A Validity Study of the Posture and Fine Motor Assessment of Infants

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This study investigated the concurrent and construct validity of the Posture and Fine Motor Assessment of Infants (PFMAI) (Case-Smith, 1991). The subjects were 90 infants, 65 of whom were healthy and full-term and 25 of whom were premature and had medical risk factors.

Concurrent validity was investigated through administration of the Peabody Developmental Motor Scales (Folio & Fewell, 1983) and the PFMAI (n = 25). Strong positive correlations resulted between the Peabody Gross Motor scale and PFMAI Posture scale and between the Peabody Fine Motor scale and PFMAI Fine Motor scale. Concurrent validity was also measured through correlation scores on the Bayley Scales of Infant Development (Bayley, 1969) with scores on the PFMAI. The correlations between the Bayley Motor scale and the PFMAI Posture scale and between the Bayley Mental scale and the PFMAI Fine Motor scale were high.

Construct validity was estimated through an evaluation of how accurately the PFMAI discriminated between the premature subjects and the full-term subjects. A discriminant analysis indicated that the PFMAI accurately classified 78% of the subjects as being either premature or full-term (i.e., 80% of the full-term subjects and 72% of the premature subjects). When the premature subjects were categorized as low-risk or high-risk according to their medical histories, the PFMAI accurately classified 66.7% of the total subject population as full-term, low-risk premature, or high-risk premature. These results indicate that the PFMAI has the adequate reliability and validity necessary for use as a clinical and a research instrument.

Uses of this instrument include obtaining baseline data for planning therapy and evaluating the short-term effectiveness of intervention focused on enhancing posture and movement. The PFMAI can assist occupational therapists in analyzing posture and movement when using a neurodevelopmental approach and provides a prototype for objective measurement of the qualitative aspects of movement.

The Posture and Fine Motor Assessment of Infants (PFMAI) (Case-Smith, 1991) is a recently developed instrument that measures components of movement and posture in early development. It provides a qualitative assessment of motor skills that can complement a motor milestone test to give a comprehensive picture of the young child.

The PFMAI provides in-depth information about how the young child performs movements, which the therapist can use to identify specific strengths and areas of concern in the child's developmental motor function. It enables the therapist to objectively measure the components of postural and motor control that are the focus of therapy when one uses a neurodevelopmental treatment approach (Bobath, 1980; Bobath & Bobath, 1984). Assistance with the child's development of discrete motor
components within the context of integrated movement patterns is also emphasized in other therapy approaches, such as spatiotemporal adaptation (Gilfolye, Grady, & Moore, 1990). If the test demonstrates reliability and validity, it will be useful to occupational therapists in early intervention settings in evaluating infants with motor delays or suspected motor disabilities.

The Need for a Qualitative Measure

Qualitative findings are often used to diagnose cerebral palsy (DeGangi, Berk, & Valvano, 1983; Towen, 1976). Motor delays in young infants may suggest any number of developmental problems or conditions, for example, mental retardation (Gibbs, 1990) or sensory integration dysfunction (DeGangi & Poisson, 1991). When qualitative findings indicate the presence of exaggerated primitive reflexes, delayed postural reactions, or abnormal muscle tone, then a diagnosis of cerebral palsy is considered (Chandler, 1990; DeGangi et al., 1983). Illingworth (1966) found that infants whose conditions were diagnosed as cerebral palsy demonstrated persistent asymmetrical tonic neck reflex, grasp reflex, crossed extensor reflex, and Moro reflex. Using the Movement Assessment of Infants (Chandler, Andrews, & Swanson, 1980), Harris (1987) found no significant differences between children with and without cerebral palsy in the presence of asymmetrical responses and primitive reflexes as measured at 4 months of age. She found that the infant’s postural responses in prone and supine positions and the therapist’s impressions of muscle tone were predictive of a diagnosis of cerebral palsy.

Gorga, Stern, and Ross (1985) developed a Neuromotor Behavioral Inventory for rating the neuromotor development of infants from birth to age 12 months. The scale measures muscle tone, developmental motor skills, the quality of movement, and neurological reflexes and reactions. Although the scale has not been published, it has been used by its authors in several research projects. The variables tested were “components of movement that are the basis of well coordinated motor abilities” (p. 758) that “can lead to identification of infants with coordination problems” (p. 757). The PFMAI is similar to the scales cited above in that it quantifies early developmental postural responses and components of the infant’s reach and grasp. A primary purpose of the PFMAI is to provide comprehensive information regarding the variables that seem to identify major motor problems (e.g., cerebral palsy) typically not identified until the infant is older.

