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## Effects of Prenatal Alcohol Exposure on Neuromotor and Cognitive Development During Early Childhood: A Series of Case Reports

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# Effects of Prenatal Alcohol Exposure on Neuromotor and Cognitive Development During Early Childhood: A Series of Case Reports

The purpose of this article is to present a series of case reports of infants and young children who were exposed to alcohol prenatally. The five infants and two 5-year-old twins in this series all presented facial features characteristic of prenatal alcohol exposure, and all had medical histories of maternal alcohol abuse. The neuromotor and cognitive development of these seven children is described by presenting results of standardized tests administered longitudinally. In addition, clinical observations of growth, behavior, feeding, and musculoskeletal development are provided. Following a discussion of these assessment results, implications for physical therapy intervention and the need for clinical research are provided. Because children with fetal alcohol syndrome or alcohol-related birth defects present a spectrum of developmental differences that often include areas of concern to physical therapists, we need to increase our involvement in the assessment and treatment of these children as well as in research efforts to examine the efficacy of these interventions. [Harris SR, Osborn JA, Weinberg J, et al. Effects of prenatal alcohol exposure on neuromotor and cognitive development during early childhood: a series of case reports. *Phys Ther.* 1993;73:608-617.]

**Key Words:** Cognitive development, Fetal alcohol syndrome, Neuromotor development.

Despite the publication of "several thousand scientific communications" concerning the teratogenic effects of

prenatal alcohol exposure<sup>1</sup> since fetal alcohol syndrome (FAS) was first recognized in 1973,<sup>2</sup> no reports could

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be located in the physical therapy literature describing the assessment or treatment of individuals with FAS. The purpose of this report, written as a companion article to the clinical perspective on FAS by Osborn and colleagues in this issue, is to present a series of case reports of infants and young children with either FAS or alcohol-related birth defects (ARBD) who have been assessed longitudinally by physical therapists and other health professionals. To be diagnosed with FAS, individuals must be characterized by abnormal signs in each of three areas: growth retardation; central nervous system (CNS) involvement; and characteristic facial features including short palpebral fissures, flat nasal bridge, flat philtrum, thin upper

lip, and flattened maxilla.<sup>1</sup> The term *alcohol-related birth defects* was coined recently to describe "attribution of an observed anatomic or functional outcome to the impact of alcohol on the offspring" and has been recommended to replace the term *fetal alcohol effects*.<sup>1(p598)</sup>

The primary goal of the following case reports is to describe the neuro-motor and cognitive development of these children and discuss behavioral characteristics that may differentiate them from typically developing children. A secondary goal is to suggest implications for treatment based on these assessment findings.

Although a number of published studies have described neonatal behavioral differences in infants with FAS<sup>3-5</sup> as well as developmental motor outcomes at a variety of different ages,<sup>6-11</sup> none of these reports have provided assessment data collected at repeated intervals (eg, every 4 to 6 months during infancy and early childhood). Following are case reports for five infants with histories of prenatal alcohol exposure who were assessed at least three times during the first 2 years of life. These case reports describing infant development are followed by case reports of a set of female monozygotic twins who were followed longitudinally from the age of 2 years 6 months to the age of 5 years 1 month by an interdisciplinary developmental assessment team. Emphasis will be placed on describing the two most recent developmental assessments of the twins.

In presenting these seven cases of children with FAS or ARBD, our goal is to highlight the neuromotor and cognitive findings resulting from the administration of standardized tests. Growth, behavioral, feeding, and musculoskeletal concerns will also be presented. Implications for physical

therapy intervention and clinical research will follow the presentation of the case reports.

### **Case Reports of Infants With FAS or ARBD**

All five infants were tested by the senior author (SRH) as part of a longitudinal development follow-up program for infants with diagnoses of neonatal addiction syndrome. All testing took place at Sunny Hill Hospital for Children in Vancouver, British Columbia, Canada, from 1990 to 1992. Tests administered included the Movement Assessment of Infants (MAI),<sup>12</sup> a 65-item neuromotor assessment tool that was administered at the first two visits (at approximately 4 and 8 months of age), and the Mental and Motor Scales of the Bayley Scales of Infant Development,<sup>13</sup> a standardized, norm-referenced assessment tool that has been used widely in longitudinal follow-up of high-risk infants. The Bayley Scales were administered at each of the follow-up visits. The MAI and the Bayley Scales were selected as appropriate tools for use in our follow-up clinic because infants exposed to drugs prenatally are at risk for neuromotor as well as cognitive deficits.<sup>14,15</sup> The purpose of the testing was to discriminate which infants were in need of early intervention services. The senior author has extensive clinical and research experience in administering these tests and also has provided numerous workshops on administration of each of these tools.

