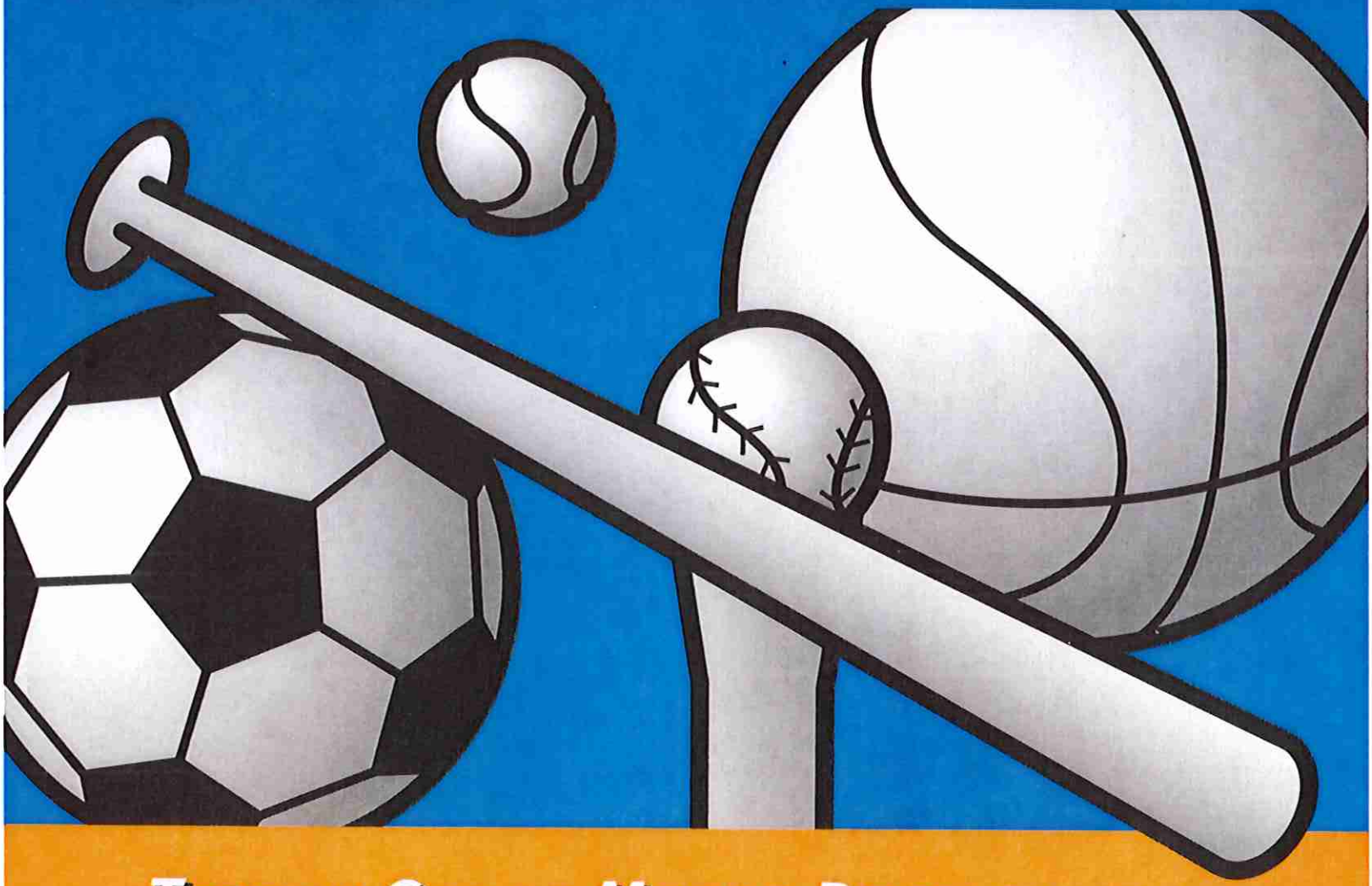
TGMD-2



Test of Gross Motor Development

Second Edition

Dale A. Ulrich

Examiner's Manual

Contents

1

Rationale and Overview of the TGMD–2

An area often overlooked by early childhood educators, including those in special education, is gross motor development. During the preschool and elementary years, a child's motor ability begins to emerge and mature. Physical growth and a child's history of movement experiences play a fundamental role in influencing shifts in patterns of movement (Thelen & Smith, 1994; B. D. Ulrich & D. A. Ulrich, 1993). If deficits in gross motor development are not identified and remediated, the child may experience lifelong problems with motor skills. In addition, secondary social consequences may arise from gross motor skill deficits that significantly distort a child's self-concept. Therefore, an important aspect of early childhood screening programs should be the evaluation of gross motor development. A need exists for well-constructed, standardized tests of gross motor development that include locomotor and object control skills. The *Test of Gross Motor Development–Second Edition* (TGMD–2) was developed to meet this need. This chapter will (a) define gross motor development, (b) explain its importance, (c) describe the test, and (d) discuss its uses.

Definition of Gross Motor Development

Clark (1994) defined motor development as "change in motor behavior over the lifespan and the processes that underlie the change" (p. 245). Gross motor skills are defined as "motor skills that involve the large, force-producing muscles of the trunk, arms, and legs" (Clark, 1994, p. 245) and are used to achieve a movement task or goal such as throwing a ball to a friend or jumping over a puddle. Gross motor development frequently includes movement behaviors that are used to transport the body from one location to another and to project and receive objects, especially balls. Hence, locomotion and object control behaviors form the nucleus of the general domain measured by the TGMD–2. In particular, the TGMD–2 measures how children coordinate their trunk and limbs during a movement task performance rather than assessing the end result (e.g., how fast they ran, how far they threw the ball).

Most motor developmentalists agree that a child's gross motor behavior changes dramatically

over the first 8 years of life (Clark, 1994; Gallahue & Ozmun, 1998; Haywood, 1993; Payne & Isaacs, 1999; Roberton, 1982; Williams, 1983). Multiple, sequential periods have been described during which qualitative differences are observed in a child's motor behavior. Table 1.1 lists several of the common periods included in current motor development textbooks, along with the related time intervals. The TGMD–2 tests skills typically developed during preschool and early elementary years, that is, "fundamental gross motor behaviors that provide a foundation for later sport-specific movement skills" (Clark, 1994, p. 250). Most authorities agree that individuals move through the various periods at different rates, based on the confluence of multiple internal (biological, psychological, motivational, cognitive, social, etc.) and external factors (Clark, 1994; Malina, 1980; Wade & Whiting, 1986).

Importance of Gross Motor Development

Piaget (1952) was among the first to stress the importance of human movement in the development of cognition. Children must explore their environment if they are to develop maximum cognitive abilities. During the early years, children spend much time interacting with their environment through movement activities such as crawling, creeping, walking, and jumping. This developmental period is critical if the child is to master the gross motor skills. Developmental psychologists have demonstrated that the onset of locomotion serves as a facilitator of skill development in multiple domains, including more advanced movement skills (Bertenthal & Campos, 1990; Campos & Bertenthal, 1991).

According to the movement skill classification system proposed by Burton (1998), fundamental gross motor skills are related to specialized and context-specific movements. Clark (1994) views fundamental motor skills as the "principal patterns of coordination that underlie later movement skillfulness" (p. 251). Edelman's (1987) work suggests that young children learn how to coordinate and control their bodies by moving and using the sensory feedback produced as a consequence of action. Patterns of movement that are repeated frequently generate stronger neural pathways that support the movement pattern.

During the early elementary years, a child's gross motor performance plays a significant role in influencing how peers view the child (Gallahue & Ozmun, 1998; Weise, 1987). A child who is less skilled than most of his or her peers will generally be chosen last to participate in group games during recess and after-school activities. The consequence of consistently being selected last or not at all must have a negative impact on a child's physical self-concept and motivation to be active.