Haley and Baryza (1991) described a model for motor assessment that includes multiple levels and recommended that motor skills be evaluated in these multiple dimensions as a basis for providing comprehensive intervention. At the most basic level, the components of movement are identified. Analysis of the components of movement helps the therapist define a focus for intervention activities by providing an understanding of the underlying problems. At the next level of assessment, the authors recommended that motor skills be measured as discrete behaviors to address in therapy and that these skills be relevant to the child’s overall ability to function. The highest level of assessment in the model is motor function, which includes the compensatory and adapted ways that the child has learned to function in his or her environment. These authors suggested that although the ability to function may be the most important to measure, document, and communicate, the analysis of motor control, which underlies function, is important for determining the therapy approach and specific techniques that will ultimately enhance the motor function outcome (Haley & Baryza, 1991). The PFMAI measures these underlying motor control components.

Information regarding the infant’s postural responses; the quality of postural stability and mobility; and the developmental levels of reach, grasp, and manipulation are important in planning and implementing occupational therapy intervention with the use of a neurodevelopmental treatment approach (Boehme, 1988). The neurodevelopmental treatment approach is a widely accepted therapeutic approach that emphasizes the inhibition of primitive or abnormal reflexes and movement patterns and the facilitation of normal postural responses. To use a neurodevelopmental treatment approach, the therapist needs a detailed understanding of the components of mobility and stability, levels of postural control, and quality of movement patterns. Handling techniques are thought to inhibit primitive responses and reinforce and encourage normal postural responses (Bobath & Bobath, 1984; Scherzer & Tscharnuter, 1982). The PFMAI was designed to assist the therapist in identifying infants’ posture and fine motor strengths and limitations, identifying the sequential skills to address in therapy, and measuring the progress made in posture and movement patterns.

Evaluating the Efficacy of Treatment

Appropriate evaluation of the effect of therapy poses a dilemma that is documented in the literature on early intervention. Although a number of motor evaluations are available, they tend to include only a few items for the first months of development (i.e., birth to age 6 months) and therefore lack sensitivity to change (Chandler, 1990). Numerous efficacy studies of intervention with young children (Bagnato & Neisworth, 1980; Holmes, Britain, Simpson, & Hassanein, 1987; Jenkins et al., 1982; Piper et al., 1986; Wright & Nicholson, 1973) suggested that the motor measurements used were not sensitive to the motor changes that occurred. Documentation of motor progress is particularly difficult for children with severe impairments who function at the lowest levels of developmental motor scales. Changes in motor skills for this
population, although small, are nonetheless significant in terms of the child's functional ability (e.g., improvements in head righting or head control).

The PFMAI provides the comprehensive and detailed information about posture and movement needed to initiate therapy. Because the items reflect small developmental changes, the test appears to be sensitive to small amounts of progress. The correlation between PFMAI scores and chronological age was .94, indicating a strong relationship of the scale's items to normal developmental progression (Case-Smith, 1989). Because the items directly reflect the objectives of neurodevelopmental treatment approach, this instrument may be particularly sensitive to changes that result directly from use of that approach. Its use in measuring the efficacy of treatment is limited by the age range (i.e., age 2 to 6 months) targeted by the test and by a lack of evidence of validity. As a measurement of efficacy, it can be used to complement the results of other evaluations that measure functional skills (DeGangi et al., 1983; Haley & Baryza, 1991).

Reliability and Validity of the PFMAI

The reliability and validity of the PFMAI were estimated in a study of 60 infants who demonstrated normal development (Case-Smith, 1989). With the use of intraclass correlation coefficients (ICCs), the results indicated near-perfect interrater reliability among four raters (ICC = .988 for the Posture scale; ICC = .989 for the Fine Motor scale). Intraclass correlation coefficients for individual items ranged from .914 to 1.00. Estimates of test-retest reliability were also high (n = 33; ICC = .853 for the Posture scale; ICC = .913 for the Fine Motor scale).

Concurrent validity of the PFMAI with the Peabody Developmental Motor Scales (Folio & Fewell, 1983) was demonstrated in 32 nondysfunctional infants in the same study (Case-Smith, 1989). Correlation coefficients of .829 for the Gross Motor and Posture sections and .673 for the Fine Motor section demonstrated a moderate relationship between these tests. Studies using other motor scales and using infants with atypical development are the next steps in investigating the test's validity.

