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ABSTRACT

This study compared the skills performance of 60 children, ages 3 to 5, with speech and language delays on the Peabody Developmental Motor Scales (PDMS) with that of national norms on the PDMS. It found that the children with speech and language delays performed the PDMS gross motor skills significantly lower than the norm at each age level. The PDMS fine motor skill performance of the 3- and 4-year-old children with speech and language delays was also significantly lower than the mean performance of the PDMS norming sample. The fine motor performance of the 5-year-old children with speech and language delays did not differ from the norming sample. Findings support the importance of using an assessment tool that will provide accurate information about the gross and fine motor performance of young children and support provision of appropriate intervention to children performing significantly lower than the norm. (Contains 46 references.) (DB)

Peabody Developmental Motor Scales Gross and Fine Motor Skill Performance of Young Children With Speech and Language Delays Versus the National Norms

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Abstract

The primary purpose of this research was to determine if the Peabody Developmental Motor Scales [PDMS] (Folio & Fewell, 1983) gross and fine motor skill norms for the three age groups of young children with speech and language delays are significantly different from the national norms of the PDMS. Sixty children between the ages of 3.0 and 5.11 years, classified as speech and language delayed were administered the PDMS. All comparisons were made with one-sample t-tests. The independent variables for the t-tests were the age norms (3,4, and 5 years). The dependent variable was the PDMS gross and fine motor total raw scores. The young children with a speech and language delay performed the PDMS gross motor skills significantly lower than the norm at each age level. The PDMS fine motor skill performance of the 3- and 4-year-old children with a speech and language delay was significantly lower than the mean performance of the PDMS norming sample. It appears that the young children with speech and language delays tend to perform the PDMS gross and fine motor skills below the PDMS norming sample.

During 1991-92, 5% percent of the school age population in the U.S. were identified with a primary disability of speech impairment, language impairment or both (U.S. Department of Education, 1993). Another 42 % of school age children with a primary disability other than speech-language received services from a speech-language pathologist, highlighting the large quantity of children with speech-language deficits.

Special education services were provided to 260,000 children, 3 to 5 years of age (3% of the total preschool population) in 1988-1989 (Office of Special Education Programs, 1990). During 1991-92 there were 66,478 children (birth to 3 years of age) and 417,346 children (3 to 5 years of age) who received special education services in the U.S. (U.S. Department of Education, 1993). According to the American Speech-Language-Hearing Association's Committee on Prevention of Speech-Language and Hearing problems (1984), 71 percent of all preschoolers with disabilities are diagnosed as having a speech or language impairment as their primary disabling condition. Motor delays and deficits are frequently found with young children with disabilities (Bigge, 1991).

The development of speech, language, and motor skills progresses rapidly between the ages of 3 to 6 years (Chapman, 1990; McCormick, 1990; Mc Lean, 1990; Mateer, 1983; Witelson, 1977). Speech and language play a critical role in one's learning environment (Bailey & Wolery, 1992; Quiros & Schrager, 1979). Children interact with their environment through their gross motor, fine motor, cognitive, speech and language skills (Bailey & Wolery, 1992). For example, children learn how to label objects quicker when they are permitted to move the object. Children with speech and language delays have trouble conveying concepts and articulating sounds (Seaman & DePauw, 1989). Intentional communication often involves a child using gross and fine motor skills to communicate to the listener (Bates, 1979). For example, a three-year-old child moves a chair to the kitchen counter and points up to the cookie jar. Because of the child's speech and language delay, he is unable to verbalize, "I want a cookie". In addition to his speech and language delay, the child does not have the gross and fine motor ability to pull himself up on the chair. This event emphasizes how children use both speech, language, gross motor, and fine motor skills to communicate to others. Children will often use their speech and language skills to communicate their movement. During the early stages of language development, children will center on their own movements (Prizant & Bailey, 1992).

Piaget's (1969) developmental milestone theory is a good application of the interrelationship between the child's development of motor and speech-language skills. The process of accommodation and assimilation play a critical role in how well children adapt to their dynamic environment. The development of young children is highly contingent on Piaget's sensorimotor and preoperational thought phases. During the sensorimotor phase, children are extremely dependent on developing their speech-language skills through movement. As their gross and fine motor skills develop, the relationship between motor and speech-language skills is strengthened. For example, children who are developmentally delayed with their ability to perform a gross motor skill such as, walking independently are limited in how they can actively explore their environment to develop their communication skills. The refinement of fine motor skills involving grasping patterns occurs during the preschool years (Cohen & Gross, 1979). According to Piaget (1969), it is during the preoperational thought phase that language becomes the leader of learning. It is not surprising to find that young children with speech and language delays often exhibit gross and fine motor skill delays.