Based on a sample of 35 high-risk infants, the authors of the MAI manual have suggested the following ranges for total risk scores at 4 months of age: 0-7=within normal limits, 8-12=suspect, and  $\geq 13$ =abnormal.<sup>12</sup> For the 8-month profile, a total risk score of  $> 10$  is considered cause for concern. Both the Mental Develop-

mental Index (MDI) and the Psychomotor Developmental Index (PDI) of the Bayley Scales have a mean of 100 and a standard deviation of 16.<sup>13</sup> The standard errors of measurement (68% confidence intervals) for the MDI and PDI vary, depending on the infant's age at testing (Tab. 1).

The five infants tested in this series all showed facial features suggestive of prenatal alcohol exposure and were born to mothers with histories of prenatal alcohol abuse. Many of the mothers also smoked during pregnancy. Other drugs used during pregnancy included cocaine, heroin, diazepam (Valium®\*), triazolam (Halcion®†), and lorazepam (Ativan®‡). As is typical of children with FAS/ARBD, all children described in the case reports were prenatally exposed to other drugs in addition to alcohol. Thus, it is virtually impossible to sort out the effects of the alcohol from the effects of the other drugs. For four of the five infants, the initial developmental assessment took place between 4 and 6 months of age; the infant described in the fourth case report was almost 9 months of age when first assessed. Subsequent follow-up visits were scheduled to occur at approximately 8, 12, and 18 months. Most of the infants were assessed within  $\pm 1$  month of these scheduled visits (Tab. 1).

#### **Infant 1**

The first infant was a Native American boy who had been in foster care since early infancy. According to his hospital chart, his mother had a history of "drug and alcohol ingestion" during pregnancy. He was assessed initially at 5 months of age; his fourth and most recent assessment was conducted at 18 months. Because he presented abnormal characteristics in all three categories associated with prenatal alcohol exposure (growth retardation, CNS involvement, and characteristic facial features), a diagnosis of FAS was made. Although initially in the 25th percentile for height and weight and above the 10th percentile for head circumference, the infant's growth parameters fell off

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†The Upjohn Company, Kalamazoo, MI 49001.

‡Wyeth-Ayerst Laboratories, Div of American Home Products Corp, PO Box 8299, Philadelphia, PA 19101.

**Table 1.** Bayley Mental Development Index (MDI) and Psychomotor Developmental Index (PDI) and Movement Assessment of Infants (MAI) Test Scores at Each Follow-up Assessment<sup>a</sup>

Infant and Assessment Tool	Age Range (mo)			
	4-6	7-9	11-13	18-20
<b>Infant 1</b>				
Bayley MDI	86	73 <sup>b</sup>	60 <sup>b</sup>	81 <sup>b</sup>
Bayley PDI	80 <sup>b</sup>	73 <sup>b</sup>	75 <sup>b</sup>	75 <sup>b</sup>
MAI	6	15 <sup>b</sup>	...	...
<b>Infant 2</b>				
Bayley MDI	89	77 <sup>b</sup>	<50 <sup>b</sup>	<50 <sup>b</sup>
Bayley PDI	108	67 <sup>b</sup>	55 <sup>b</sup>	62 <sup>b</sup>
MAI	14 <sup>b</sup>	...	...	...
<b>Infant 3</b>				
Bayley MDI	104	83 <sup>b</sup>	92	...
Bayley PDI	118	96	97	...
MAI	1	3	...	...
<b>Infant 4</b>				
Bayley MDI	...	<50 <sup>b</sup>	50 <sup>b</sup>	<50 <sup>b</sup>
Bayley PDI	...	69 <sup>b</sup>	59 <sup>b</sup>	<50 <sup>b</sup>
MAI	...	24 <sup>b</sup>	...	...
<b>Infant 5</b>				
Bayley MDI	91	69 <sup>b</sup>	84	100
Bayley PDI	85	80 <sup>b</sup>	98	94
MAI	8 <sup>b</sup>	10 <sup>b</sup>	...	...