Construct validity was estimated through a correlation of scores of the 60 normal infants with their chronological ages. A high-positive correlation of .94 indicated that the test's items are consistent with the progression of normal motor development (Case-Smith, 1989). More information about the test's construct validity is needed to use the test to identify infants who are at risk for developing motor problems. If the PFMAI is a valid measure of the quality of posture and fine motor control, it should be able to accurately discriminate infants known to have poor-quality posture and movement from infants without developmental motor problems.

Infants who are born prematurely and have medical risk factors demonstrate major motor delays in the first year of life (Bennett, Chandler, Robinson, & Sells, 1981; Fisch, Bilek, Miller, & Engel, 1975; Fitzhardinge et al., 1976; Pape, Buncic, Ashby, & Fitzhardinge, 1978; Rothenberg et al., 1983; Ungerer & Sigman, 1983). The finding that high-risk premature infants differ from full-term healthy infants in quality of movement and attainment of developmental motor skills is consistent within the literature (Gorga et al., 1985; Sell, Luick, Poisson, & Hill, 1980). Of interest then is whether the PFMAI can identify the motor differences between these two groups of infants.

Purpose

The purpose of this study was to further investigate the validity of the PFMAI. The following research questions guided the study:

1. As an indication of concurrent validity, does the PFMAI correlate with the Peabody Developmental Motor Scales and the Bayley Scales of Infant Development (Bayley, 1969)?
2. As an estimate of construct validity, does the PFMAI accurately discriminate between full-term healthy infants and premature high-risk infants?

Method

Subjects

Ninety infants—25 premature and 65 full-term—were evaluated. Three occupational therapists participated in identifying subjects through the neonatal follow-up clinics of two hospitals. Problems in scheduling and accurate identification of infants who met the study's criteria of age, weight, and medical risk factors resulted in fewer subjects than desired. However, the sample of 25 premature infants was adequate for the planned statistical analysis. The 65 full-term infants were recruited from two different sites, Richmond, Virginia (N = 18) and Columbus, Ohio (N = 47).

The subjects ranged in age from 2 through 6 months (adjusted age was used for the premature infants). The mean age for the 65 full-term subjects was 20.6 weeks (4.5 months). Each full-term subject was born within 2 weeks of the normal 40-week gestational age. They were healthy and were developing typically, according to their caregivers.

The mean adjusted age for the 25 premature subjects was 18.7 weeks (4 months); the mean chronological age was 27.6 weeks (6 months). In all of the analyses, age was adjusted for prematurity with estimated gestational age. The mean estimated gestational age of the infants at birth was 30 weeks. Each premature infant weighed less than 2,000 g; the mean birth weight was 1,345 g. Each had at least one medical risk factor, as follows: 20 infants had respiratory distress syndrome; 9, anoxia or asphyxia; 7, apnea; 6, intraventricular hemorrhage or periventricular...
leukomalacia; 6, hyperbilirubinemia or other metabolic problems; 5, bronchopulmonary dysplasia; and 2, patent ductus arteriosus.

**Instrument**

The PFMAI consists of a Posture section and a Fine Motor section (see the Appendix for a sample of the test items). The Posture section measures proximal stability and postural control with items organized into sections that rate head, shoulder, and pelvic stability and mobility. The items measure how well the infant moves against gravity, that is, the developmental level of righting reactions, the amount of time he or she holds an antigavity position, and the dynamic nature of postural control. For the prone position, items include the degree of neck and trunk extension, the head’s arc of movement when held upright, the range of lateral weight shift when prone on elbows, and the stability of the pelvis during upper trunk movement. For the supine position, postural control is judged by the stability of arms and legs when lifted against gravity (e.g., length of time the infant holds arms and legs in space), how well the infant brings his or her arms and legs to midline, and the freedom and variety of movement observed at the shoulders and hips.

The Fine Motor section measures fine motor control through a rating of the type and quality of reaching, the grasping pattern, and the quality of isolated arm and hand movement when three different objects are presented. Items rate the method of approaching objects (i.e., direct or circuitous reach), the amount of active thumb movement and isolated finger movement, the developmental level of grasp, and the use of hands together.