Just a quick look at the development of the sensory input systems reinforces how atypical motor development can influence delays in the development of speech and language skills of young children. Development of posture and equilibrium plays such a significant role in the coordination of motor activities that are the foundation of the process of learning. The cerebellum coordinates information from vision, proprioception, and vestibular centers that produce movement (Quiros & Schrager, 1979). The visual and vestibular systems are two of the primary input systems that influence the development of gross and fine motor skills (Auxter, Pyfer, & Huettig, 1992). Both of these systems develop before the child reaches 6 years of age. If the visual, vestibular, or both systems do not completely develop, a delay with one or both of these input systems occurs, effecting motoric development.

Children with language delays and disabilities develop their language more slowly and experience greater academic problems than do their peers throughout life (Chapman, 1990; Scarborough & Dobrich, 1990; Aram & Hall, 1989; Aram & Nation, 1980; Garvey & Gordon, 1973; Morley, 1973; Schery, 1985; Weiner, 1972, 1974). For example, Aram & Hall (1989) concluded that 60% of young children with language delays were later placed into special education classrooms. Children with a language disorder also demonstrate deficits with their cognitive, motor, sensory, and emotional skills (Chapman, 1990; Bishop & Rosenbloom, 1987; Leonard, 1979; Stark, Mellits, & Tallal, 1983). A relationship has been shown to exist between poor fine motor performance and language impairment (Bishop & Edmundson, 1987). Silva and Ross (1980) concluded that there is a significant relationship between motor development and printing, reading, math, drawing, speech, intelligence, and language development with 3- to 6-year-old children.

A relationship exists between severe articulation disorders and motor deficits (Scarborough & Dobrich, 1990; Bernthal & Bankson, 1981; Bilto, 1941; Jenkins & Lohr, 1964; Prins, 1962). As early as 1962, Prins reported that children 3 to 6 years of age with articulation disorders scored significantly lower on IQ, gross and fine motor skills than their peers. About the same time Jenkins and Lohr (1964) reported that first grade children with severe articulation deficits had a significantly lower motor ability level than their peers. Speech-language pathologists continue to report that children with articulation disorders have a higher incidence of motor deficits than their peers (Cermak, Ward, & Ward, 1986; Sommers, 1988). At this point in time there is a need for additional research investigating the specific relationships between speech and language delays and various aspects of motor coordination (Cermak, Ward, & Ward, 1986).

The purpose of this study was to determine if the Peabody Developmental Motor Scales [PDMS] (Folio & Fewell, 1983) gross and fine motor skill norms for the three age groups of young children with speech and language delays are significantly different from the national norms of the PDMS. All comparisons were made with one-sample t-tests. The independent variables for the t-tests were the age norms (3, 4, and 5 years). The dependent variable was the PDMS gross and fine motor total raw scores.

Method

Subjects

All of the subjects (N = 60) met the criteria for speech and language delay in accordance with the Texas State Board of Education. Children between the ages of 3.0 (36 months) and 5.11 years (71 months) meeting the criteria for speech and language delay were identified by the speech-language pathologist of the public school districts. The children were selected as subjects if speech and language delay was their only identified disability. An equal number of subjects (n = 20 per group) were placed into one of the three age groups: 3.0 to 3.11 years, 4.0 to 4.11 years, and 5.0 to 5.11 years. The demographic characteristics of the subjects are summarized in Tables 1 and 2.

Peabody Developmental Motor Scales Instrument

The literature was reviewed in order to select a motor ability assessment instruments for use in the study. The criteria for the selection of the assessment instrument was (a) quality of the standardization process, (b) validity, (c) reliability, (d) objectivity, and (e) administrative feasibility. The instrument selected was the Peabody Developmental Motor Scales [PDMS] (Folio & Fewell, 1983).

The PDMS is a standardized, assessment instrument designed to evaluate the developmental level of gross and fine motor skills for children from birth to 6.11 years (Folio & Fewell, 1983). The PDMS is both a norm-referenced and criterion-referenced test. A stratified quota sampling was used to select 617 children, ages birth to 6.11 years (83 months). The sample was stratified by ethnic background, geographical area, and gender (females = 49%, males = 51%). Early research and development of the PDMS included children with hearing, deaf-blind, and visual disabilities (Folio, 1973, 1975; Folio & DuBose, 1974). Many of the test items were reconstructed so that children with these disabilities would not be penalized for their disability

(Folio & Fewell, 1983). For example, the evaluator is instructed to provide a visual demonstration for many of the test items, placing the emphasis on gross and fine motor performance rather than language performance.

