Peabody Developmental Motor Scales, Second Edition

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The *Peabody Developmental Motor Scales* (PDMS-2) was developed over a ten year period and became the first nationally standardized assessment providing separate gross and fine motor scores. The Education of the Handicapped Act Amendments of 1986 and the Disabilities Education Act of 1997 increased early intervention in therapy services for young children with developmental delays, increasing the need and desire for this assessment. The foundation of this assessment focuses on the concept that motor development proceeds in an orderly sequence (Folio & Fewell, 2000). Several researchers including Shirley (1931), McGraw (1939), Gesell (1940), and Bayley (1969, 1993), contributed to the assessment protocol on the gross and fine motor scale  in regards to motor development and skill level of young children.

The first assessment was developed based on the interaction between child’s maturation and experience as guidelines for development.  Practice, environmental interaction, and learning were identified by theorists to improve motor skills. Evidence from theorists proved that intervention enhanced motor skills as well as promoting sequential skills through targeted motor development programs.  These theorists include Folio (1975), DuBose and Folio (1977), Harris (1981), Jenkins, Fewell, and Harris (1983), Campbell and Stewart (1986), Boucher and Doescher (1992), and Block and Davis (1996) who all contributed to significant gains in motor development (Folio & Fewell, 2000).

Qualitative and quantitative approaches were used by Block (1995) to evaluate the components of skills and movement performance (Folio & Fewell, 2000). Many occupa­tional therapists use the PDMS scales to establish eligibility for special education preschool programs, determination of the need for occupational therapy ser­vices, and to determine motor development (Boulton, 1995).

The PDMS-2 is a norm and criterion-referenced developmental assessment comprised of two scales: the Gross Motor Scale and the Fine Motor Scale. The normative sample consisted of 2,003 persons residing in 46 states. The characteristics of the sample match information reported by the U.S. Bureau of the Census in 1997 for children under five years old with regard to geographic region, gender, race, rural or urban residence, ethnicity, family income, parent education, and disability. The analysis of the test scores provides relevant data from the sample population. The standard scores have a mean of 10 and a standard deviation of 3. “Quotient standard scores are based on a distribution having a mean of 100 and a standard deviation of 15” (Folio & Fewell, 2000, p. 40). The standard scores are the result of the percentiles associated with the raw scores made by children in the standardized population (Folio & Fewell, 2000).

This assessment is norm-referenced as it looks at the actual performance of the child, a starting entry point based on age, and can compare the child’s performance to that of their peers amongst the same age group. Norm age equivalent values are indicative of the motor age that relates to a raw score made by an individual.  In comparison, the criterion referenced aspect of the assessment involves the specific criterion items based on the performance of the subtests. The determined score shows whether or not the child performed well or poorly on a given task in the subtest (Folio & Fewell, 2000).

Reliability of test measurements are key concepts involved in presenting practical usefulness of an assessment. Three types of reliability measures were reported in the PDMS-2 manual and in later studies: test-retest, interrater and standard error of measure for total raw scores.  Test-retest reliability was examined by testing 38 children distributed across all age groups a second time within one week. “The Interclass Pearson Product-Moment Correlation between the total raw scores of the two testing’s reflected .999 for the Gross Motor Scale and .997 for the Fine Motor Scale” (Burton & Miller, 1998, p. 197).

As a second reliability measure, Folio & Fewell had the performances of thirty-six children representing all age groups scored by two persons: the test administrator and an observer. Interclass Pearson Product-Moment Correlations between the two sets of total raw scores were very high: .998 for the Gross Motor Scale and .996 for the Fine Motor Scale (Folio & Fewell, 2000). There have also been many other studies testing the reliability of this assessment further supporting the interrater reliability. In the study by Boulton et al. (1995), Intrarater correlation coefficients between ratings was .99 for both raters involved in a study involving children with cerebral palsy being videotaped and rated independently by two raters two times, with the second viewing coming three to six months after the first. The correlation for the four individual skill areas ranged from .88-.99 (Boulton et al.,1995).

The standard error of measure for total raw scores became the third reliability test; this was calculated for each group by dividing the standard deviation by the square root of the number of subjects (Folio & Fewell, 2000).