Each item has four mutually exclusive choices (1–4), listed in a developmental sequence. From these, the examiner judges which response accurately describes the child’s movements. The test is designed to be minimally intrusive for the child. The recommended sequence of items requires minimal handling of the child and is scored primarily through careful hands-off observation. The test requires approximately 45 min to administer.

**Procedure**

After receiving approval from the Ohio State University’s Human Subject Research Committee, permission for the subjects to participate in the study was obtained from the facility administrators and the parents. A demographic form was completed by the parent for each full-term subject. A demographic and medical history form for each premature subject was completed by the therapists with the use of the hospital chart. The subjects were tested in quiet areas in their day-care facilities or in hospital clinics by five trained occupational therapy students and myself. Training consisted of viewing a videotape of the PFMAI administered to a typical 4-month-old child. Then, working in pairs, the students administered and scored two tests and discussed their discrepancies in scoring.

To score the Posture section, the examiners observed the subject on the floor in the prone position for 10 min and then in the supine position for 10 min. Each subject was required to make progressively greater postural adjustments as facilitated by placement of toys (according to the test’s instructions). Because administration of the test items does not follow a rigid sequence, the examiner had the flexibility to follow the infant’s preference for position and activity.

For scoring of the Fine Motor section, the subject was placed in an infant seat in a comfortable upright position. This test calls for the use of three different objects: a red cube, the “Tons of Fun” rattle from Discovery Toys,¹ and the Red Rings from Johnson and Johnson.² These were held within the subject’s reach. Each object was presented repeatedly to elicit the best response; the subject’s best response was recorded.

**Reliability**

Interrater reliability was measured during testing of 28 of the full-term subjects. The raters worked in pairs, with one rater administering the items and both raters separately scoring the items. Pairs were selected by convenience.

Internal consistency of the PFMAI was evaluated with the use of Cronbach alpha coefficients. Internal consistency estimates of reliability relate to the homogeneity of test items. They describe how well the items measure the same variable (Tuckman, 1978). The Cronbach alpha is based on the average correlation among items within a test and the number of items (Deitz, 1989). It is important to obtain this estimate of reliability before investigating validity, because internal consistency is a basic characteristic needed prior to consideration of concurrent or construct validity.

**Concurrent Validity**

Concurrent validity is estimated through the correlation of two measurements that seem to measure the same characteristics or behaviors, administered to the same subjects at approximately the same time (Anastasi, 1982; Dunn, 1989). To estimate concurrent validity, we administered the Peabody Developmental Motor Scales to 25 of the healthy full-term subjects. This test was administered in the same PFMAI testing session if the subjects demonstrated adequate endurance for a long testing session. For the subjects who became irritable or hungry during the testing, the rater returned the next day to administer the

¹Manufactured by Discovery Toy, Inc., Martinez, CA 94553.
²Available through Parents Magazine, Child Development Products, New York, NY.
Peabody scales. Assessment of infants is strongly influenced by behavioral state, time of feedings, fatigue, and other factors (Chandler, 1990). Therefore, the examiners were sensitive to the infant's state and, when possible, adjusted the amount and sequence of testing to obtain optimal responses. Summed scores were used from the Peabody Gross and Fine Motor scales and the PFMAI Posture and Fine Motor scales. With the use of Pearson correlation coefficients, I correlated the Peabody Gross Motor scores with the PFMAI Posture scale scores and the Peabody Fine Motor scale scores with the PFMAI Fine Motor scale scores.

A second concurrent validity estimate was computed through the correlation of the Bayley Scales of Infant Development scores with the PFMAI scores. Of the 28 subjects who were administered both tests, 23 were premature and 5 were full-term. The same rater performed the PFMAI and the Bayley Scales of Infant Development for the full-term infants. The neonatal occupational therapist administered the Bayley Mental and Motor scales to the premature subjects, and I administered the PFMAI. The PFMAI was administered first, unless the infant was unwilling to separate from the parent and be placed on the mat. When the infant resisted separation, the Bayley Scales of Infant Development were given first, because many of the items on this test can be administered with the infant in the parent’s lap. The summed Bayley Mental scale scores were correlated with the PFMAI Fine Motor scale scores, and the Bayley Motor scale scores were correlated with the PFMAI Posture scale scores with the use of Pearson correlation coefficients. These correlations were appropriate because the Bayley Mental scale contains primarily fine motor items and the Bayley Motor scale emphasizes gross motor milestones.