<sup>a</sup>Standard errors of measurement (68% confidence interval) for the Bayley MDI are  $\pm 4.6-5.7$  at 4-6 months,  $\pm 6.9$  at 7-9 months,  $\pm 6.7$  at 11-13 months, and  $\pm 5.3$  at 18-20 months; those for the Bayley PDI are  $\pm 5.4-7.0$  at 4-6 months,  $\pm 6.6$  at 7-9 months,  $\pm 5.8$  at 11-13 months, and  $\pm 4.6-5.5$  at 18-20 months.<sup>13</sup>

<sup>b</sup>Scores that are suspect or abnormal.

such that, at 18 months, he was below the 5th percentile for height, weight, and head circumference.

Craniofacial features characteristic of FAS included brachycephaly, short palpebral fissures, low-set ears, small nose, smooth philtrum, and thin upper lip. The infant demonstrated other characteristics associated with prenatal alcohol exposure such as abnormal palmar creases, small fifth fingers, and pectus excavatum. Although his 4-month MAI total risk score was within normal limits (Tab. 1), his 8-month risk score was 15, which is above the recommended cut-off score of 10 and thus suggests movement concerns. At both of these early visits, MAI concerns included

generalized hypotonia, persistent primitive reflexes (asymmetrical tonic neck reflex, tonic labyrinthine reflex-supine, trunk incurvatum reflex), delayed head-righting reactions, tremulousness, and delays in fine and gross motor milestones.

The infant's Bayley MDI had shown considerable variability. Although his initial assessment was in the low normal range, subsequent MDIs were from 1.0 to 2.5 standard deviations below the mean. His Bayley PDI was quite consistent across the four visits, ranging from about 1.0 to 1.5 standard deviations below the mean (Tab. 1).

As is typical of infants exposed to alcohol or other drugs prenatally, the infant had frequent episodes of profuse sweating (diaphoresis). He also has had a history of feeding and drinking difficulties, gagging on anything other than pureed food at age 12 months and eating only pureed or junior baby foods at age 18 months. He continued to drink from a bottle at age 18 months. During the first year postnatally, he also had a history of vomiting and constipation. He showed persistent and sustained attention during administration of the Bayley Scales at his most recent visit at 18 months. At each of the four testing sessions, he was noted to be very sociable and cooperative.

## Infant 2

The infant described in the second case report was a boy of apparently mixed Native American and Caucasian heritage. He was born at 36 to 37 weeks' gestational age and had been in foster care since hospital discharge in early infancy. Prenatal maternal history included periodic drinking bouts (seven to eight beers) as well as use of heroin, intravenous cocaine, Valium®, Halcion®, and Ativan®. He was assessed initially at 4 months of age (corrected for prematurity), at which time a number of dysmorphic features were noted including short palpebral fissures, epicanthal folds, flat nasal bridge, flat philtrum, thin upper lip, bilateral hair whorls, and low-set ears. Because his growth had consistently fallen between the 60th and 90th percentiles, he would not qualify for a diagnosis of FAS but rather would be described as having ARBD, in spite of the fact that his developmental delays were much more significant than those of infant 1.

When assessed initially at 4 months, his Bayley scores were both within normal limits, although the MDI was in the low normal range. His MAI total risk score, however, was considered abnormal due to a predominance of risk items reflecting generalized hypotonia, persistent primitive reflexes (asymmetrical tonic neck reflex, palmar grasp, and tonic laby-

rinthine reflex-supine), delayed head-righting reactions, and failure to show any response (eg, eye widening, stilling) to the sound of the Bayley bell or rattle. He was noted also to have astasia (refusal to bear weight on his feet when placed in supported standing). Because of the MAI concerns, this infant was reassessed at approximately 6.5 months' corrected age, at which time his Bayley MDI had dropped to about 1.5 standard deviations below the mean and his PDI had decreased to 2.0 standard deviations below the mean. At his two most recent visits (approximately 12 and 19 months' corrected age), his MDI had dropped to  $>3.0$  standard deviations below the mean and his PDI had decreased to about 2.5 standard deviations below the mean.

Musculoskeletal concerns noted in this infant at the first visit were bilateral talipes equinovarus and tibial bowing, for which he was treated with corrective shoes prescribed by a pediatric orthopedist. Because the infant could actively dorsiflex his ankle and evert his foot following tactile stimulation of the lateral border of the foot, the equinovarus appeared to be functional rather than structural. It had resolved by his last visit, although there was still some evidence of tibial bowing, which became particularly noticeable after he started walking. Another concern noted at the 4- and 6.5-month visits was lack of auditory responses to the Bayley bell and rattle. A subsequent audiology assessment at 10 months of age, however, indicated his hearing was normal.