It is important to determine reliability coefficients in order to determine the accuracy of a test regarding error variance. The scores and subtests associated with the PDMS-2 have been analyzed for error variance within three sources: content sampling, time sampling and interscorer differences. It is important to have internal consistency within subtests in regards to how they relate to one another. Seven subgroups were studied and tested to determine error variance for content sampling. The subgroups studied varied among sex, ethnicity, linguistic differences and disorders, further proving the tests reliability. Time sampling refers to the period of time in which the test-retest method occurs. The PDMS-2’s stability-over-time reliability was investigated and proved sufficient coefficients in magnitude of test scores ability over time. Interscorer differences may offer a tremendous amount of variability in scoring. The PDMS-2 reduces this error by providing clear administration procedures, detailed guidelines governing scoring, and the opportunity to practice the scoring (Folio & Fewell, 2000). Although the reliability of the PDMS-2 has been proven with many different measures, it is important to consider that the source of error will still be present. “For example, a test with almost perfect reliability (i.e., .95) at all three of these sources of error still contains 15% error” (Folio & Fewell, 2000, p. 36). The examiner must be able to alleviate quick judgments based exclusively on test data when observing the skill mastery of the child’s performance. Determination of collected data and diagnoses must be supported by other resources including clinical reasoning and experience to provide the most accurate determination for therapeutic interventions (Folio & Fewell, 2000).

Although proving validity is a continual process, examiners are able to deduce that the PDMS-2 is an accurate measure of motor abilities based on the following validity tests. Folio & Fewell (1983) presented information regarding the content validity, criterion-prediction validity and construct validity. The content-description validity can be understood through three demonstrations: rationale, results of conventional item analysis procedures and Item Response Theory (IRT) and differential item functioning analysis.  Rationale was an influence on validity as it was the basis of the beginning of the PDMS-2. It was built upon a developmental framework, subtests and items based on the work of the involved developmentalists. Others further contributed by presenting knowledge on effects of interventions on motor skill development enabling the authors to write more specific criteria used in the PDMS-2.  Following these details were results of motor interventions implemented by teachers and therapists that helped in refining procedures, skills, and environments with more ecological validity. In the test manual, Folio & Fewell (1983) presented information regarding subtests verified by examining A Taxonomy of the Psychomotor Domain by Harrow (1972) (Folio & Fewell 2000).

The composite scores differentiate between gross and fine motor skills.  Often children may have normal motor skills when initiating the use of larger muscles, yet serious problems when using smaller muscles. This assessment allows for examiners to accurately identify the services needed and will direct the instruction or therapy needed by understanding the areas encompassing deficiencies (Burton & Miller, 1998).

When determining the conventional item analysis, time-tested procedures are used to ensure validity of items selected for a test.  The item-total-score Pearson correlation index was the method of choice.  If a test has low reliability, it is likely to be invalid.  The value of using a discrimination index to select the best items is of great importance.  The median discriminating powers of PDMS-2 scores for six age groups; Table 7.1 in the test manual presents statistics computed only on items that have some variance (Folio & Fewell, 2000). The lack of bias in a test item is shown by the results of differential item functioning analysis. Ultimately, the content validity demonstrated that the results of the PDMS-2 were similar to well documented tests of motor development.

Criterion-related validity, now referred to as criterion-prediction validity, looks at the effectiveness of a test on an individual’s performance during particular activities.  Two studies involving the PDMS-2 were conducted using the obtained data from the normative sample. Raw scores were then transformed to subtest standard scores and quotients (Folio & Fewell, 2000).

Folio & Fewell examined the correlations between the PDMS-2 scores with those of the *Peabody Developmental Motor Scales* (PDMS) for the first study. The composites of the Gross Motor Quotient (GMQ) and the Fine Motor Quotient (FMQ) of both tests were correlated. Both were administered on the same day to thirty children at Hollins College in Virginia. The age range of the children ranged from 1 month to 11 months and was 63% male; two participants were African Americans and the rest European Americans.  As seen in Table 7.3 of the PDMS-2, the correlations of coefficients between the two tests were in a very high range.  Specifically, the relationship between both motor quotients exceeded .80 which is high enough to support the equivalency of the tests. The above stated correlations demonstrate support for the validity of the PDMS-2 scores (Folio & Fewell, 2000).