Construct Validity
Because the PFMAI was developed primarily for use with high-risk infants, it is important that it demonstrate the ability to identify this at-risk group. A discriminant analysis procedure with the 65 full-term and 25 premature infants estimated the test’s ability to correctly categorize infants as full-term or premature. The ability of the test to measure the differences between full-term and premature subjects was also estimated with an analysis of covariance, with age as the covariant. The effect of age needed to be considered because test scores in my earlier study were highly correlated with age (r = .94) (Case-Smith, 1989). The difference between the full-term and premature infants in age by week approached, but did not reach, significance (F = 3.04, p = .085).

A second discriminant analysis was performed given the evidence in the literature that sick premature infants were those most likely to demonstrate poor-quality movement (Gorga et al., 1985) and delayed motor skills (Bennett et al., 1981). In this analysis, the premature subject group was separated into the categories of low-risk subjects (i.e., those with few medical risk factors) and high-risk subjects (i.e., those with multiple medical risk factors). The criteria for low-risk subjects were (a) estimated gestational age at birth between 28 and 36 weeks (m = 31.4 weeks), (b) birth weight between 1,250 and 2,000 g (m = 1,565.2 g), and (c) two or fewer medical complications at birth (m = 1.3). The criteria for high-risk subjects were (a) born before 30 weeks gestational age (m = 28.8 weeks), (b) birth weight less than 1,500 g (m = 1,153.2 g), and (c) having two or more medical risk factors during the neonatal period (m = 2.9).

Results
Interrater reliability was estimated with the use of intraclass correlation coefficients. The coefficients (n = 28) were .978 for the Posture scale, .971 for the Fine Motor scale, and .959 for the total test. Estimates of internal consistency for the PFMAI with the use of the Cronbach alpha coefficients (n = 89) were as follows: total scale, .99; total Posture scale, .97; head control items (Posture scale), .86; shoulder control items (Posture scale), .89; pelvic control items (Posture scale), .92; total Fine Motor scale, .98; arm control items (Fine Motor scale), .96; grasp items (Fine Motor scale), .95.

Concurrent Validity
As evidence of concurrent validity, the Pearson correlation coefficient between the PFMAI Posture scale and the Peabody Gross Motor scale (n = 25) was .835; between the PFMAI and Peabody Fine Motor scale, it was .670. The correlation coefficient between the PFMAI Posture scale and the Bayley Motor scale (n = 28) was .742; between the PFMAI Fine Motor scale and the Bayley Mental scale, it was .845. All the correlations were significant at p < .01. The positive correlations indicate that the tests were measuring similar but not equivalent variables.

Construct Validity
The results of the discriminant analysis used to evaluate how accurately the PFMAI discriminated between the premature infants and full-term infants are shown in Table 1.

<table>
<thead>
<tr>
<th>Actual Group</th>
<th>n</th>
<th>Predicted Group</th>
<th>Membership</th>
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<tbody>
<tr>
<td>Full-term infants</td>
<td>65</td>
<td>52 (80%)</td>
<td>13 (20%)</td>
</tr>
<tr>
<td>Premature infants</td>
<td>25</td>
<td>7 (28%)</td>
<td>18 (72%)</td>
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</table>

*Case-Smith, 1991.*
The PFMAI and age accurately classified 78% of the premature and full-term infants.

As a second measure of the PFMAI's ability to identify differences between the premature and full-term infants, the results of an analysis of covariance with age as the covariant are shown in Table 2. The differences between PFMAI scores of the two groups were highly significant ($F = 25.5, p < .0005$ for the Posture scale; $F = 26.5, p < .0005$ for the Fine Motor scale).

A second discriminant analysis was completed to determine whether the PFMAI and age could accurately categorize groups of full-term infants, low-risk premature infants, and high-risk premature infants. The PFMAI correctly discriminated 66.7% of the infants (see Table 3).

An analysis of covariance with age as the covariant was computed for the three groups. Table 4 shows the actual means for each group and the means adjusted for age. The full-term infants scored higher on each of the PFMAI scales. The high-risk premature infants scored the lowest of the three groups when scores were adjusted for age. The three groups were significantly different ($F = 18.09, p < .0005$ for the Posture scale; $F = 13.58, p < .0005$ for the Fine Motor scale). A post hoc analysis with the Scheffé procedure (Weiner, 1971) indicated that scores on the Posture scale differed between the full-term infants and the high-risk premature infants ($F = 18.09, p < .05$) and between the high-risk premature infants and the low-risk premature infants ($F = 4.35, p < .05$). Posture scores were not significantly different between full-term infants and low-risk premature infants. Fine motor scale scores differed between the full-term infants and the high-risk premature infants ($F = 13.13, p < .05$) and between the full-term infants and the low-risk premature infants ($F = 5.07, p < .05$), but not between the high-risk premature infants and the low-risk premature infants ($F = .22$).