The infant had consistently shown very unusual behaviors, including a flat affect, perseverant hand-waving, and staring at his left hand, at the initial 4-month visit. During his most recent visit, his mood fluctuated from extreme fussiness to smiling and laughing, with no apparent stimulus for either behavioral state. In addition, he demonstrated a number of "autistic-like" behaviors including intense stranger anxiety, unusual fears of inanimate objects, tactile and oral hypersensitivity, perseverant motor

behaviors and vocalizations, rocking and other self-stimulatory behaviors, and obsessive interest in spinning the wheels on his stroller.

The infant had also had persistent feeding problems and, at the corrected age of 19 months, would eat only pureed foods and drink only from a bottle. He would not finger-feed nor had he ever brought food, toys, or any other objects to his mouth to either taste or explore them—behaviors that are universally characteristic of typically developing infants.

### **Infant 3**

The third infant, also a Native American boy, had some characteristics to suggest ARBD. By physician's report, his mother consumed 4 to 6 beers per day during the first month of pregnancy. She also smoked cigarettes and took other drugs until about the fourth month of gestation. Although not growth-retarded, the most noticeable physical characteristic of this infant was microphthalmia (small eyes). Other characteristic features include a broad, flat nasal bridge and low-set ears. Although his growth continued to be within normal limits, his weight and head circumference had dropped at his most recent visit (approximately 13.5 months of age) from the 50th to the 25th percentile.

At his initial assessment at about 5.5 months of age, the infant had Bayley and MAI scores that were well within normal limits; his Bayley PDI was  $>1.0$  standard deviation above the mean (Tab. 1). At his second visit, at age 9 months, his MDI had dropped to 83, which is just slightly greater than 1.0 standard deviation below the mean. Reportedly, his mother was continuing to drink and abuse drugs while this infant and his two older brothers were living with her. Just after his second follow-up visit, this infant and his brothers were taken from his mother to be cared for by their maternal grandparents.

By the child's third follow-up visit at about 13.5 months of age, he had

been living with his grandparents for the past 3.5 months in an environment that was obviously much more stable and nurturing than his previous home situation. At that most recent visit, his MDI had increased 9 points such that it was again within normal limits, albeit on the low side of normal. His PDI remained solidly within normal limits. There are at least two possible explanations for the increase in his cognitive score. The standard error of the mean for the Bayley Mental Scale was approximately 6 to 7 points at these latter two assessment ages. His "true score," therefore, was  $\pm 6$  to 7 points at each of the assessments, a factor that could easily have contributed to the 9-point improvement noted. Another, more tempting hypothesis is that the change in home environment may have positively influenced his performance.

Based on his overall performance, this infant was the least impaired of the five infants in this series. His growth was still within normal limits, and his most recent developmental testing demonstrated age-appropriate performance. He was very cooperative and compliant during all three evaluation sessions.

### **Infant 4**

The fourth infant in this series, a girl, was assessed initially at almost 9 months of age. Of apparently mixed (Native American and Caucasian) heritage, this infant was born at 38 weeks' gestational age and weighed 2,400 g. She had been in foster care since 4 months of age. At birth, a "mildly sunken nasal bridge" as well as tremors, excessive crying, sneezing, diarrhea, and irritability were observed by the hospital pediatrician. Other dysmorphic characteristics were a small upturned nose, epicanthal folds, flat midface, thin upper lip, flat philtrum, and dysplastic toenails. Her mother had a long history of drug use, including cocaine, marijuana, and alcohol. This infant's growth had varied between the 10th and 50th percentiles, but her growth rate did not appear to be decelerating.

**Table 2.** Characteristic Features of Prenatal Alcohol Exposure and Their Presence in the Five Infants Studied\*

Characteristic	Infant No.				
	1	2	3	4	5
Growth retardation (<10th percentile)	+	-	-	-	-
Characteristic facial features	+	+	+	+	+
Cognitive delay	+	+	-	+	±
Motor delay	+	+	±	+	±
Generalized hypotonia	+	+	-	+	±
Feeding/oral-motor concerns	+	+	-	-	-
Orthopedic abnormalities	+	+	-	-	-
Behavioral concerns	-	+	-	+	+

\*+ = characteristic was present, - = characteristic was not present, ± = variability in appearance of the characteristic across repeated assessments.

Developmentally, this infant demonstrated consistent and significant delays during all three testing sessions. At her initial assessment, both Bayley scores and the MAI score were abnormal (Tab. 1). The MAI total risk score of 24 reflected the following concerns: generalized hypotonia, tremulousness, delayed automatic reactions, inconsistent auditory and visual responses, and delayed gross motor and fine motor skills. Many of these concerns persisted into the second visit at approximately 13.5 months. Other behavioral concerns noted at the second visit included a flat affect and stranger anxiety.