Children with disabilities who possess lower social skills due to fewer opportunities to interact socially with their peers should be provided with intensive instruction and therapy designed to significantly improve their movement skill development. It makes sense that a child with a developmental disability, who possesses adequate movement skills, would be asked to participate in physical activities more often by his or her peers.

Overview of the TGMD–2

The TGMD–2 is composed of two subtests that measure gross motor abilities that develop early in life. It

TABLE 1.1
Sequential Periods Reflecting Qualitative Differences in Motor Behaviors

Time Interval	Stage	Major Periods
Middle elementary through adulthood	4	Sport- and context-specific movements
Preschool and early elementary years	3	Fundamental gross motor behaviors
First 12–14 months	2	Preadapted behavior repertoire
Neonatal (first 2–3 months)	1	Reflexive and spontaneous movements

was designed to assess the gross motor functioning in children 3 through 10 years of age and has empirically determined reliability and validity. The test measures 12 gross motor skills that may be taught to children in preschool, early elementary, and special education classes. The normative sample consists of 1,208 persons residing in 10 states. The test can be used by occupational therapists, physical therapists, diagnosticians, adapted and general physical education teachers, and others who are interested in examining the gross motor abilities of young children.

The methods used to build the TGMD–2 and the procedures for giving, scoring, and interpreting the test are described later in the manual. Before addressing these topics, some basic information about the test is useful, specifically descriptions of the two subtests, the composite that is formed by combining the subtests, and the test components.

Description of the Subtests

The two subtests that make up the TGMD–2 are described briefly in this section. Detailed justifications for the selection of formats, contents, and components are discussed in the Content-Description Validity section of Chapter 6; administration and scoring procedures are presented in Chapter 2; and interpretation matters are described in Chapter 3. The purpose of this section is to familiarize the reader with the subtests that compose the TGMD–2. Numerous skills are grouped into the two subtests, Locomotor and Object Control, each assessing a different aspect of gross motor development.

Locomotor. The Locomotor subtest measures the following gross motor skills that require fluid coordinated movements of the body as the child moves in one direction or another:

1. *Run*—the ability to advance steadily by springing steps so that both feet leave the ground for an instant with each stride.
2. *Gallop*—the ability to perform a fast, natural three-beat gait.
3. *Hop*—the ability to hop a minimum distance on each foot.
4. *Leap*—the ability to perform all of the skills associated with leaping over an object.
5. *Horizontal Jump*—the ability to perform a horizontal jump from a standing position.
6. *Slide*—the ability to slide in a straight line from one point to another.

Object Control. The Object Control subtest measures the following gross motor skills that demonstrate efficient throwing, striking, and catching movements:

1. *Striking a Stationary Ball*—the ability to strike a stationary ball with a plastic bat.
2. *Stationary Dribble*—the ability to dribble a basketball a minimum of four times with the dominant hand before catching the ball with both hands, without moving feet.
3. *Catch*—the ability to catch a plastic ball that has been tossed underhand.
4. *Kick*—the ability to kick a stationary ball with the preferred foot.
5. *Overhand Throw*—the ability to throw a ball at a point on a wall with the preferred hand.
6. *Underhand Roll*—the ability to roll a ball between two cones with the preferred hand.

Description of the Composite

The Gross Motor Quotient (GMQ) is formed by combining the standard scores of the Locomotor and Object Control subtests and is the best measure of an individual's overall gross motor ability. The composite is discussed in greater detail in Chapter 3 of this manual.

Test Components

The TGMD–2 kit includes this Examiner's Manual and a supply of Profile/Examiner Record Forms. The manipulatives used in the administration of the test need to be supplied by the examiner. The Examiner's Manual provides the rationale for the test, a description of the constructs being measured, the psychometric information on reliability and validity, instructions for administrating and scoring the test, descriptive pictures of the skills being tested, the information on interpreting the results, and the normative tables. The Profile/Examiner Record Form is used to describe the child and plot the standard scores obtained on the two subtests and the composite and to record the child's performance on the subtest items. The materials needed for administering the TGMD–2 are depicted in Figure 1.1, all of

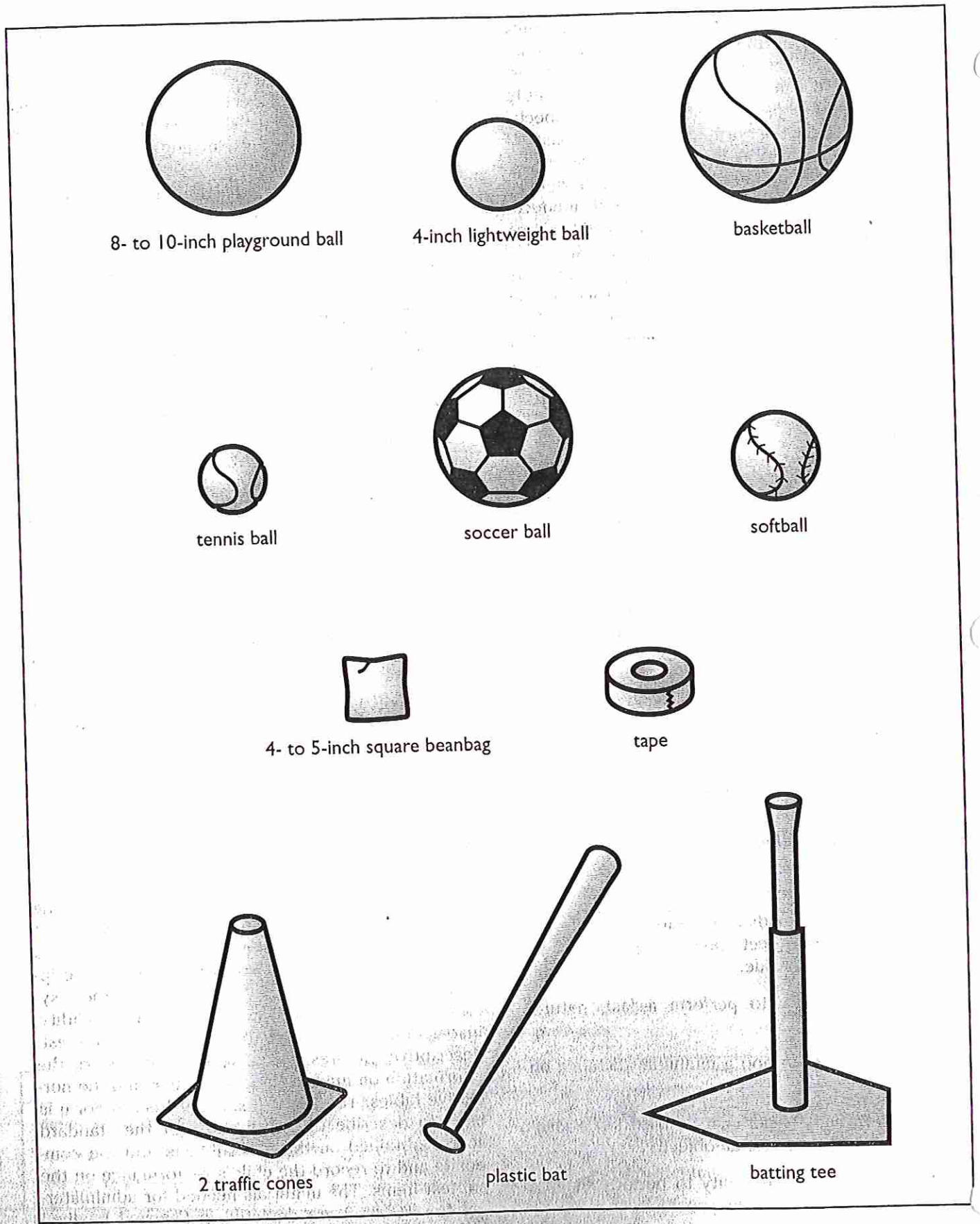


Figure 1.1. Test materials needed for administering the TGMD–2.

which are supplied by the examiner. Most of the materials can be found in preschool and elementary programs, physical and occupational therapy rooms, and gyms, or may be purchased commercially.