Discussion

The results of this study reinforce and expand the evidence of the reliability and validity of the PFMAI obtained previously (Case-Smith, 1989). Additional information regarding the test’s reliability with high-risk premature infants was obtained. The reliability correlation coefficients

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Age-Adjusted Scores on the Posture and Fine Motor Assessment of Infants* for Premature and Full-Term Subjects ($N = 90$)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Posture Scale</td>
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<td></td>
<td>Actual Score (M)</td>
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<tr>
<td>Group</td>
<td>n</td>
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<tr>
<td>Full-term infants</td>
<td>65</td>
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<tr>
<td>Premature infants</td>
<td>25</td>
</tr>
</tbody>
</table>

*Case-Smith, 1991.

Table 3

<table>
<thead>
<tr>
<th>Discriminant Analysis for the Posture and Fine Motor Assessment of Infants* for Three Groups of Infants</th>
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<tbody>
<tr>
<td>Actual Group</td>
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<tr>
<td>Full-term infants</td>
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<tr>
<td>Low-risk premature infants</td>
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<tr>
<td>High-risk premature infants</td>
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</table>

*Case-Smith, 1991.

Table 4

<table>
<thead>
<tr>
<th>Age-Adjusted Scores on the Posture and Fine Motor Assessment of Infants* for Full-Term, Low-Risk, and High-Risk Premature Subjects</th>
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<tbody>
<tr>
<td>Group</td>
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<tr>
<td>Full-term infants</td>
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<tr>
<td>Low-risk premature infants</td>
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<td>High-risk premature infants</td>
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*Case-Smith, 1991.

in this study were slightly lower than those in the first study; however, the lower level of training of the examiners may account for the difference.

The estimates of internal consistency and interrater reliability were high for the test as a whole as well as for individual sections. Evidence of the test’s reliability supports further investigation of the test’s validity.

Concurrent Validity

Concurrent validity was measured with full-term subjects through a correlation of the PFMAI scores with the Peabody Developmental Motor Scales scores. This study’s correlations ($r = .835$ between Gross Motor and Posture scales and $r = .67$ between the Fine Motor scales) are almost identical to the correlations obtained in the previous study ($n = 33; r = .83$ for Gross Motor and Posture scales and $r = .67$ for Fine Motor scales) (Case-Smith, 1989). The consistent results provide evidence that the Gross Motor scale of the Peabody Developmental Motor Scales has a strong correlation with the PFMAI Posture scale, whereas the Fine Motor scales have a fair or moderate correlation. Examination of the items of both scales reveal that the Peabody Gross Motor scale places more emphasis on righting reactions and the ability to maintain antigravity positions (e.g., head alignment, prone on extended arms, sitting) than it does on mobility skills. Infants in the test’s age range (2 to 6 months) exhibit increasingly higher levels of postural stability but have few mobility skills. Because the PFMAI...
measures postural stability and control against gravity, it logically correlates with the Peabody Gross Motor scale.

The fine motor sections of the PFMAI and the Peabody Developmental Motor Scales measure somewhat different variables, as evidenced by the lower correlation (.67). The PFMAI evaluates developmental motor patterns and motor control. Eye—hand coordination and cognitive skills are not considered within the items. The Peabody Fine Motor scale includes ocular motor skill and eye—hand coordination as elements of fine motor skill. Therefore, the scales measure substantially different variables, and high correlations between them would not be expected.

In the second study of concurrent validity, correlations between the Bayley Motor scale and the PFMAI Posture scale (.742) and between the Bayley Mental scale and the PFMAI Fine Motor scale (.845) were adequate to demonstrate concurrent validity of the PFMAI and the Bayley Scales of Infant Development. These moderate correlations indicate that the tests measure different behaviors and characteristics. The unusual finding that the Bayley Mental scale, which has a primary purpose of measuring cognition, has a strong correlation with the PFMAI Fine Motor scale may be explained through examination of the items of each scale. Most of the Bayley Mental scale items in the first 6 months require that the child exhibit a developmental progression of fine motor skill. As in other tests of mental abilities at early ages, cognition is measured by specific fine motor skills (Gibbs, 1990).