A second study compared the correlation of the scores of the PDMS-2 with those of the Mullen Scales of Early Learning: AGS Editions (MSEL:A) (Mullen, 2006). This comparison was of the six subtests and three composites of the PDMS-2 with the fine and gross motor scales of the MSEL:A.   The tests were administered on the same day to 29 children in Evansville, Indiana. The children’s ages ranged from 2 months to 66 months and were 62% male; one participant was African American and the remainder were European Americans. The correlation of the coefficients between the two tests is stated in Table 7.4 of the PDMS-2 and demonstrates a moderate to high range (Folio & Fewell, 2000). Once more, the relationships of the two tests exceed .80 in the gross and fine motor quotients, which is high enough to support the equivalency of the tests as well as the validity of the PDMS-2 scores.

The construct-identification validity is supported by three basic constructs thought to underlie the PDSM-2 and four related testable questions determined by generation of hypotheses based on logical and empirical methods. The ability to confirm that the factor structure of the PDMS-2 matches the arrangement of the subtests is done by confirmatory factor analysis. This test of validity is a possibility due to the fact that two well-defined, yet correlated motor abilities are involved in the assessment.  Confirmatory factor analysis is able to provide a more precise test of construct validity than is provided by exploratory factor analysis, thus giving the ability to provide adequate validity when comparing the subtests. This type of analysis is able to not only confirm the structure of the test, but specifically that test items are within the correct subtest category (Folio & Fewell, 2000).

This assessment was developed to improve upon the existing motor assessment instruments of the PDMS. The PDMS-2 is an early childhood motor development program that provides both in-depth assessment and training or remediation of both fine and gross motor skills of children from birth through age five. The assessment is composed of six subtests that measure interrelated motor abilities that develop early in life. The PDMS-2 has extensive referencing and has been used greatly in early intervention services. There also has been literature supporting the gross motor scale to be appropriate to detect global measure of change in an infant’s motor development (Folio & Fewell, 2000).

The utility of the PDMS-2 is focused amongst five valued principal uses. First, results of the assessment can be used to determine a child’s motor proficiency in relation to peers of his or her age. The second principal regarding the quotients compares both the GMQ and the FMQ to determine if a child is relatively different in his or her motor abilities. Third, qualitative and quantitative aspects of the individual are assessed, which in turn give value to educational and therapeutic interventions. The next principal focuses on progress which is important to acknowledge as it can be evaluated over time. The ability to make comparisons across administrations is due to the record of successive administrations of quantitative information regarding the child’s performance. Lastly, the PDMS-2 is valued as a great research tool because the scores can be utilized to study motor development in heterogeneous populations of children, the role motor ability plays when looking at academic success, and the effectiveness of disparate motor interventions (Burton & Miller, 1998).

Various rooms and settings are acceptable for the administration of the PDMS-2. Appropriate examples of these include an average sized room, a hallway or even an outdoor space. The main requirement of the setting is that it will allow for minimal distraction and free from noise or people. The parent or caregiver is allowed to stay in the room if the child is reluctant to perform without their accompaniment. The subtest items to be assessed will determine the setting of choice (Folio & Fewell, 2000).

When administering the Gross Motor subtests, a soft landing will be appropriate for most, such as a mat, cushioned table or carpeted floor. Many of the tests will require running, jumping and ball throwing; these items will require a large open space. Many of the items require special preparation such as the taping off of lines and distance measurements, all of which can be found in the Examiner Record Booklet and are specified in the Guide to Item Administration (Folio & Fewell, 2000).

During many of the Fine Motor subtests, a requirement of appropriate seating with a table will be required. The items will also specify whether or not the use of a table will be involved. The table will need to be large enough for the child to be able to sit opposite of, or side by side with the examiner. The only materials that should be on the table at one time are those that are specific to the subtest item being performed. If the child does not feel comfortable sitting alone or in a high chair, he or she will be allowed to sit on the lap of the administrator or caregiver. It is important for the tables and chairs to be the right height to fit that of the preschooler being tested. If this is not possible, making accurate adaptations such as a stool to rest the feet on will be required to ensure the child’s comfort level during the assessment. Also, any adaptations the child normally uses when sitting would be appropriate to use during the test as well. Overhead lighting will be appropriate in these settings to facilitate easy writing with no cast shadows during testing (Folio & Fewell, 2000).