PDMS Scoring

The scoring system of the PDMS is based on a 0, 1, or 2 for each test item. The criteria for a 0 is "the child cannot or will not attempt the item, or the attempt does not show that the skill is emerging" (Folio & Fewell, 1983, p. 18). The criteria for a 1 is "the child's performance shows a clear resemblance to the item criterion but does not fully meet criterion" (Folio & Fewell, 1983, p. 18). The criteria for a 2 is "the child performs the item according to the specified item criterion" (Folio & Fewell, 1983, p. 18). A basal and ceiling level must be established for each child performing the test. The basal (baseline) age level is "the first level at which the child scores 2 on all items or the level below the first level at which the child scores 0 or 1 on only one item and 2 on the remaining items" (Folio & Fewell, 1983, p. 18). The ceiling age level is "the level at which the child scores 0 or 1 on all items or scores 2 on only one item and 0 or 1 on the remaining items" (Folio & Fewell, 1983, p. 19).

The raw score for each skill category in the gross and fine motor scale is based on a basal and ceiling score. Each raw score can be converted to a percentile ranking, z or T-score, and developmental motor quotient. Z scores are provided because many school systems use 1.0 and 1.5 standard deviations below the mean to identify children with special needs. Based on the T-score norms for all of the gross and fine motor skill areas one can examine the total Gross-Motor Scale and Fine-Motor Scale scores to evaluate if a child is performing at the same level for each scale level.

The total raw score for each scale can be converted to an age equivalent score. Because some school systems determine adapted physical education eligibility by gross and fine motor age equivalent scores, they are included in the PDMS. The correlation coefficient and coefficient of determination for the Gross-Motor scores and Fine-Motor scores were reported as $r = .99$ and r

=.99, r = .98, respectively. This means that age equivalent scores for each scale account for at least 99% of the variability when predicting the scale scores according to age.

PDMS Validity

Since the Gross and Fine-Motor Scale items are based on the Taxonomy of the Psychomotor Domain (Harrow, 1972), Folio and Fewell (1983) report that the PDMS has content validity. Construct validity was determined by using t-tests to compare the total scores for the Gross-Motor and Fine-Motor Scale scores by age. Since all of the comparisons except for two were significant ($p < .01$), it was concluded that the performance of gross motor and fine motor skills improve with age. The Gross-Motor and Fine-Motor Scale scores were compared using t-tests between the clinical and norming samples. For the majority of the comparisons the probability values were below .001, with the remaining values being less than .05. The construct validity data provide evidence that the PDMS is a sound assessment tool that can help identify any discrepancies from typical development.

The PDMS has adequate concurrent validity, Bayley Scales of Infant Development (Bayley, 1969), r = .37 and PDMS, r = .36; West Haverstraw Motor Development Test (New York State Rehabilitation Hospital, 1964), r = .55 and PDMS, r = .20. Since the Gross and Fine-Motor Scale items are based on the Taxonomy of the Psychomotor Domain (Harrow, 1972), the PDMS has content validity (Folio & Fewell, 1983). Since the PDMS has high construct validity ($p < .001$), the performance of gross motor and fine motor skills improve with age. The standardization procedure, administrative feasibility, strong test-retest reliability for the Gross-Motor and Fine-Motor total scores (r = .99, r = .99), and strong interrater reliability for the Gross-Motor and Fine-Motor Scales (r = .99, r = .99) provides strong evidence that the PDMS is a sound assessment instrument for evaluating the gross and fine motor ability of children from bir' to 6.11 years.

PDMS Reliability

The small standard errors of measurement for the Gross-Motor and Fine-Motor Scale total scores demonstrate the accuracy of both subtests. The test/retest reliability correlations (1 week after the initial administration of the PDMS) for the Gross-Motor and Fine-Motor total scores were strong, $r = .99$ and $r = .99$, respectively. These correlations demonstrate the strong stability of the PDMS and the dependability of the test scores.