Uses of the TGMD–2

The primary uses of this test are (a) to identify children who are significantly behind their peers in gross motor skill development, (b) to plan an instructional program in gross motor skill development, (c) to assess individual progress in gross motor skill development, (d) to evaluate the success of the gross motor program, and (e) to serve as a measurement instrument in research involving gross motor development.

Identification and Screening

The TGMD–2 can be used to identify those individuals who would most benefit from special education services in physical education. To ensure that the test identifies these individuals, items were selected that represent the common gross motor skills usually acquired by children in preschool and early elementary grades (ages 3 through 10). Motor skill sequences that make up the gross motor ability are measured rather than the overall outcome. Directions for scoring the items were written so that professionals, with a minimum of training, can administer the test. The test provides normative and criterion-referenced interpretations.

Instructional Programming

Specific gross motor skill strengths and weaknesses can be identified with the TGMD–2. Precise measurement of mastery or nonmastery of specific behavioral components within each gross motor skill will help teachers design programs that will facilitate maximum learning. Children can be grouped for instruction on the basis of skills that they have not mastered. The goal of preschool and early elementary gross motor programs is to have all children achieve a predetermined level of mastery in fundamental gross motor skill development. Additional or specially designed instruction can be prescribed for children who are experiencing gross motor skill delays. An Individualized Education Program (IEP) can be developed with the information provided by this test. Annual goals and short-term objectives along with a statement of the present level of functioning can easily be developed from the test results. Statements of current level of performance can include a listing of gross motor skills the child has achieved or the percentile rank corresponding to his or her level of achievement. The skills included on the TGMD–2 reflect movement skills proposed by the National Association for Sport and Physical Education (1995) as appropriate for students in kindergarten, second grade, and fourth grade.

Assessment of an Individual's Progress

The third use of the TGMD–2 is to continuously evaluate a child's progress in mastering gross motor skills. Objective-based instruction requires that educational prescriptions be updated when progress is made or changed when interventions are not successful. Federal special educaiton mandates require documentation of progress for children who are receiving specially designed instruction in the form of an IEP. The standardized TGMD–2 is useful for documenting the effectiveness of instructional programming in gross motor development. By counting the number of specific performance criteria that have been learned over time, a statement of a child's progress can be made. Also, the standard scores provided for the subtests and the gross motor composite can be used for this purpose.

Program Evaluation

The effectiveness of a specific gross motor development program can be evaluated by randomly selecting students from various classes, pretesting those students, implementing the instructional program, and following up with a posttest of the selected students. A comparison of pretest and posttest results will indicate whether the students made significant progress. Professionals responsible for delivering gross motor programs should have a valid and reliable assessment tool, such as the TGMD–2, to document the effectiveness of their programs. Teachers should establish realistic expectations for the amount of progress children should make from the beginning through the end of the school year.

Research Tool

The TGMD–2 is useful to researchers who are interested in studying the effects of various instructional paradigms on the gross motor development of chil-

dren with and without disabilities. The availability of reliable, valid, and well-standardized instrumentation to measure the dependent variable (gross motor skill development, locomotor skill development, or object control skill development) is critical for this type of research.

Many researchers have used the TGMD to study the gross motor skill development of various groups of children (Aponte, French, & Sherrill, 1990; Cole, Wood, & Dunn, 1991; Dummer, Haubenstricker, & Stewart, 1996; Harvey & Reid, 1997; Merriman, Barnett, & Isenberg, 1995; Woodard & Surburg, 1997). Other studies have used the TGMD to identify subjects who are performing poorly on gross motor skills and then assign the subjects to different levels of the independent variable (e.g., type of instruction, type of placement, type of teacher, type of reinforcement). The most interesting studies look for explanations or factors associated with poor motor skill performance and changes in performance over time. Many graduate students have used the TGMD in their theses and dissertations.

2

General Testing Information

This chapter discusses important matters that an examiner should consider before administering the *Test of Gross Motor Development–Second Edition* (TGMD–2) and provides vital information about administering and scoring the test.

Information To Consider Before Testing

This section includes information about examiner competence, appropriate testing conditions, time needed to complete the testing, testing procedures, accounting for situational and subject error, and sharing of test results.

Examiner Competence

Examiners who give and interpret the TGMD–2 should have some training in assessment that results in a basic understanding of test statistics; general procedures governing test administration, scoring, and interpretation; and specific information about motor development and its testing. Supervised practice in administering and interpreting motor development tests is also desirable. This special training can be obtained from numerous sources. Most often, the training can be acquired by enrolling in college courses devoted to assessment. Such courses frequently are found in departments of kinesiology, general and special education, psychology, and occupational and physical therapy. Workshops sponsored by local school agencies or private consultants are other sources of training. Examiners with such experience should have little difficulty in mastering the procedures necessary to give, score, and interpret the TGMD–2 properly.

Examiners who are using the TGMD–2 for the first time should consider the following recommendations:

1. Study the content of this manual carefully. Ask a colleague or supervisor about any information that you do not understand.
2. Thoroughly practice giving and scoring the subtest items. Practice giving the test to at least three persons before using it in a real situation. Ask someone who is experienced in test administration to observe your testing and help you with scoring and interpretation.

3. Consistently praise and encourage the examinee, but avoid prompting or otherwise deviating from testing procedures. Remarks such as "Throw hard" or "Jump far" are appropriate. However, comments that appear to reflect on the level of the examinee's ability, such as "Very good" or "That's right," should not be used during test administration.
4. You may test two or three students at a time. As each child in a group is assessed on an item, the other children are encouraged to watch and rest. When testing children simultaneously, alternate the sequence of individuals so that one child does not always go first or last.

Testing Conditions

Testing conditions should be arranged prior to beginning the test to help minimize administration time and distractions. All materials needed for testing should be readily available. Students should wear rubber-soled shoes during testing to minimize the chance of slipping and falling, thus promoting safety and maximum effort in performing the locomotor skills. It is better to have the child go barefoot than to have him or her wear socks only.

Testing Time

The entire TGMD–2 can be given in approximately 15 to 20 minutes for one child. Testing time will vary with the child's age and the examiner's experience. Before administering the TGMD–2, the examiner should gather several balls for the striking, catching, kicking, and throwing items to minimize the time spent on ball retrieval after each trial. To avoid needless delay, the examiner should move the examinee fairly rapidly through the skills in both subtests. Usually the TGMD–2 can be completed in one testing session. However, for some individuals, the testing may have to be conducted during several sessions. The examinee should be evaluated under optimal circumstances.

Testing Procedures

The administration of the TGMD–2 is rather easy because most examiners and examinees are familiar with the skills being tested. Standardized procedures must be followed when the examiner wants to compare a child's scores to those made by peers in the normative sample. If the examiner is not interested in comparing a student's scores with the normative data, adaptations of the procedures and performance criteria can be made to meet the examiner's unique needs. If desired, instructional decisions can be made without reference to test norms. The following requirements are standard for administering the test in an attempt to minimize any discriminatory practices by ensuring that the child understands the examiner's directions:

1. Prior to testing, fill in the appropriate information on the cover of the Profile/Examiner Record Form and review all of the performance criteria for each skill.
2. Precede assessment with an accurate demonstration and verbal description of the skill to be performed.
3. Provide a practice trial to assure that the child understands what to do.
4. Provide one additional demonstration when the child does not appear to understand the task.
5. Administer two test trials and score each performance criterion on each trial.

Accounting for Situational and Subject Error

Lyman (1991) noted that the reliability of any test can be affected by five inherent sources of error: test content, stability over time, examiner–scorer, examinee, and situation. In considering these error sources, the first three are the responsibility of the test designers. Chapter 5 presents information on the reliability of the TGMD–2 and shows that its results may be interpreted with confidence.