The moderate correlation between the Bayley Motor scale and the PFMAI Posture scale indicates that the two instruments measure similar but not identical variables. A second interpretation of the results is that the variable measured by the PFMAI, that is, posture, is associated with the variables measured by the Bayley Motor scale—motor skills and mobility. The significant correlation between the PFMAI and the Bayley Motor scale can be interpreted to mean that postural control is an underlying prerequisite for motor milestone achievement. Haley (1986) demonstrated that the development of gross motor milestones as measured by the Bayley Motor scale had a high positive correlation with the development of postural control. Research supporting this logical relationship strengthens the theoretical assumption on which neurophysiological treatments, such as neurodevelopmental treatment, are based (Hale, 1986). In neurodevelopmental treatment, the occupational therapist focuses on increasing proximal stability and postural control as the essential base for motor function and achievement of motor milestones (Bly, 1991; Bobath, 1980). Although evidence of the relationship between postural control and motor milestones does not imply that improvement of the former will enhance the latter, it is consistent with that theoretical premise. Demonstration of the relationship in an atypical sample (premature infants) further strengthens the validity of the relationship.

**Construct Validity**

Previous studies (Bennett et al., 1981; Fisch et al., 1975; Gorga et al., 1985; Pape et al., 1978; Rothberg et al., 1983; Ungerer & Sigman, 1983) demonstrated that premature infants with medical risk factors were delayed in motor development through at least 2 years of age. In the discriminant analysis of the present study, the PFMAI and age identified the full-term and high-risk premature infants with 78% accuracy. Given that the motor development of some of the premature infants was not delayed, this is probably a low estimate of the test's ability to identify infants with documented motor delays.

When the subjects were categorized into three groups, the PFMAI was significantly different between two of the three group pairs. Specifically, posture differed between full-term and high-risk premature infants and between low-risk and high-risk premature infants. These results are consistent with research results indicating that the posture of premature high-risk infants differs from that of both full-term infants and low-risk premature infants (Gorga et al., 1985). Sell et al. (1980) demonstrated that premature low-birth-weight infants differed from healthy full-term infants in motor abilities measured at term age. Gorga et al. (1985) found that at 3 and 6 months of age, sick (high-risk) premature infants differed from both full-term and healthy (low-risk) premature infants on measures of quality of movement. Specifically, control of the head and shoulders was less developed in the high-risk premature infants.

The finding of lack of difference in scores on the PFMAI Posture scale between the full-term infants and the low-risk (healthy) premature infants is similar to that of other studies (Gorga et al., 1985; Palisano, 1986). Piper, Darrah, Byrne, and Watt (1990) found that at 4 months of age, premature infants with normal neurological status did not differ from full-term infants in measures of postural tone, automatic reactions, and volitional movements. The scale used in their study, the Movement Assessment of Infants (Chandler et al., 1980), is similar in purpose to the PFMAI. The consistency of these or my results with others suggests that the PFMAI Posture scale is a valid measure of postural control in the young infant.

The present study provides evidence that the PFMAI can identify qualitative differences in high-risk premature infants. Information about these differences can contribute to the formulation of a plan for therapy and in guiding decisions about the emphasis of treatment. The PFMAI measures components of postural control (e.g., active lateral weight shift when prone on elbows, stability of the pelvis when kicking) and of fine motor control (e.g., a directed reach vs. a circuitous reach, isolated thumb movement), which are often the focus of neurodevelopmental treatment. The differences found between premature and full-term infants in these components of movement lend support to addressing these variables in therapy.
The results of the discriminant analysis also indicate that the PFMAI can be used to identify infants at risk for motor control problems. DeGangi, Berk, and Valvano (1983) suggested that qualitative motor differences are often critical to identifying children with cerebral palsy. Towen (1976) indicated that qualitative findings should be combined with documented developmental motor milestones in identifying children with neurological impairments, such as cerebral palsy. For example, children with mental retardation may exhibit motor milestone delays but not demonstrate qualitative differences in motor control. Children with cerebral palsy typically demonstrate both motor milestone delays and poor quality of posture and movement. It is recommended that the PFMAI be used with a standardized scale of motor milestones (such as the Bayley scales) to obtain a comprehensive picture of the infant's motor development.