An occupational therapist, physical therapist, diagnosticians, early intervention specialists, adapted physical education teachers and psychologists who have a thorough understanding of the tests characteristics are all qualified to perform the PDMS-2. Examiners are expected to have a complete understanding of test statistics; general procedures leading test administration, scoring and interpretation; specific information about gross and fine motor ability testing; and development in atypically developing children. Completion of a training involving the administration and interpretation of gross and fine motor ability tests is also highly recommended of the examiner (Burton & Miller, 1998). This assessment is used across a spectrum of children demonstrating an intellectual disability, sensory impairment, behavioral disorder, learning disability as well as typically functioning individuals.

The PDMS-2 is organized into six subtests of skills within two domains, which are assessed in correspondence to motor skills through various activities. These categories include: reflexes, stationary, locomotion, object manipulation, grasping, and visual-motor integration.

Automatic reactions are developed and retained through the reflexes subtest. Reaction to postural balance from environmental events, alignment of the head with the midline of the body, and primitive protective reflexes all become integrated neurologically producing voluntary movements around six to eight months. Infants with persistence in primitive reflexes will demonstrate obligatory responses which interfere with normal movement patterns. Muscle strength, control, and tone mature toward the end of an infant's first year of life which allows greater postural control and body stability. Postural reactions including protecting, righting, and equilibrium reactions develop between four to eighteen months of age and remain throughout life. Protective reactions include extension of an arm to brace a child’s fall forward, backward, or sideways. Righting reactions are used to bring the body back into postural alignment when tilting or shifting the head. Equilibrium reactions may occur in any body position in response to a loss of balance.

Stationary reactions are represented through the use of balance and control to maintain a center of gravity. The child is positioned in various movement patterns to gain control of body parts. Stabilization of the head as well as the trunk when sitting, along with standing and walking are all skillful motor actions that develop gradually. Once these motor actions are accomplished, complicated skills are developed and challenged.

The locomotion unit allows the child to expand movement within different environments. Rolling, crawling, creeping, walking, and running are the primary responses that facilitate movement during childhood.  As the child matures, these actions become integrated and are used in games as well as in sports (Folio & Fewell, 2000).

Participation in partner or group motor activities requires the object manipulation subtest. This test enables a child to throw, catch, bounce, and kick balls. Lightweight balls may be initially used, but can be graded up depending on the child’s mastery of the skill (Folio & Fewell, 2000). This subtest may also be integrated with other skills, allowing the child to participate in sports, games and social events.

The grasping subtest involves the movement and development of the hands. This takes place when the child is able to move their arms toward a visual target and grasp the desired object. Aging increases a child's control and release between their fingers and palms. Children begin by primarily using their fingers together as a whole until development of fine motor control is gained, enabling the use of each finger separately. The palms develop grasp to crumble objects and sweeping hand movements become more self-directed and controlled throughout maturity. Refined hand use is recommended for children entering kindergarten allowing the ability for finger separation (Folio & Fewell, 2000).

Visual motor integration involves the child’s ability to examine or track an object based on a number of items that require motor movement integration. Visual attention, visual discrimination, visual figure-ground perception, visual spatial relationships, visual perception and motor integration are all parts assessed. This subtest of the PDMS-2 tests both gross and fine motor skill systems (Folio & Fewell, 2000).

Administration of the PDMS-2 assessment lies within a 45-60 minute time frame. Assessment of fine and gross-motor parts consumes 20-30 minutes. The entry points, basal level, and ceiling level determine the scoring of each of the six subtests (reflexes, stationary, locomotion, object manipulation, grasping and visual motor integration). The entry points determine where the examiner should begin testing. This is based on a normative sample of 75% of children passed. Clinical judgment should be implemented when working with a child with a known disability so appropriate testing can begin with successful results. It is also important to note that testing a child with disabilities usually requires a longer amount of time. Testing is allowed to be broken into shorter segments over no more than a five day period if the child is not able to complete the total assessment or has a shorter attention span (Folio & Fewell, 2000).