By the third and final follow-up visit at almost 20 months of age, the infant's Bayley scores were >3.0 standard deviations below the mean. She had a very stiff quality of movement and persistent W-sitting posture. Other unusual behaviors noted were frequent dropping or throwing of test materials, abnormal fear of inanimate objects (eg, the small Bayley ball), and self-abusive face-slapping. Her foster mother reported twice-daily temper tantrums, tactile hypersensitivity of the scalp, and an abnormal fear of being placed in the bathtub. The infant's flat

affect persisted, with the only changes in expression resulting from her unusual fears or her tantrums. Both developmentally and behaviorally, this infant exhibited severe disturbances that were somewhat similar to those of the infant in case report 2.

### Infant 5

The fifth and final infant in this series was a Native American girl whose mother was reported to have consumed beer and other alcoholic beverages and to have smoked marijuana during pregnancy. Born full-term at 3,360 g, this infant showed signs of withdrawal including sneezing, irritability, diarrhea, and diaphoresis. Characteristic facial features included flat nasal bridge, short palpebral fissures, and ocular hypertelorism. This infant was also noted to have a high arched palate. Her growth continued at ≥50th percentile.

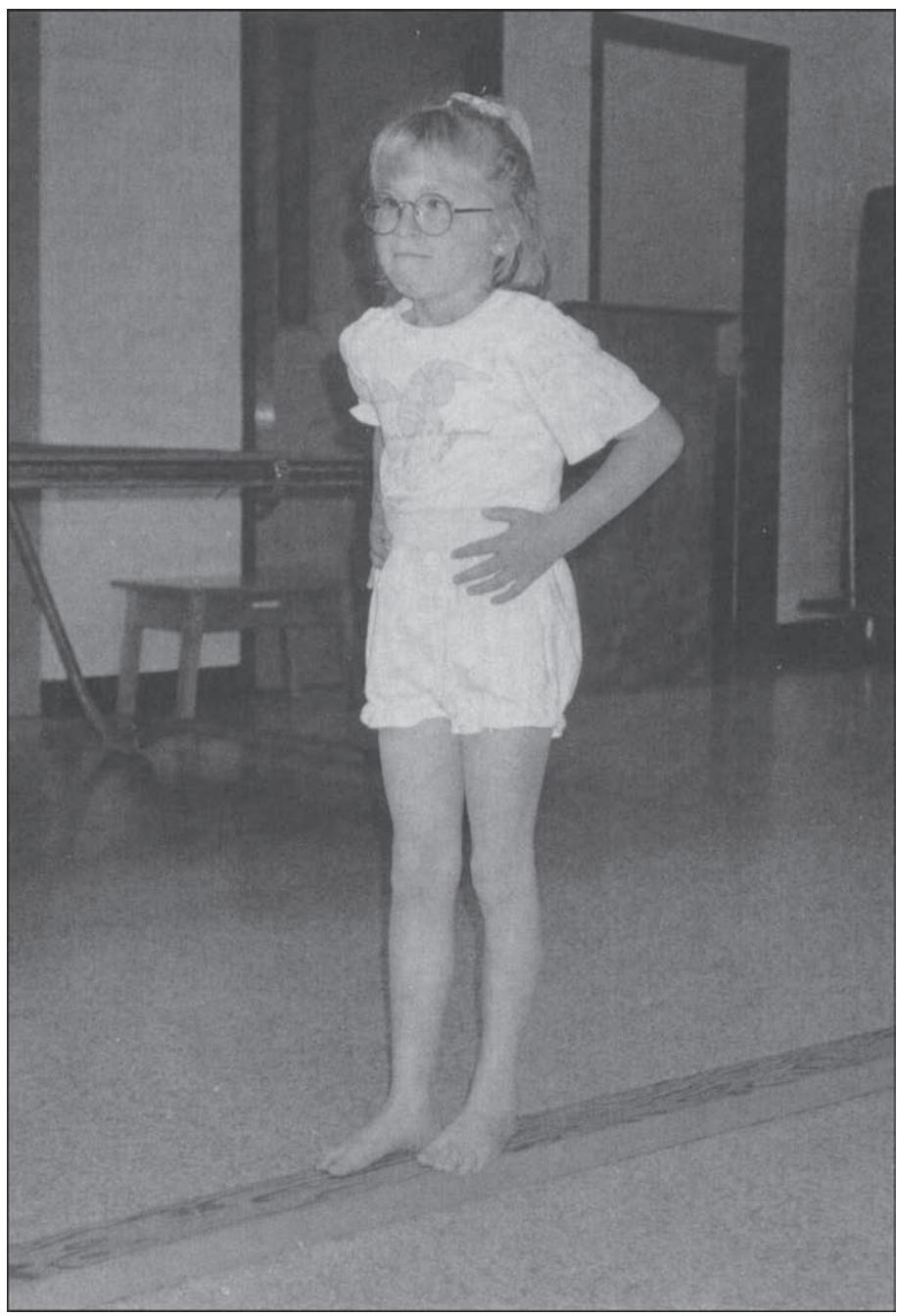
The infant was assessed initially at almost 5 months of age, at which time her Bayley scores were in the low normal range and her MAI total risk score was in the suspect range (Tab. 1). Risk behaviors noted on the MAI included increased tone in hip adduc-