The final two sources of error variance arise from the situation in which examinees are tested and from within the examinees themselves. Numerous factors can affect these two sources of error. An examiner has the responsibility to control or account for the obvious variables that can adversely affect examinee performance (e.g., improper clothing or footwear, amount of space needed, no rest breaks). In all situations, these error sources and others should be considered in the analysis of results.

How a testing situation influences a person's performance cannot be accurately measured. Similarly, how a person's physical and emotional well-being contributes to test error cannot be precisely determined. Therefore, examiners must be alert to certain conditions (e.g., fatigue, state of health, nervousness, attitude toward the test, attention level) that may affect the examinee's performance. Because

information of this type is impressionistic and subjective, it should be treated only as a possible factor that may have influenced performance. The testing environment should be arranged to minimize distractions and to satisfy specific directions for each item.

Sharing the Test Results

Test results should be shared with responsible persons eligible to receive such information. The examiner should always consider the following three points when sharing the TGMD–2's findings:

1. A thorough understanding of the purposes, content, and construction of the TGMD–2 is necessary prior to any presentation. The Examiner's Manual should be made available when presenting results to those people unfamiliar with the test. The section "Uses of the TGMD–2" in Chapter 1 would be of particular interest, as well as the data in Chapters 4 through 6 concerning normative statistics, reliability, and validity.
2. When test scores are shared, they should always be accompanied by a personal interpretation from the examiner regarding (a) their meaning, (b) possible alternative interpretations, (c) reports of other diagnostic workups and how they relate (if at all) to the TGMD–2, (d) suggestions for instructional changes if necessary, and (e) recommendations for further testing that may be appropriate. All of these points should be discussed before making final recommendations to parents or students.
3. Every effort should be made to translate the TGMD–2's results into the language that is familiar to the person with whom the information is being shared. Examiners should refrain from using educational jargon.

Administration and Scoring Directions

Specific directions for administering and scoring the TGMD–2 are provided in this section. The items and scoring criteria can be found in Appendix A and the Profile/Examiner Record Form.

Administration Procedures

To achieve a valid interpretation of a child's TGMD–2 performance, the scales must be administered exactly as specified in Appendix A, which is an illustrated guide to administering and scoring the TGMD–2 skills. This appendix provides the examiner with the name of the skill, materials needed, directions for administration, performance criteria, and an illustration of the skill tested. The appendix is to be used as a reference when the examiner has any questions about item administration or scoring. For convenience, the criteria are included without illustrations in the Profile/Examiner Record Form. However, the examiner must be thoroughly familiar with the illustrated guide before administering the test from the Profile/Examiner Record Form.

Occasionally, examiners need to probe a child's skills for the purpose of instructional or treatment programming. In these instances the directions can be adapted to fit the child's individual needs while retaining the intent of the item. When the purpose of testing is to determine both eligibility for or placement in a program and instructional or treatment programming for a child with disabilities, the examiner should first administer an item as directed. If the child receives a score of 0 for the item, the examiner should readminister the item with adapted directions. In such instances, the norms can be used with the scores obtained from the first administration of each item, but not with the scores obtained from the second administration, which were obtained under conditions different from those used in the standardization. The child's performance during the adapted administration should provide the examiner with important information about appropriate instructional activities.

Scoring the TGMD–2

Each gross motor skill includes several behavioral components that are presented as performance criteria. In general, these behaviors represent a mature pattern of the skill. If the child performs a behavioral component correctly, the examiner marks a 1; if the child does not perform a behavioral component correctly, the examiner marks a 0. It is inappropriate to assign a score of .5 to show that the child displays the criterion but is inconsistent. After completing this procedure for each of the two trials, the examiner totals the scores of the two trials to obtain a raw skill score for each item (run, gallop, hop, etc.). The skill scores add up to a raw subtest score (Locomotor, Object Control), which is converted to a standard score using Appendix B. Then, using Appendix C, subtest standard scores are combined and converted to an overall Gross Motor Quotient.

3

Interpreting the TGMD–2 Results

This chapter contains a discussion of how to record, analyze, and use the scores from the *Test of Gross Motor Development–Second Edition* (TGMD–2). Specifically, the topics relate to (a) completing the Profile/Examiner Record Form, (b) test scores and their interpretation, (c) what the composite measures, (d) what the subtests measure, (e) interpreting the TGMD–2 items for instructional programming, and (f) cautions in interpreting test results.

Completing the Profile/Examiner Record Form

Space is provided in the Profile/Examiner Record Form for specifying pertinent information about the child and the examiner, recording the student's test performance and results, noting testing conditions, and graphically displaying results. As an example, page 1 of Justin's completed Profile/Examiner Record Form is provided in Figure 3.1.

Section I. Identifying Information

Section I on the front page of the Profile/Examiner Record Form provides space for recording relevant data about the person being tested and about the individual giving the test. As expected, this information includes the examinee's name, gender, age, grade, and school, as well as the examiner's name and title.

The examinee's exact age is determined by subtracting the birth date from the date on which he or she was tested. For example, consider Justin who was born on July 8, 1991, and tested on November 16, 1999:

	Year	Month	Day
Date of Testing	99	11	16
Date of Birth	91	7	8
Age	8	4	8

Justin is 8 years, 4 months, and 8 days old.

Occasionally, one has to borrow a year (12 months) or a month (30 days) to subtract properly. Suppose Justin's birthday were November 17, 1990:

	Year	Month	Day
Date of Testing	99	11	16
Date of Birth	90	11	17

Because 17 cannot be subtracted from 16, 30 days (i.e., 1 month) are borrowed from the adjacent month's column and added to the 16 days. The date of testing is now 99-10-46:

TGMD–2

Test of Gross Motor Development–Second Edition

Profile/Examiner Record Form

Section I. Identifying Information

Name: Justin
Male ☑ Female ☐ Grade: 2

Date of Testing	99	11	16
Date of Birth	91	7	8
Age	8	4	8

School: Perry Elementary
Referred by: Kasi Holt
Reason for Referral:
Examiner: Sarah Bailey
Examiner's Title: Physical Education Teacher

Section II. Record of Scores

First Testing

	Raw Score	Standard Score	Percentile	Age Equivalent
Locomotor	33	5	5	5-6
Object Control	27	3	1	4-9
Sum of Standard Scores		8		
Gross Motor Quotient		64	<1	

Second Testing

	Raw Score	Standard Score	Percentile	Age Equivalent
Locomotor				
Object Control				
Sum of Standard Scores				
Gross Motor Quotient				

Section III. Testing Conditions

A. Place Tested: School gym

	Interfering				Not Interfering
B. Noise Level	1	2	3	4	(5)
C. Interruptions	1	2	3	4	(5)
D. Distractions	1	2	3	4	(5)
E. Light	1	2	3	4	(5)
F. Temperature	1	2	3	4	(5)

G. Notes and other considerations:

Section IV. Other Test Data

Name of Test	Date	Standard Score	TGMD–2 Equivalent

Section V. Profile of Standard Scores

Standard Scores	Locomotor	Object Control	Standard Scores	Quotients	Gross Motor Quotient	Quotients
20	.	.	20	150	.	150
19	.	.	19	145	.	145
18	.	.	18	140	.	140
17	.	.	17	135	.	135
16	.	.	16	130	.	130
15	.		15	125	.	125
14	.	.	14	120	.	120
13	.	.	13	115	.	115
12	.	.	12	110	.	110
11	.	.	11	105	.	105
10	—	—	10	100	—	100
9	.	.	9	95	.	95
8	.	.	8	90	.	90
7	.	.	7	85	.	85
6	.	.	6	80	.	80
5	X	.	5	75	.	75
4	.	.	4	70	.	70
3	.	X	3	65	X	65
2	.	.	2	60	.	60
1	.	.	1	55	.	55

Figure 3.1. The TGMD–2 Profile/Examiner Record Form, completed for Justin.