The scoring system along with the provision of a clear description of the behavioral criterion for each item, are the elements that distinguish the PDMS-2 from other published movement product tests (Burton & Miller, 1998). The norms are based on scoring each item as 0, 1 or 2. A score of 0 indicates that a child could not or would not attempt the item or the attempt does not show that the skill is emerging. A score of 1 indicates that the child’s performance shows a clear resemblance to the item specifics, but does not fully meet the criterion. A score of 2 refers to a child that performs according to the specified criterion. The examiner will have little to no difficulty when deciding on whether the attempt is at the level of a 2, due to the fact that the child’s performance of the skill will either be at the level of mastery or not. The test developers indicate that the major area of judgment is whether a response should be scored as a 0 or 1, but this problem has been since remedied with the development of the second edition, by offering a clear and concise explanation of the criteria for the score of 0 or 1 on every item in the test (Folio & Fewell, 2000).

Due to the large number of test items, the test administrator begins a test at the entry level which is determined by the child’s age. If the child does not score a 2 at their age level skills, the test administrator tests backwards according to the next section of three, to find the level that the child is proficient at. The test administrator then scores the test and establishes the child’s basal and ceiling level.  The basal level is established when a child scores a 2 three times in a row. This shows that a child is proficient in these skills and scoring begins from this point. It can be assumed that the child is equally proficient at all items below this level as they would need to have mastered them in order to be successful on the immediate items being tested. The child continues to test on each item until they score a 0 three times in a row; this determines the child’s ceiling level. Once the ceiling level has been established, testing stops (Folio & Fewell, 2000).

The raw score is made up of the total score between the basal and ceiling level. It also includes every item that came before the basal level to be scored as a 2. The test administrator converts the raw score into the standard score, age equivalent and percentile by using the appropriate appendices. Next, the sums of all of the standard scores of each subtest within either the gross or fine motor category are determined.

The results of subtests that measure the use of the large muscle systems are known as the Gross Motor Quotient (GMQ). The composite score of these results involve three of four subtests used to test this section. The subtests include: Reflexes (birth to 11 months old), Locomotion (all ages), Object Manipulation (12 months and older) as well as Stationary (all ages). This process is repeated for the two fine motor subtests to find the Fine Motor Quotient (FMQ). Lastly, the sums of all of the subtests standard scores are totaled and converted to determine the Total Motor Quotient (TMQ) using the appropriate appendix. The GMQ and FMQ are the best estimate of movement abilities for those categories and the TMQ is the best estimate of an individual’s overall motor abilities (Folio & Fewell, 2000). The three level scoring system allows for individual differences found in all children including children with disabilities.

Another helpful aspect during the assessment is the recommendation from the authors that encourage test administrators to record comments within the narrative report concerning the child’s performance during the particular domain. These comments will help assist others working with the child to improve learning environments and increase performance (Folio & Fewell, 2000).

The selection of an appropriate motor development test is dependent not only on clinical practicality, but more importantly on the clinicians’ intended purpose for assessment. Although the first edition was based on important key concepts, developers saw a need to revise the PDMS, resulting in the PDMS-2 in 2000. This revised edition adopted a general developmental framework and incorporated the use of both qualitative and quantitative approaches to guide assessment (Folio & Fewell, 2000).

Some of the highlighted changes involved in the *Peabody Developmental Motor Scales-Second Edition* include the division of six new subtests, quotient totals which are indicative of overall ability of the child, and the three point rating scale with specific scoring criteria. According to the developers Folio & Fewell (2000), the new PDMS-2 has extensive clinical application, meeting the needs of most clinicians for assessing motor development (Folio & Fewell, 2000). Furthermore, the PDMS-2 includes the broad scope of motor range by measuring the fine motor and gross motor functions. The PDMS-2 has the practical value of being suitable to assess various populations of children, who otherwise would be at risk of motor delays or known physical disabilities.

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**Multiple Choice Questions**

**1. Which developmental domain is not tested if the child is over the age of 12 months?**

**A. Locomotion**

**B. Visual-Motor Integration**

**C. Grasping**

**D. Reflexes- Correct Answer**

**2. What scoring sequence determines the discontinuation (ceiling level) of The Peabody Developmental Motor Scales (PDMS-2)?**

**A. 1, 0, 0**

**B. 0, 0, 0- Correct Answer**

**C. 2, 2, 2**

**D. 0, 1, 0**

**3. Which BEST defines the Peabody Developmental Motor Scales (PDMS-2)?**

**A. Norm Reference—Correct Answer**

**B. Criterion Reference**

**C. Both A and B**

**D. None of the above**