearman correlations were computed. Significant correlations were found before surgery between the gross and fine motor skills composite scores (BOMP), visual motor integration (VMI), K-ABC mental processing composite (MPC), academic achievement (ACH) and level of school functioning (DSBQ; Table 4). These correlations generally remained one year after surgery except for the VMI. There were no significant correlations between DSBQ and height, weight, age, sex, SES nor prior number of hospital/surgical experiences. There were no significant correlations for height or weight with gross, fine, and perceptual motor development nor with intelligence or academic achievement.

DISCUSSION

The physical and psychological development of children with CHD was examined in order to evaluate their overall educational performance. Both of our hypotheses were confirmed in that the children were at risk for educational and growth problems regardless of severity of the cardiac defect and risk factors for learning problems increased with the severity of the defect.

A notable percentage of children in both groups demonstrated a significant discrepancy between intellectual potential, represented by their mental processing composite (MPC) and academic achievement and between Sequential and Simultaneous processing skills. This performance pattern on the K-ABC is often found for children with a learning disability (Kaufman & Kaufman, 1983). That is, when intellectual potential is significantly above academic achievement and cognitive processing abilities are significantly discrepant, the child may be

Table 3 Gross, Fine and Visual Motor Integration Skills
Group 1 and 2 Mean Scores and Standard Deviations

Bruininks-Oseretsky Test

	Gross Motor						Fine Motor					
	Group 1 (Acyanotic)			Group 2 (Cyanotic)			Group 1 (Acyanotic)			Group 2 (Cyanotic)		
Time	M	SD	n	M	SD	n	M	SD	n	M	SD	n
Preop	50.1	12.7	25	40.1	13.6	19	46.7	10.4	25	44.6	11.7	20
1 month Postop	45.8	10.3	23	35.1	12.1	18	47.3	11.8	23	43.3	10.7	19
4 months Postop	50.2	15.5	21	40.2	14.5	17	47.5	11.6	21	46.8	8.8	18
12 months Postop	50.5	11.1	23	37.7	17.4	17	48.4	11.4	23	44.6	12.2	18

Developmental Test of Visual Motor Integration (M = 100 SD = 15)

Time	Group 1 (Acyanotic)			Group 2 (Cyanotic)		
	M	SD	n	M	SD	n
Preop	99.8	10.9	25	92	9.9	22
1 month Postop	100	11.9	23	91.5	9.9	19
4 months Postop	99.3	11.4	21	91.7	8.8	17
12 months Postop	103	16.9	23	94	11.4	20

Gross, Fine, Visual Motor Integration (95% confidence intervals)

	Group 1 (Acyanotic)	Group 2 (Cyanotic)
Gross Motor Composite	45.0 - 54.4	31.3 - 44.8*
Fine Motor Composite	46.1 - 53.8	39.5 - 48.0*
Visual Motor Integration	95.6 - 105.5	88.7 - 96.3*

*Confidence interval *does not* overlap with the mean for the norm group

Table 4 Test Correlations
Kaufman Mental Processing Composite and Academic Achiebement, Beery Visual Motor Integration, Bruininks-Oseretsky Motor Proficiency, and Deasy-Spinetta Behavior Questionnaire

Preop Correlations (n = 43)	MPC	ACH	VMI	BOMP
Mental Processing Composite (MPC)				
Academic Achievement (ACH)	.64**			
Visual Motor Integration (VMI)	.43**	.34*		
BO Motor Proficiency (BOMP)	.32*	.46**	.64**	
DS Behavior Questionnaire (DSBQ)	-.36*	-.32*	-.37*	-.50**
One-Year Postop Correlations (n = 38)				
Mental Processing Composite (MPC)				
Academic Achievement (ACH)	.78*			
Visual Motor Integration (VMI)	.50**	0.30		
BO Motor Proficiency (BOMP)	.36*	0.26	0.32	
DS Behavior Questionnaire (DSBQ)	-.38*	-.38*	-0.23	-.49**

* $p < .05$
** $p < .01$

considered at risk for learning disabilities if there is also a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written. About five percent of the total population of school children are estimated to have learning disabilities as defined by the California Education Code. In our study, this pattern of scores was found for 12% of Group 1 (acyanotic, correctible) children at preop and postop, which is higher than the state prediction. In addition, 38% of Group 2 (cyanotic, palliative) at preop and 44% at postop met the state criteria for the learning disabled.

There were also other important differences between groups in our sample of children with CHD. Mental processing and academic achievement scores for Group 1 improved significantly one year after surgery; whereas, these scores did not change for Group 2. Significant pre/post surgery IQ changes have not been delineated in the literature although concerns regarding negative effects of surgery on intellectual functioning have been expressed (Clarkson, MacArthur, & Barratt-Boyes, 1982; Iwamoto et al., 1990). In our study, the number of prior surgeries and severity of diagnosis were not correlated with level of intelligence, as found in earlier studies (DeMaso et al., 1990). One explanation may be that the small range of IQ scores could limit the likelihood of achieving significant correlations between intelligence and these risk factors. However, severity of the defect

and degree of operative risk were negatively correlated with academic achievement. Because academic achievement was not controlled by the research selection process, as was the level of intelligence, a broader range of academic scores might be expected. The association of severity of the cardiac condition and achievement levels appears to be a valid finding which is corroborated by earlier research (Morris et al., 1993). Furthermore, children with cyanotic CHD have been retained in school more often than their peers (Nuutinen et al., 1989). One explanation of the differences in performance between groups found in our study is that for Group 1, the surgery was corrective and likely to be their only cardiac operation, so improvement in performance might be predicted. For Group 2, the surgery was palliative, so significant functional improvement would be less likely.