	Year	Month	Day
Date of Testing	99	10	46
Date of Birth	90	11	17

However, because 11 months cannot be subtracted from 10 months, 12 months (i.e., 1 year) are borrowed from the adjacent year's column. The date of testing becomes 98-22-46. Simple subtraction is applied (see below), and Justin's age is found to be 8 years, 11 months, and 29 days.

	Year	Month	Day
Date of Testing	98	22	46
Date of Birth	90	11	17
Age	8	11	29

For purposes of using the normative tables, do not round a student's age upward. Thus, in the latter example, Justin would be 8 years 11 months of age, not 9 years 0 months.

Section II. Record of Scores

In Section II, the examiner records the examinee's raw score, standard score, percentile, and age equivalent for each subtest. The raw scores are recorded first. These are followed by the standard scores and percentiles, which are located in the normative tables in Appendix B, and age equivalents, which are found in Appendix D. A complete description of percentiles and standard scores is provided later in this chapter. Space is provided for a First Testing and a Second Testing, if the examiner uses the TGMD–2 for pretest and posttest.

For example, Justin scored 33 points on the Locomotor subtest. The examiner consulted Table B.1 in Appendix B to transform Justin's raw score to a standard score and percentile. According to this table, a raw score of 33 for an individual who is 8 years 4 months of age is transformed into a standard score of 5 and a percentile of 5. Because Justin is male, Table B.3 in Appendix B was used to convert his raw score of 27 on the Object Control subtest into a standard score of 3 and a percentile of 1. For a female examinee, the examiner would use Table B.2 in Appendix B.

Also in Section II on the Profile/Examiner Record Form, the examiner records the sum of the subtest standard scores, which is used to determine the Gross Motor Quotient. Using Table C.1 in Appendix C, the sum of the standard scores for the Locomotor and Object Control subtests is converted into a total Gross Motor Quotient. In Justin's case, the sum of the standard scores is 8 (5 + 3), which translates to a Gross Motor Quotient of 64 and a percentile rank of < 1.

Section III. Testing Conditions

In Section III, the examiner identifies the testing site and rates five conditions on their level of interference. Any recommendations or considerations regarding the testing environment that may be relevant to the interpretation of the test results are also written in this section.

Section IV. Other Test Data

The results of any other relevant tests that may have been given to the child are recorded in Section IV. Specifically, the name of the test, the date administered, and the TGMD–2 equivalent are noted. These equivalents are based on a distribution having a mean of 100 and a standard deviation of 15. If a test does not report standard scores based on this distribution, the scores can be converted to TGMD–2 equivalents using Table 3.1. A precise conversion can be obtained using this formula: TGMD–2 equivalent = $(15/SD)\ (X - M) + 100$. In the equation, SD and M refer to the standard deviation and mean, respectively, of some other test (e.g., 1.96 and 5 for stanines, 10 and 50 for T-scores); X is the student's actual standard score on that test.

Section V. Profile of Scores

In Section II, the test's results are reported in numeric form; in Section III, the results are presented graphically. To form the profile, the standard scores for the subtests and the Gross Motor Quotient are plotted on the graph. From a quick glance, the examiner can identify the presence of any discrepancies among the scores plotted. The result of any other motor or development test that has been given to the examinee is also plotted on the graph.

Section VI. Subtest Performance Record

As the child demonstrates performance of the subtest items, the examiner records whether the child meets the performance criteria. The examiner records a 1 if the child performs a behavioral component correctly or a 0 if not.

TABLE 3.1
Relation of Various Standard Scores to Percentile Rank and to Each Other

Percentile Rank	Standard Scores					
	TGMD–2 Composite Score	TGMD–2 Subtest Score	NCE Score	*T*-score	*z*-score	Stanine
99	150	20	99	83	+3.33	9
99	145	19	99	80	+3.00	9
99	140	18	99	77	+2.67	9
99	135	17	99	73	+2.33	9
98	130	16	92	70	+2.00	9
95	125	15	85	67	+1.67	8
91	120	14	78	63	+1.33	8
84	115	13	71	60	+1.00	7
75	110	12	67	57	+0.67	6
63	105	11	64	53	+0.33	6
50	100	10	50	50	0.00	5
37	95	9	43	47	−0.33	4
25	90	8	36	43	−0.67	4
16	85	7	29	40	−1.00	3
9	80	6	22	37	−1.33	2
5	75	5	15	33	−1.67	2
2	70	4	8	30	−2.00	1
1	65	3	1	27	−2.33	1
1	60	2	1	23	−2.67	1
1	55	1	1	20	−3.00	1

Test Scores and Their Interpretation

The TGMD–2 yields four types of scores: raw scores, percentiles, standard scores, and age equivalents (for subtests). These scores are the most important information associated with a child's TGMD–2 performance because their analysis, augmented by additional test information, direct observation of behavior, and knowledge acquired from other sources, will eventually result in a proper diagnosis of the child's gross motor ability. Because of their importance, each type of score is discussed separately and suggestions are provided for their proper use and interpretation.

Raw Scores

A raw score is the total number of performance criteria scored correct for a subtest. Because the level of difficulty for items on different subtests varies, these scores are of little clinical value. For example, if a child scored 18 raw score points on both the Locomotor and Object Control subtests, that does not necessarily mean that his or her skill level regarding the contents represented by the subtests is equal. In fact, a raw score of 18 achieved on two subtests may mean the examinee has done poorly on one subtest and well on another. The value of raw scores is generally limited to research purposes (i.e., either to make group comparisons or to compute correlation coefficients).

Percentiles

Percentiles, or percentile ranks, represent values that indicate the percentage of the distribution that is equal to or below a particular score. For example, a percentile of 81 means that 81% of the standardization sample scored at or below the examinee's score. Because this interpretation is easy to understand,

percentiles are popular scores for practitioners to use when sharing test results with others. Note that the distance between two percentile ranks becomes much greater as those ranks are more distant from the mean or average (i.e., the 50th percentile). Percentiles are generated for the subtests and composite using tables in Appendixes B and C.

Subtest Standard Scores

Standard scores provide the clearest indication of an examinee's subtest performance. Based on the distribution with a mean of 10 and a standard deviation of 3, subtest standard scores are converted from raw scores using the tables in Appendix B. Guidelines for interpreting standard scores are shown in Table 3.2.

Standard scores allow examiners to make comparisons across subtests. As stated earlier, if a child scores 18 raw score points on both Locomotor and Object Control subtests, examiners are unable to make interpretations based solely upon raw scores. However, standard scores of 18 for both subtests tell the examiner that the child scored equally well on both measures (i.e., "very superior," according to Table 3.2). In the same way, if a person obtains standard scores of 3 for the Locomotor subtest and 18 for the Object Control subtest, an examiner could conclude that locomotion was a relative weakness, whereas object control was a relative strength.

Gross Motor Quotient

The most reliable score for the TGMD–2 is the Gross Motor Quotient because it is a composite of the results of the two subtests. This quotient is another type of standard score and is derived by adding the subtest standard scores and converting the sum to a quotient (i.e., a standard score having a mean of 100 and standard deviation of 15) using Appendix C. Test performance reported in these terms is interpreted as shown in Table 3.2.

Age Equivalents

Age equivalents for tests of developmental abilities have traditionally been termed developmental ages. An age equivalent score provides the examiner with a rough estimate as to how the child's raw score on a subtest relates to age. For example, a raw score of 33 on the Locomotor subtest yields an age equivalent of 5-6, which suggests that the child's locomotor skills are equivalent to those of an individual who is 5 years 6 months of age. Appendix D lists the age equivalents for the TGMD–2 subtest raw scores.

What the Gross Motor Quotient Measures

Guidelines for interpreting the quotient value in terms of diagnosing gross motor development are offered in this section. The quotient score is the most useful value derived from the TGMD–2. This is because it reflects the basic constructs built into the test, is highly reliable, and is composed of both subtests rather than only one.