PDMS Objectivity

The interrater reliability for the total scores of both the Gross-Motor and Fine-Motor Scales were $r = .99$ and $r = .99$, respectively. The excellent interrater reliability indicates how confident one can be about the test results of the PDMS. Based on the small standard errors of measurement, test/retest reliability coefficients, and interrater reliability coefficients for the Gross-Motor and Fine-Motor Scales, it may be concluded that the PDMS is a sound assessment tool for evaluating the gross and fine motor ability of children birth to 6.11 years (83 months).

PDMS Administrative Feasibility

The length of time to administer the Gross-Motor Scale is from 20 to 40 min; and it takes approximately 20 to 30 min for the Fine-Motor Scale. The time is dependent on the child's gross and fine motor level, and splinter skills. The administration of the PDMS can be broken down into smaller segments as long as the testing is completed within 1 week. The administration and interpretation of the PDMS requires that the evaluator have an extensive background in the motor development of children from birth to 6.11 years (83 months) and an understanding of the PDMS testing manual. Specific directions for group administration of the PDMS are provided even though the PDMS was not designed to be administered to a group. The PDMS does meet the criteria of being administratively feasible, providing comprehensive information about a child's gross and fine motor skills.

It can be concluded that the criteria for selecting the PDMS as a motor ability assessment instrument have been thoroughly examined. The PDMS has adequate concurrent and content validity, and high construct validity. The standardization procedure, administrative feasibility, strong test-retest reliability, and strong interrater reliability for the Gross-Motor and Fine-Motor Scales provides strong evidence that the PDMS is a sound assessment instrument for evaluating the gross and fine motor ability of children from birth to 6.11 years (83 months).

Data Collection

When administering the PDMS, either the Gross-Motor or Fine-Motor Scale was randomly administered first. Each subject completed the PDMS within 5 consecutive school days. The evaluator provided both verbal directions and a visual demonstration to each subject for every test item. The administration of the PDMS Gross-Motor Scale took approximately 20 to 40 min; it took 20 to 30 min to complete the PDMS Fine-Motor Scale. The duration of each testing period depended on the child's gross and fine motor level and severity of splinter skills. Many children with developmental delays demonstrate splinter skills where there is a gap in the development of their motor skills, e.g., a child cannot hop but can skip.

Design and Analysis

Descriptive statistics was conducted for each of the subjects on the variables of age, gender, type of speech and language delay, and the 8 scores of the PDMS. These descriptive statistics are presented in Table 3. All analyses of the data were done using BMDP statistical software (Dixon, 1990). Ranges, means, standard deviations, and standard error of means were calculated.

All comparisons were made with one-sample t-tests using the BMDP3D statistical program. The independent variables for the t-tests were the age norms (3, 4, and 5 years). The dependent variable was the PDMS gross and fine motor total raw scores.

Results and Discussion

The PDMS (Folio & Fewell, 1983) gross motor skill performance of the young children with a speech and language delays differed significantly from the national norms of this test for each age group. Results of the one-sample t-tests appear in Table 4. The young children with speech and language delays performed significantly lower than the norm at each of the age levels.

The PDMS fine motor skill performance of the 3- and 4-year-old children with a speech and language delay was significantly different than the PDMS norming sample. These results are presented in Table 5. The 3- and 4-year-old children with a speech and language delay performed the PDMS fine motor skills at a significantly lower level than the normative sample. The fine motor performance of the 5-year-old children with a speech and language delay did not differ from the PDMS norming sample.

According to Folio and Fewell (1983), the PDMS test/retest reliability coefficients for the Gross-Motor and Fine-Motor total scores were strong, $\underline{r} = .99$ and $\underline{r} = .99$, respectively. These correlations demonstrate the strong stability of the PDMS and the dependability of the test scores. Since the nonstandardized version of the PDMS (Folio & DuBose, 1974) was used to evaluate the gross motor skills of 4 and 1/2-year-old neurologically delayed children with their peers, it is not suprising that the PDMS is a valid assessment tool of gross and fine motor skills for young children with speech and language delays. As a result, many of the test items were reconstructed so that children with these disabilities would not be penalized for their disability (Folio & Fewell, 1983).

Even though the final standardization population did not purposefully include children with disabilities, the development of the PDMS focused on gross and fine motor ability (Folio & Fewell, 1983). The skill categories of the PDMS are skill clusters that were constructed to identify the strengths and weaknesses of a child. With the support of construct validity for the PDMS as a sound assessment tool with young children with speech and language delays, the PDMS can help identify any discrepancies from typical motor development for young children with speech and language delays.