tors, retention of tonic labyrinthine reflex-supine, upper-extremity tremulousness, astasia, and immaturity in development of automatic reactions.

During the infant's second visit at almost 9 months of age, her Bayley MDI had dropped to almost 2.0 standard deviations below the mean and her Bayley PDI had decreased only slightly to just greater than 1.0 standard deviation below the mean. The MAI total risk score was right at the cutoff for being concerning; muscle tone (as assessed by consistency, extensibility, and antigravity postures) and primitive reflexes were observed to be within normal limits, but automatic reactions were slightly immature. At 13 months of age, both Bayley scores improved considerably such that they were both within normal limits again. The child's foster mother reported a number of behavioral concerns, however, including screaming and "thrashing of arms" and throwing herself backward both when challenged or when unprovoked. Other concerns expressed included the child's lack of fear, lack of realization of dangers, pulling her hair out, hitting herself and others, and sudden outbursts of temper.

### Summary of Infant Cases With Implications for Treatment and Research

As can be seen from these case reports, prenatal exposure to alcohol and other drugs results in a variety of neuromotor, cognitive, behavioral, and musculoskeletal abnormalities (Tab. 2). Only one of the five infants (infant 1) is currently growth retarded and, therefore, the only one with a diagnosis of full FAS. Interestingly, this infant has fared much better developmentally and behaviorally than two of the other infants (2 and 4) who would be classified as having ARBD, reinforcing the notion that prenatal alcohol exposure results in a diverse continuum of disabilities. Physical therapists should be aware that alcohol exposure can result in a wide spectrum of developmental delays and behavioral concerns in



**Figure 1.** Twin A walking forward on balance board, hands on hips (item 143 from Peabody Gross Motor Scale).

both infants with diagnoses of FAS and infants with ARBD.

Each of these five infants is enrolled in a provincially funded Infant Development Program (IDP) that provides home-based early intervention and family consultation approximately twice a month. In addition, three of the infants (1, 2, and 4) receive physical therapy services through their IDP.

During their first 12 to 15 months postnatally, the physical therapy was developmentally based direct service and included activities such as promoting hands-to-midline and hands-to-knees, encouraging active trunk rotation and movement into and out of sitting, facilitating quadrupedal and knee-standing activities, and encouraging independent walking. Once these children attained independent

ambulation, physical therapy intervention changed to a consultation or monitoring model with emphasis on balance activities (balance board, balance beam) and developmentally appropriate play activities. For example, the consultation program for infant 4 involved a series of gross motor and fine motor activities at various stations in a large room in the preschool where she was encouraged to move from station to station and engage in the various activities. Because the ability to play spontaneously is frequently lacking in these children, these are very appropriate and functionally oriented activities.

In the case of infant 2, the physical therapy focus changed from gross motor activities during the first postnatal year to consultation regarding his feeding and behavioral concerns. A recent visit by the senior author to this child's preschool classroom indicated that, at the age of 27 months, he was still refusing to eat any solid foods, such as crackers, cookies, or fruit. Attempts by the senior author at using tactile desensitization strategies in the oral area with this youngster resulted in his taking a small bite of a banana. It would be interesting to involve children similar to this child in single-subject research designs aimed at improving their eating abilities through either neurodevelopmental or behavioral intervention strategies.

There have been no published studies in which the effectiveness of early-intervention strategies has been assessed for children with FAS or ARBD. The use of treatment techniques to influence target behaviors, such as oral-motor therapy for feeding difficulties or balance activities to enhance balance or postural control, should be assessed. Physical therapists who are involved in the care and treatment of these children could contribute greatly to the examination of treatment efficacy for these children.