Strictly speaking, the TGMD–2 Gross Motor Quotient is merely a numeric representation of an examinee's overall performance on the particular abilities

TABLE 3.2
Descriptive Ratings for Subtest Standard Scores and Gross Motor Quotient

Subtest Standard Scores	Gross Motor Quotient	Descriptive Ratings	Percentage Included
17–20	> 130	Very Superior	2.34
15–16	121–130	Superior	6.87
13–14	111–120	Above Average	16.12
8–12	90–110	Average	49.51
6–7	80–89	Below Average	16.12
4–5	70–79	Poor	6.87
1–3	< 70	Very Poor	2.34

measured by the TGMD–2 subtests. In everyday parlance, it is the best estimate of an individual's current gross motor development. High scores on the composite are made by children with well-developed locomotor and object control skills. These children are likely to be described as skilled, well coordinated, graceful, and fluid in their movements; as having good visual–motor integration; or as being "athletic." Low scores are made by those children who have weak locomotor and object control skills. A mild deficit in gross motor abilities can cause a child's movements to be clumsy, uncoordinated, or inefficient. More severe gross motor problems may limit a child's ability to move from place to place or to throw an object without assistance.

What the Subtests Measure

Guidelines for interpreting the subtest values in terms of diagnosing specific strengths and weaknesses are described in this section. Additional information about what the subtests measure is found in Chapter 1, the section titled "Overview of the TGMD–2," and in Chapter 6, the section titled "Content-Description Validity."

General Information About the Subtests

A subtest is built to tap a specific area within a relatively larger domain. For instance, the Locomotor subtest measures the child's ability to move from place to place. However, gross motor skills comprise many abilities, of which locomotion is only one. Although such an ability does yield some information about a person's motor skills, a better index of gross motor skills is the Gross Motor Quotient because it is a composite of two subtests and represents a variety of skills. In short, the examiner can have more confidence in interpreting the composite score than the individual subtest scores.

Because of this, the composite score should be given more credence and attention than subtest scores. This said, evaluation of subtest performance remains useful in generating hypotheses or speculation about why a person did well or poorly on a composite. High standard scores for the Locomotor subtest are made by those children who have well-developed mobility skills that help them move from place to place in an efficient manner. Low standard scores on this subtest are made by those children who may have agility or coordination problems. High standard scores on the Object Control subtest are made by those children who have well-developed ball skills. Low scores are made by those children who have weak object manipulation, grasping, and visual–motor integration skills.

Specific Content of the Subtests

The subtest findings should be interpreted only in terms of specific content and skills measured:

1. The *Locomotor* subtest measures skills involved in moving the center of gravity from one point to another.
2. The *Object Control* subtest measures skills involved in projecting and receiving objects.

Figure 3.1, the example of a TGMD–2 Profile/ Examiner Record Form summary sheet completed for Justin, appeared earlier in this chapter. Justin is a second grader who has demonstrated deficiencies in his gross motor functioning. He was tested using the TGMD–2 to determine his exact strengths and difficulties. An examination of Justin's Locomotor subtest standard score of 5 falls within the "poor" category. (See Table 3.2 earlier in this chapter for a guide to interpreting standard scores.) His standard score of 3 for Object Control falls within the "very poor" category. Justin's Gross Motor Quotient score of 64 also is in the "very poor" range (see Table 3.2). These results indicate that further assessment is necessary and that Justin will likely require special gross motor instruction in both locomotor and object control skills.

Interpreting TGMD–2 Items for Instructional Programming

Guidelines for interpreting the TGMD–2 results for instructional programming are provided in this section, as well as an illustration of using the TGMD–2 results to plan individualized motor instruction. One of the primary concerns of professionals responsible for delivering physical education services is the transformation of standardized test results into instructional programming. The performance criteria listed in the TGMD–2 Profile/Examiner Record Form facilitates this task. The teacher's responsibility is to plan instructional activities to help the student learn the motor behaviors (performance criteria) that have not been mastered. By reviewing the completed Profile/ Examiner Record Form, the teacher can select

the unlearned behaviors that are the highest priority and develop instructional objectives that will guide the child's gross motor development program. Table 3.3 lists the percentage of children in the standardization sample who mastered a certain gross motor skill at each age from 3 through 10 years. This table can be used to help select the skills for a student's instructional program, assuming the student has not already acquired the performance criteria for the skills. Tables 3.4 and 3.5 (for the Locomotor subtest and the Object Control subtest, respectively) provide information on what percentage of children in the standardization sample achieved each specific performance criterion across the 12 gross motor skills at each age. These tables should be helpful in deciding which performance criteria to include in a child's gross motor program and for establishing realistic expectations. The results of the gross motor development assessment allow the teacher to pinpoint specific skill strengths and weaknesses that guide the instructional process.

The information provided earlier in Figure 3.1 is used to help the teacher design Justin's physical education program. Justin's standard scores indicate that he may have weaknesses in both areas of gross motor development (i.e., locomotor and object control skills). Figure 3.2 presents the results of Justin's performance on the initial assessment of each individual skill. According to these results, Justin is deficient in many of these skills. His adapted physical education teacher has decided to work on locomotor and object control skills because Justin is deficient in both areas. Based on information in Tables 3.3 through 3.5, his teacher has developed the following program objectives for Justin's IEP:

1. Justin will be able to demonstrate a run, moving his arms in opposition to his legs with his elbows bent, four out of five trials, for three consecutive classes.
2. Justin will be able to demonstrate a leap, reaching with the arm opposite the lead foot, four out of five trials, for three consecutive classes.
3. Justin will be able to demonstrate a hop of any kind on the right foot and then the left, four out of five trials, for three consecutive classes.
4. Justin will be able to demonstrate a horizontal jump with a preparatory movement that includes flexion of both knees with arms extended behind his body, four out of five trials, for three consecutive classes.

TABLE 3.3
Percentage of Children in Standardization Sample Demonstrating Mastery on TGMD–2 Subtest Skills at Ages 3 Through 10

TGMD–2 Skill	Age							
	3	4	5	6	7	8	9	10
Locomotor Subtest								
Run	40	54	54	76	80	84	85	85
Gallop	5	13	24	40	46	54	55	56
Hop	2	14	31	32	42	49	52	53
Leap	7	21	14	22	28	38	48	50
Horizontal Jump	10	11	17	30	35	44	44	45
Slide	11	29	34	59	60	75	81	86
Object Control Subtest								
Striking a Stationary Ball	13	12	17	21	35	41	47	49
Stationary Dribble	2	5	9	23	39	51	72	74
Catch	1	4	15	40	64	72	76	83
Kick	6	10	23	25	42	62	66	66
Overhand Throw	6	12	18	30	41	50	52	55
Underhand Roll	1	6	11	21	37	38	40	42

TABLE 3.4
Percentage of Children Demonstrating Mastery on Locomotor Subtest Skills at Ages 3 Through 10