Although few studies have assessed learning disabilities in children with CHD, neurological dysfunction has been identified as a morbidity factor (Ferry, 1990; Miller, Mamourian, Tesman, Baylen, & Myers, 1994; O'Dougherty et al., 1983; Savageau et al., 1982). One explanation for the frequency of learning disabilities is that the cardiac defect produces hemodynamic changes which affect brain functioning (Aram et al., 1985); however, we concur with O'Dougherty et al. (1983) that a single explanation for IQ variability is unlikely when the many factors influencing cognitive development are considered.

It has been suggested that hypoxemia also plays a role in the delay of motor functioning of cyanotic children (Bellinger et al., 1995; Gonzales-Pardo, 1981). Group 1 children who were acyanotic and had less severe cardiac defects performed similarly to the norm for gross, fine and visual motor integration skills; whereas Group 2 children were similar to the norm for fine motor skills, but below the norm for gross and visual motor integration skills. It may be that children with an illness, such as CHD, are more likely to focus on developing fine motor skills, rather than more physically demanding gross motor skills that are dependent on strength. Motor development deficits, as found in our study, are consistent with the literature — they have long been associated with severity of diagnosis (Wright, Hicks, & Newman, 1979) and cyanotic children have demonstrated both reduced gross motor performance and perceptual motor skills (Rausch de Traubenberg, 1970). Also consistent with our findings, visual motor integration level has been associated with level of intelligence and the presence of learning disabilities (Beery, 1989). Although no significant correlations between academic achievement measured on the K-ABC and gross and fine motor development were found in our study, motor skills were significantly correlated with teachers' reports of school achievement and they are considered to be an important factor in children's functioning (Wright & Nolan, 1995).

School functioning was rated on the DSBQ by classroom teachers who compared the attitudes and behaviors of the children with CHD to those of their typical classroom peers. There were significant differences when considering diagnostic group. For children in Group 1, overall school functioning was similar to their typical peers, whereas children in Group 2 were functioning below their typical peers. Nevertheless, teachers reported that students in both groups were more likely to have identified learning disabilities than the typical student.

Teachers also identified students in both groups as having problems with socialization. They reported that Group 2 was commensurate with the average student in terms of general classroom behavior, but they also described Group 2 as immature and complaining. Group 1 behaved better than the average student, but was described as withdrawn and having difficulty interacting with peers. It may be that teachers see Group 1 as well-behaved in a constricted sense; that is, not creating a problem for the teacher, but not exhibiting normal, healthy behavior either. Our results supported those found by Utens et al. (1993) that CHD patients with normal IQ scores had more internalizing than externalizing problems, reflecting greater social isolation, than their referent group. A similar behavior pattern was described by Oates, Turnbull, Simpson and Cartmill (1994), who found that children with CHD were fearful and inhibited, rather than demonstrating antisocial, acting out behavior, and Kramer et al. (1989), who reported increased feelings of anxiety in CHD children.

Children in both groups were below average for height and weight pre- and post surgery, which is consistent with the literature (Nuutinen et al., 1989). Nevertheless, percentiles for weight improved after surgery for both groups, whereas there were no improvements in height pattern. We suggest that the weight increase reflects increased oxygenation of the tissues secondary to more efficient cardiac output following surgery. However, as with cognitive and motor development, the causes of growth retardation in children with CHD are multiple and not well understood (Gonzales-Pardo et al., 1981; Wright & Nolan, 1995).

We did not find a correlation between growth failure and low intellectual functioning or academic achievement as previously identified in the literature (Kramer

et al., 1989; O'Dougherty et al., 1983). This may also be due to the selection criterion for inclusion in the study, which required participants to have at least average intelligence. That is, since children with gross problems in cognitive functioning were not included in the sample population, such associations might not be found due to the limited range of intellectual functioning of the participants.

In summary, both strengths and weaknesses of children with CHD were identified in this study. Children with both acyanotic and cyanotic conditions showed evidence of psychoeducational problems. This is consistent with Yang, Liu and Townes (1993) who found acyanotic heart disease negatively impacted neuropsychological and behavioral functioning even though the children appeared to be healthy. We concur with Wright and Nolan (1995) that the increased incidence of educational problems and the nature of the cognitive difficulties in children with corrective cardiac surgery are not fully explained by chronic hypoxia or by other factors related to surgery. We agree with Schlieper (1985) that delay in physical growth and development, learning disabilities, poor social skills and high rates of absenteeism exacerbate school problems.

Neither an exclusive focus on the children's physical health or an overemphasis on the negative, psychosocial aspects of the illness seems warranted. Rather, there is value in an approach that examines individual, identified patterns of potential weaknesses in conjunction with developing remedial strategies and alternative coping styles based on identified strengths. This may provide alternative methods of assisting these children and their families in making optimum physical and psychological adaptations in their world because children with CHD are at risk of having problems in school despite continuing improvements in surgical and medical management. For the pediatrician, as well as the educator, there needs to be recognition that these children can have significant learning problems even when the operation is successful.

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