### **Case Reports: 5-Year-Old Identical Twins With FAS**

The next two case reports describe a set of Caucasian monozygous female



**Figure 2.** Twin A walking forward on 1.2-m (4-ft) circle (item 100 from Peabody Gross Motor Scale).

twins with FAS who were tested most recently at the age of 5 years 1 month. Born at term, twin A weighed 2,530 g and twin B weighed 1,820 g (a birth weight of <2,500 g at term is considered small for gestational age). Delivery was by emergency cesarean section due to fetal distress. The pregnancy was unplanned and was not confirmed until the fourth month of gestation. The birth mother was em-

ployed as a cocktail waitress and recalled drinking two or three Irish coffees each evening after work, five or six nights per week. Based on physician reports in her hospital chart, she had been a heavy smoker (approximately one pack per day) and may also have used marijuana. Private adoption was planned prior to delivery and took place when the twins were 3 weeks of age.

Early history was significant for sleep disturbances and difficulties with feeding. The twins were referred for pediatric and developmental assessments at 8 months of age because of hypotonia and delays in motor milestones; they had poor head control and were unable to sit independently. Chromosome assessment revealed normal karyotypes. Fetal alcohol syndrome was subsequently diagnosed at 25 months of age based on the overall developmental delays; growth retardation (height and weight at  $\leq$ 10th percentile); and characteristic facial features including short palpebral fissures, flattened midface, long philtrum, and thin upper lip.

### Twin A

Twin A was assessed initially at 33 weeks of age on the Gesell Developmental Schedules<sup>16</sup>; her gross motor level was found to be at 20 weeks or roughly 60% of her age level. At 22½ months on the Gesell measure, she was functioning at 13 to 15 months in gross motor skills. The Bayley Mental Scale was administered at 28 months, with a resultant MDI of 67; twin A's estimated level of gross motor development at 28 months was 16 to 18 months. She was assessed initially on the Gross Motor Scale of the Peabody Developmental Motor Scales (PDMS)<sup>17</sup> at 41 months of age, at which time her age equivalent was 18 to 23 months (about 50% of age level).

The most recent interdisciplinary assessments for both twins occurred at the age of 4 years 5 months (53 months). Psychological assessment for twin A showed a Stanford-Binet IQ of 71 (low average range), with relative strengths in auditory and language tasks and relative weaknesses in complex visual tasks, auditory memory, and spatial relations. Receptive and expressive vocabulary were at the 3-year-9-month (45-month) level, with visuomotor integration at the 38-month level. Physical therapy assessment reported low truncal tone, mildly lordotic posture, tight heel-cords, and a tendency to run stiffly and on her toes; her gross motor age equivalent on the PDMS was 29 to 35



**Figure 3.** Twin B walking forward on balance board, hands on hips (item 143 from Peabody Gross Motor Scale).

months (about 60% of age level). Medical concerns noted at this visit

included recurrent serous otitis media, a history of esotropia, and a history of tremulousness.

At 5 years 1 month (61 months), the Gross Motor Scale of the PDMS<sup>15</sup> was administered to twin A by a physical therapist (senior author). The PDMS was chosen because it is a standardized, norm-referenced test that has been used extensively for assessing motor development of children with a variety of different developmental delays. During and immediately following administration of the PDMS, clinical observations of muscle tone, range of motion, and automatic reactions were made. Apparent joint hyperextensibility was noted, as evidenced by slight elbow hyperextension and slight genu recurvatum (Fig. 1). Primitive reflexes had all been integrated. She had sufficient automatic reactions to maintain upright balance while running or walking on a balance beam. Twin A was noted to be able to run, hop on one foot, walk on the balance board, attempt to skip, and walk on a circle (Fig. 2). She had a basal age on the PDMS of 18 to 23 months and a ceiling age level of 54 to 59 months. Her gross motor age equivalent was 39 to 40 months, which was approximately 65% of age level. Percentile scores for the gross motor subtests and the total score were all at either the 1st or 2nd percentile, indicating that 98% to 99% of her age-mates were performing at higher levels.

Twin A was noted to be cooperative during testing, although she became somewhat tired and frustrated toward the end of the 2-hour testing session.