Performance Criteria	Age							
	3	4	5	6	7	8	9	10
1. Run								
Arms move in opposition to legs, elbows bent	68	68	73	89	90	94	95	95
Brief period where both feet are off the ground	92	96	97	98	99	99	99	99
Narrow foot placement, landing on heel or toe (i.e., not flat footed)	86	91	93	94	94	96	96	98
Nonsupport leg bent approximately 90 degrees (i.e., close to buttocks)	52	75	82	88	90	90	91	92
2. Gallop								
Arms bent and lifted to waist level at takeoff	7	23	32	49	60	62	66	68
A step forward with the lead foot followed by a step with the trailing foot to a position adjacent to or behind the lead foot	30	51	71	81	82	88	88	92
Brief period when both feet are off the floor	53	68	80	94	95	95	96	97
Maintains a rhythmic pattern for four consecutive gallops	29	34	63	86	88	91	92	93
3. Hop								
Nonsupport leg swings forward in pendular fashion to produce force	5	32	54	65	72	80	80	82
Foot of nonsupport leg remains behind body	10	42	61	75	80	83	86	79
Arms flexed and swing forward to produce force	9	30	50	56	64	71	75	76
Takes off and lands three consecutive times on preferred foot	49	61	83	90	91	96	98	98
Takes off and lands three consecutive times on other foot	27	50	74	83	87	91	93	96
4. Leap								
Take off on one foot and land on the opposite foot	29	48	57	69	78	80	81	83
A period where both feet are off the ground longer than running	46	65	72	82	85	91	92	95
Forward reach with the arm opposite the lead foot	13	27	24	31	41	46	56	63
5. Horizontal Jump								
Preparatory movement includes flexion of both knees with arms extended behind body	22	32	44	75	76	82	84	88
Arms extend forcefully forward and upward reaching full extension above the head	16	22	30	43	49	55	61	61
Take off and land on both feet simultaneously	81	88	74	81	83	84	86	90
Arms are thrust downward during landing	23	47	48	72	76	88	89	91
6. Slide								
Body turned sideways so shoulders are aligned with the line on the floor	35	59	60	65	68	84	85	91
A step sideways with lead foot followed by a slide of the trailing foot to a point next to the lead foot	48	66	67	91	92	95	95	95
A minimum of four continuous step–slide cycles to the right	53	56	69	89	95	96	96	97
A minimum of four continuous step–slide cycles to the left	22	36	55	87	94	95	95	95

5. Justin will be able to strike a stationary ball, with his dominant hand gripping the bat above his nondominant hand, four out of five trials, for three consecutive classes.
6. Justin will be able to demonstrate a kick, in which there is a rapid continuous approach to the ball, four out of five trials, for three consecutive classes.
7. Justin will be able to demonstrate an overhand throw where he transfers his weight by stepping with the foot opposite the throwing hand, four out of five trials, for three consecutive classes.

TABLE 3.5
Percentage of Children Demonstrating Mastery on Object Control Subtest Skills at Ages 3 Through 10

Performance Criteria	Age							
	3	4	5	6	7	8	9	10
1. Striking a Stationary Ball								
Dominant hand grips bat above nondominant hand	67	80	80	82	91	93	94	95
Nonpreferred side of body faces the imaginary tosser with feet parallel	40	52	59	68	75	84	88	89
Hip and shoulder rotation during swing	29	49	50	58	74	78	81	83
Transfers body weight to front foot	26	36	38	51	67	68	68	68
Bat contacts ball	50	53	63	64	67	68	72	74
2. Stationary Dribble								
Contacts ball with one hand about belt level	26	31	40	54	58	68	84	85
Pushes ball with fingertips (not a slap)	3	22	28	56	68	79	80	88
Ball contacts surface in front of or to the outside of foot on the preferred side	22	37	63	84	87	89	95	95
Maintains control of ball for four consecutive bounces without having to move feet to retrieve it	6	20	33	66	79	84	89	93
3. Catch								
Preparation phase where hands are in front of the body and elbows are flexed	57	60	83	85	93	95	95	97
Arms extend while reaching for the ball as it arrives	33	67	74	82	94	94	94	94
Ball is caught by hands only	2	7	48	51	68	80	82	88
4. Kick								
Rapid continuous approach to the ball	69	71	77	86	91	91	91	95
An elongated stride or leap immediately prior to ball contact	16	17	28	32	50	67	72	73
Nonkicking foot placed even with or slightly in back of the ball	51	68	87	90	94	95	95	98
Kicks ball with instep of preferred foot (shoelaces) or toe	69	70	84	89	92	93	93	98
5. Overhead Throw								
Windup is initiated with downward movement of hand/arm	31	39	33	64	73	79	79	79
Rotates hips and shoulders to a point where the nonthrowing side faces the wall	20	29	31	49	65	69	73	76
Weight is transferred by stepping with the foot opposite the throwing hand	11	27	44	60	72	73	76	79
Follow-through beyond ball release diagonally across the body toward the nonpreferred side	26	46	53	65	72	82	85	85
6. Underhand Roll								
Preferred hand swings down and back, reaching behind the trunk while chest faces cones	28	55	58	81	88	88	89	92
Strides forward with foot opposite the preferred hand toward the cones	5	18	21	51	67	73	76	80
Bends knees to lower body	40	52	50	58	71	75	79	83
Releases ball close to the floor so ball does not bounce more than 4 inches high	28	39	49	55	64	65	66	67

Cautions in Interpreting Test Results

In this manual, a method for testing gross motor ability is presented. Even though the TGMD–2 was designed carefully, standardized thoroughly, and researched extensively, certain limitations involved in its use should be considered. Two of these limitations are discussed in this section.

Test Reliability: A Cause for Concern

The fact that inherent test error cannot be extracted entirely from a measurement instrument is reason for caution in the interpretation of test results. Put another way, even the most reliable of tests that possess "acceptable" levels of reliability still have an alarming amount of error in them.

Anastasi and Urbina (1997) described a procedure for estimating a test's "true variance" that is based on pooling the error associated with time sampling, content sampling, and interscorer difference. Assuming that a particular test is reliable at the lowest acceptable level (i.e., .80) at all three of these sources of error, the true variance of the test is only 40%. This "acceptable" test actually has more error in its scores than it has true variance! Certainly, considerable caution is required in such instances. Examiners should be cautious in interpreting the results of even those tests that are reliable at the highest levels because they still possess considerable error. For example, a test with almost perfect reliability (i.e., .95) at all three of these sources of error still contains 15% error.

Because of this, test results, especially when they are used to make judgments about individuals, must always be handled carefully. Results based on tests having reliabilities of less than .80 should not be taken at all in such instances. In every case, diagnoses and hypotheses resting on test data have to be confirmed by other observations.

Tests Don't Diagnose

Too often examiners forget the dictum that "tests don't diagnose, people do" and base their diagnoses exclusively on test results, a hazardous enterprise at best. Test results are merely observations, not diagnoses. They specify a performance level at a given time under a particular situation, but they do not tell the examiner why a person performed as he or she did.

The questions concerning the why of the test performance are the very essence of diagnosis, and they can be answered only by an insightful, competent test examiner. Test results make useful contributions to diagnosis, but in the end, practical diagnoses rest on the clinical skills and experience of examiners. Test results are merely aids to clinical judgment.

Many factors can combine to cause a person to perform in a particular way on a test. For example, low scores on the TGMD–2 can be caused by poor motivation and inexperience as well as by developmental disability or cerebral palsy. To make diagnostic judgments, the examiner requires information that goes far beyond that which is available from test results.