The PDMS (Folio & Fewell, 1983) gross motor skill performance of the young children with speech and language delays was lower than the norm at each of the age levels. This finding was consistent with previous research that concluded that children with speech and language disabilities appear to have a higher incidence of motor deficits than their peers (Bishop & Rosenbloom, 1987; Leonard, 1979; Sommers, 1988; Stark, Mellits, & Tallal, 1983). Researchers have reported that the linguistic skills of young children with speech and language delays are related to their gross and fine motor skills (Bishop & Edmundson, 1987; Paul, Cohen, & Caparulo, 1983; Silva & Ross, 1980; Sommers, 1988).

In the present study, the 3- and 4-year-old children with a speech and language delay performed the PDMS fine motor skills at a lower level than the PDMS norming sample. Previous research by Smith (1989) supports the findings of the present study. Smith found that children with gross motor developmental delays will frequently have deficits with their fine motor development. Also, it appears that fine motor development correlates with verbal skill development (Bishop & Edmundson, 1987).

The fine motor performance of the 5-year-old children with speech and language delays did not differ from the PDMS norming sample. These results are consistent with longitudinal research involving children with both language and fine motor delays diagnosed between 3 and 4 years of age. By the time the children were 5 and 1/2 years of age, they no longer demonstrated fine motor delays; they were no longer performing their fine motor skills at levels significantly below their peers (Bishop & Edmundson, 1987).

The young children with a speech and language delays performed the PDMS gross motor skills significantly lower than the norm at each age level. The PDMS fine motor skill performance of the 3- and 4-year-old children with a speech and language delay was significantly lower than the mean performance of the PDMS norming sample. It appears that the young children with speech and language delays tend to perform the PDMS gross and fine motor skills below the PDMS norming sample. These findings reinforce the importance of using an assessment tool that will provide accurate information about the gross and fine motor performance of young children. In addition to a reliable assessment tool, appropriate intervention needs to be provided to children who are performing significantly lower than the norm. We need to better understand how young children with speech and language delays develop their gross and fine motor skills (Heriza, 1991).

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Table 1

Demographic Characteristics of Subjects

Variable	n	%
Gender		
Female	21	35
Male	39	65
Speech and Language Delay		
Articulation	32	53
Language	5	8
Articulation & Language	19	32
Fluency	4	7
School Setting		
Suburban	48	75
Rural	12	25

Table 2

Description of Young Children with Speech and Language Delays by Classification

Speech and Language Delay	Age		
	3 years	4 years	5 years
Articulation	11	7	14
Language	1	4	0
Articulation and Language	8	7	4
Fluency	0	2	2

Table 3

Descriptive Statistics for PDMS Score

Variable	Range (Low - High)	M	SD	SEM
DMQ:				
Gross Motor	49 (65 - 114)	77.27	15.27	2.79
Fine Motor	51 (65 - 116)	81.70	15.91	2.90
Combined	45 (65 - 110)	79.48	13.59	2.48
Age Equivalent:				
Gross Motor	43 (16 - 70)	39.50	13.92	2.54
Fine Motor	60 (19 - 79)	47.70	13.63	2.49
Mean Motor Age Equivalent	54 (18 - 72)	43.67	13.41	2.45
Total Raw Score:				
Gross Motor	175 (156 - 331)	244.83	44.54	8.13
Fine Motor	172	197.00	28.54	5.21

Note. The Developmental Motor Quotient (DMQ) is the standard score for the PDMS.

Table 4

Comparison of PDMS Gross Motor Total Raw Scores for Young Children with Speech and Language Delays vs. National Norms

Age Level	Group	M	t	p
3	NL	254.00		
			-4.30	.0004
	SLD	217.70		
4	NL	291.00		
			-4.66	.0002
	SLD	246.65		
5	NL	321.00		
			-3.57	.0020
	SLD	289.95		

Note. NL = National PDMS Norm; SLD = Speech and Language Delay; df = 19 for all comparisons.

Table 5

Comparison of PDMS Fine Motor Total Raw Scores for Young Children with Speech and Language Delays vs. National Norms

Age Level	Group	M	t	p
3	NL	188.00		
			-2.55	.0196
	SLD	176.45		
4	NL	204.00		
			-2.94	.0085
	SLD	192.30		
5	NL	216.00		
			.73	.4748
	SLD	289.95		

Note. NL = National PDMS Norm; SLD = Speech and Language Delay; df = 19 for all comparisons.