#### **Twin B**

Like her sister, twin B was assessed initially on the Gesell instrument at 33 weeks of age; her gross motor level was 24 weeks or about 70% of age level. At 23 months, her gross motor skills were in the 12- to 15-month range on the Gesell measure (about 60% of age level). Her Bayley MDI at 28 months was 69, and her gross motor age level was estimated at 16 to 18 months (60% of age level). At

the interdisciplinary assessment at 4 years 5 months (53 months), twin B received a Stanford-Binet IQ score of 72 (low average range), with relative strength in visual memory and relative weaknesses in spatial tasks and short-term auditory memory. Receptive and expressive vocabulary were at the 3-year-7-month level as was visuomotor integration. As with twin A, physical therapy assessment at this time reported truncal hypotonia and a mildly lordotic posture; her gross motor age equivalent on the PDMS was equivalent to that of her sister (29–35 months) at about 60% of age level. Medical concerns included recurrent serous otitis media and a history of tremulousness.

The Gross Motor Scale of the PDMS was readministered to twin B at 5 years 1 month (61 months) by a physical therapist (KJ). Clinical observations indicated that muscle tone and range of motion, although not assessed, appeared to be within normal limits. Automatic reactions included the ability to stand on the dominant foot (one-footed balance) for up to 6 seconds and on the nondominant foot for 3 seconds. Twin B, like her sister, was able to walk on a balance board with skills close to her age level (Fig. 3). Her ball skills (receipt and propulsion) were at about a 4-year level (Fig. 4).

Although they differed in performance on certain items, twin B's overall performance on the Peabody Gross Motor Scale was identical to that of her sister. She had a basal level at 18 to 23 months and a ceiling level at 54 to 59 months, with an overall age equivalent of 39 to 40 months (65% of age level); percentile scores were all at the 1st or 2nd percentile. Twin B was alert and cooperative throughout the PDMS testing.

#### **Summary of Twins and Clinical Implications**

Neither of these girls would appear to be developmentally different to the average observer. Because they are both small for their ages, their gross motor delays may not seem as signifi-



**Figure 4.** Twin B throwing tennis ball at wall target (item 150 from Peabody Gross Motor Scale).

cant as they actually are. As can be seen from the photographs, these children might appear, to the average layperson, to be typical preschoolers.

The twins are enrolled in a special needs preschool and receive speech and language therapy through that program as well as privately. They do not receive individualized physical

therapy or occupational therapy but did partake in gymnastics classes between the ages of 3 and 4.5 years. Both children showed relative strengths in balance board activities, which may be a reflection of their involvement in gymnastics. Such community-based activities are probably more appropriate for children with these types of developmental

delays than individualized, clinically based therapies. Children with FAS or ARBD who show more significant delays in both motor and cognitive areas, however, may be candidates for direct physical therapy.

### Conclusions

As can be gleaned from these seven case reports, children with FAS or ARBD show great diversity in neuro-motor and cognitive delays. Caution should be exercised, however, in interpreting results from the various standardized tests in that no Native American children were included in the normative samples for any of these tests and the normative data for the Bayley Scales of Infant Development have been criticized recently for being out-of-date.<sup>18,19</sup> Furthermore, the within-infant variability noted in the Bayley scores during the first postnatal year in the infant case reports is similar to findings reported by Coryell and colleagues<sup>20</sup> in their longitudinal assessments of full-term and preterm infants using the Bayley Motor Scale. As these authors noted,<sup>20</sup> clinical decisions regarding referral for intervention or discontinuation of follow-up should never be made based on an isolated test score. It is encouraging to note that the Bayley Scales are being revised and new normative data are currently being collected.<sup>21</sup>

Additional impairments such as feeding disorders and behavioral disturbances also vary widely. The children in this series who have diagnoses of full FAS are actually less severely involved and more functional than some of the children described here who lack the full syndrome.

Because the children in our series were born to mothers with prenatal histories of abusing other drugs, in addition to alcohol, it is impossible to sort out which of the developmental delays among our children are due solely to the alcohol exposure. Our clinical experience, however, as well as recent reports in the literature, suggest that "there does not appear to be developmental sequelae

associated with prenatal narcotic exposure."<sup>22(p597)</sup>

The developmental motor delays, musculoskeletal abnormalities, and feeding difficulties (see clinical perspective by Osborn and colleagues in this issue) that can result from prenatal alcohol exposure are areas of concern to physical therapists. What remains to be examined, however, is what effect we might have in remediating these difficulties or in minimizing the emergence of functional impairments. Single-subject research designs provide an appropriate experimental model for clinically evaluating the effectiveness of physical therapy interventions. Such research is needed to further assess our role and usefulness in the management of infants and young children with FAS or ARBD.

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