**Study Limitations**

Generalization of the study results is limited by the relatively small sample of premature subjects. A greater number of subjects would strengthen our confidence in the results. Investigation of concurrent validity was limited by the availability of instruments that are similar in content and purpose to the PFMAI. Although the Peabody Developmental Motor Scales and the Bayley Scales of Infant Development evaluate the motor development of young infants, these scales lack sensitivity to motor delays in the age range of the subjects in this study. The Peabody Developmental Motor Scales results in large standard deviations when used on infants from birth through age 5 months (Folio & Fewell, 1983). Moreover, the Peabody Developmental Motor Scales has poor validity for discriminating motor delays in infants under 5 months of age. The validity of the comparison instruments needs to be considered when interpreting the results of this study.

**Conclusion**

The PFMAI demonstrates adequate reliability and validity to be used as a clinical and a research instrument. It demonstrates concurrent validity with two measures of motor skill: the Peabody Developmental Motor Scales and the Bayley Scales of Infant Development. In addition, the PFMAI accurately discriminates infants who are premature and high-risk from infants who are full-term and healthy.

Uses for the PFMAI include obtainment of baseline data for planning and implementing therapy addressing posture and movement and evaluation of the short-term effectiveness of such intervention. The instrument can assist the occupational therapist in analyzing posture and movement when using a neurodevelopmental approach. The instrument provides an example of how qualitative aspects of movement can be measured objectively. As such, it may be used in research that examines the relationship of the components of posture and movement and the attainment of motor milestones. The PFMAI may be used to evaluate the direct effectiveness of neurophysiological treatments on underlying motor components and to compare those results with achievement of functional motor skills.

**Acknowledgments**

The study was supported by the American Occupational Therapy Foundation. Copies of the PFMAI may be obtained through the Foundation. I thank the following therapists for their assistance in data collection: Karen Monfort, Patty Helsel, Jayne Shepherd, Lillian Castrataro, and Charlotte Griffith.

**Appendix**

**Sample Items from the Posture and Fine Motor Assessment of Infants**

<table>
<thead>
<tr>
<th>Shoulder Control in Prone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder stability when weight bearing on arms.</td>
</tr>
<tr>
<td>a. Arms are retracted with elbows behind shoulders. Child presses into this position briefly.</td>
</tr>
<tr>
<td>b. Elbows are slightly behind shoulders. Position prohibits lateral weight shift.</td>
</tr>
<tr>
<td>c. Elbows are directly under or slightly in front of shoulders and are maintained for one minute or more.</td>
</tr>
<tr>
<td>d. Weight bearing on hands with elbows extended momentarily.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shoulder Control in Supine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder mobility.</td>
</tr>
<tr>
<td>a. Moves arm infrequently and generally on the surface.</td>
</tr>
<tr>
<td>b. Moves arm in less than 45° range of shoulder flexion or abduction.</td>
</tr>
<tr>
<td>c. Moves arm in a range of 50° to 90° shoulder flexion and abduction using a variety of planes of motion.</td>
</tr>
<tr>
<td>d. Moves arm in greater than 90° range of shoulder flexion.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fine Motor: Red Cube</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of grasp.</td>
</tr>
<tr>
<td>a. Grasp is not attempted or palmar grasp is attempted but is unsuccessful.</td>
</tr>
<tr>
<td>b. Palmar or ulnar palmar grasp is used to secure and hold the cube.</td>
</tr>
<tr>
<td>c. Uses radial palmar grasp and thenar eminence to secure and hold cube.</td>
</tr>
<tr>
<td>d. Uses inferior radial grasp with thumb used as a stabilizer.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fine Motor: Red Rings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach to rings.</td>
</tr>
<tr>
<td>a. Does not reach for ring, although arms may activate.</td>
</tr>
<tr>
<td>b. Reach for ring is hit or miss with poor accuracy. Child may touch ring.</td>
</tr>
<tr>
<td>c. Reach to ring is circuitous and accurate. Touches ring on first approach.</td>
</tr>
<tr>
<td>d. Exhibits a directed, accurate, and smooth reach.</td>
</tr>
</tbody>
</table>

**References**


Roithberg, A., Messels, M., Bagnato, S., Murphy, J., Gifford, K., & McKinley, K. (1989). Infants weighing 1,000 grams or less at birth: Developmental outcome for ventilated and nonventilated infants. Pediatrics, 85, 599-602.