Section VI. Subtest Performance Record

Preferred Hand: Right ☐ Left ☐ Not Established ☐
Preferred Foot: Right ☐ Left ☐ Not Established ☐

Locomotor Subtest

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
1. Run	60 feet of clear space, and two cones	Place two cones 50 feet apart. Make sure there is at least 8 to 10 feet of space beyond the second cone for a safe stopping distance. Tell the child to run as fast as he or she can from one cone to the other when you say "Go." Repeat a second trial.	1. Arms move in opposition to legs, elbows bent	0	0	0
			2. Brief period where both feet are off the ground	1	1	2
			3. Narrow foot placement landing on heel or toe (i.e., not flat footed)	1	1	2
			4. Nonsupport leg bent approximately 90 degrees (i.e., close to buttocks)	1	1	2
					Skill Score	6
2. Gallop	25 feet of clear space, and tape or two cones	Mark off a distance of 25 feet with two cones or tape. Tell the child to gallop from one cone to the other. Repeat a second trial by galloping back to the original cone.	1. Arms bent and lifted to waist level at takeoff	0	0	0
			2. A step forward with the lead foot followed by a step with the trailing foot to a position adjacent to or behind the lead foot	1	1	2
			3. Brief period when both feet are off the floor	1	1	2
			4. Maintains a rhythmic pattern for four consecutive gallops	1	1	2
					Skill Score	6
3. Hop	A minimum of 15 feet of clear space	Tell the child to hop three times on his or her preferred foot (established before testing) and then three times on the other foot. Repeat a second trial.	1. Nonsupport leg swings forward in pendular fashion to produce force	1	1	2
			2. Foot of nonsupport leg remains behind body	1	1	2
			3. Arms flexed and swing forward to produce force	1	1	2
			4. Takes off and lands three consecutive times on preferred foot	1	1	2
			5. Takes off and lands three consecutive times on nonpreferred foot	1	1	2
					Skill Score	10
4. Leap	A minimum of 20 feet of clear space, a beanbag, and tape	Place a beanbag on the floor. Attach a piece of tape on the floor so it is parallel to and 10 feet away from the beanbag. Have the child stand on the tape and run up and leap over the beanbag. Repeat a second trial.	1. Take off on one foot and land on the opposite foot	1	1	2
			2. A period where both feet are off the ground longer than running	0	1	1
			3. Forward reach with the arm opposite the lead foot	0	0	0
					Skill Score	3

(continues)

Figure 3.2. Justin's performance results.

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
5. Horizontal Jump	A minimum of 10 feet of clear space and tape	Mark off a starting line on the floor. Have the child start behind the line. Tell the child to jump as far as he or she can. Repeat a second trial.	1. Preparatory movement includes flexion of both knees with arms extended behind body	0	0	0
			2. Arms extend forcefully forward and upward reaching full extension above the head	0	0	0
			3. Take off and land on both feet simultaneously	0	0	0
			4. Arms are thrust downward during landing	0	0	0
					Skill Score	0
6. Slide	A minimum of 25 feet of clear space, a straight line, and two cones	Place the cones 25 feet apart on top of a line on the floor. Tell the child to slide from one cone to the other and back. Repeat a second trial.	1. Body turned sideways so shoulders are aligned with the line on the floor	1	1	2
			2. A step sideways with lead foot followed by a slide of the trailing foot to a point next to the lead foot	1	1	2
			3. A minimum of four continuous step–slide cycles to the right	1	1	2
			4. A minimum of four continuous step–slide cycles to the left	1	1	2
					Skill Score	8
					Locomotor Subtest Raw Score (sum of the 6 skill scores)	33

Object Control Subtest

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
1. Striking a Stationary Ball	A 4-inch lightweight ball, a plastic bat, and a batting tee	Place the ball on the batting tee at the child's belt level. Tell the child to hit the ball hard. Repeat a second trial.	1. Dominant hand grips bat above nondominant hand	0	0	0
			2. Nonpreferred side of body faces the imaginary tosser with feet parallel	0	0	0
			3. Hip and shoulder rotation during swing	0	0	0
			4. Transfers body weight to front foot			
			5. Bat contacts ball	0	0	0
					Skill Score	0
2. Stationary Dribble	An 8- to 10-inch playground ball for children ages 3 to 5; a basketball for children ages 6 to 10; and a flat, hard surface	Tell the child to dribble the ball four times without moving his or her feet, using one hand, and then stop by catching the ball. Repeat a second trial.	1. Contacts ball with one hand at about belt level	1	1	2
			2. Pushes ball with fingertips (not a slap)	1	1	2
			3. Ball contacts surface in front of or to the outside of foot on the preferred side	1	1	2
			4. Maintains control of ball for four consecutive bounces without having to move the feet to retrieve it	1	1	2
					Skill Score	8

(continues)

Figure 3.2. Continued.

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
3. Catch	A 4-inch plastic ball, 15 feet of clear space, and tape	Mark off two lines 15 feet apart. The child stands on one line and the tosser on the other. Toss the ball underhand directly to the child with a slight arc aiming for his or her chest. Tell the child to catch the ball with both hands. Only count those tosses that are between the child's shoulders and belt. Repeat a second trial.	1. Preparation phase where hands are in front of the body and elbows are flexed	1	1	2
			2. Arms extend while reaching for the ball as it arrives	1	1	2
			3. Ball is caught by hands only	1	1	2
					Skill Score	6
4. Kick	An 8- to 10-inch plastic, playground, or soccer ball; a beanbag; 30 feet of clear space; and tape	Mark off one line 30 feet away from a wall and another line 20 feet from the wall. Place the ball on top of the beanbag on the line nearest the wall. Tell the child to stand on the other line. Tell the child to run up and kick the ball hard toward the wall. Repeat a second trial.	1. Rapid continuous approach to the ball	0	0	0
			2. An elongated stride or leap immediately prior to ball contact	0	0	0
			3. Nonkicking foot placed even with or slightly in back of the ball	1	1	2
			4. Kicks ball with instep of preferred foot (shoelaces) or toe	1	1	2
					Skill Score	4
5. Overhand Throw	A tennis ball, a wall, tape, and 20 feet of clear space	Attach a piece of tape on the floor 20 feet from a wall. Have the child stand behind the 20-foot line facing the wall. Tell the child to throw the ball hard at the wall. Repeat a second trial.	1. Windup is initiated with downward movement of hand/arm	0	0	0
			2. Rotates hip and shoulders to a point where the nonthrowing side faces the wall	0	0	0
			3. Weight is transferred by stepping with the foot opposite the throwing hand	0	0	0
			4. Follow-through beyond ball release diagonally across the body toward the nonpreferred side	0	1	1
					Skill Score	1
6. Underhand Roll	A tennis ball for children ages 3 to 6; a softball for children ages 7 to 10; two cones; tape; and 25 feet of clear space	Place the two cones against a wall so they are 4 feet apart. Attach a piece of tape on the floor 20 feet from the wall. Tell the child to roll the ball hard so that it goes between the cones. Repeat a second trial.	1. Preferred hand swings down and back, reaching behind the trunk while chest faces cones	1	1	2
			2. Strides forward with foot opposite the preferred hand toward the cones	1	1	2
			3. Bends knees to lower body	1	1	2
			4. Releases ball close to the floor so ball does not bounce more than 4 inches high	1	1	2
					Skill Score	8
					Object Control Subtest Raw Score (sum of the 6 skill scores)	27

Figure 3.2. Continued.

4

Normative Information

The procedures used to norm the *Test of Gross Motor Development–Second Edition* (TGMD–2) are described in this chapter. Specifically discussed are the methods used to select the sample, the demographic characteristics, and the types of normative scores provided.

Sample Selection Procedures

The TGMD–2 was normed on a sample of 1,208 persons in 10 states: California, Illinois, Indiana, Kansas, Maryland, Minnesota, Missouri, New York, Texas, and Wisconsin. The sample used to prepare the TGMD–2 norms was tested in the Fall of 1997, the Spring of 1998, and the Fall of 1998. The norming sites representing each of the four major U.S. geographic regions were selected by three methods. First, individuals in the PRO-ED research department's database who had participated in previous norming efforts and who were identified as physical educators were contacted. Second, the PRO-ED customer files were accessed to find individuals who had purchased the first edition of the TGMD (D. A. Ulrich, 1985). Each person was sent a letter requesting his or her participation in the standardization effort. Those who responded were sent materials to test 20 students in their area whose demographic makeup matched that of their community. Finally, the authors established major sites in San Diego, California; Bloomington and Indianapolis, Indiana; Rochester, New York; and Austin, Texas. These procedures resulted in 1,208 persons being tested as part of the normative sample.

Demographic Characteristics of the Sample

The procedures described in the previous section resulted in a normative sample that is representative of the nation as a whole. The characteristics of the sample with regard to geographic region, gender, race, rural or urban residence, parent education, and disability are reported as percentages in Table 4.1. In the table, the percentages for these characteristics are compared with those reported in the *Statistical Abstract of the United States* (U.S. Bureau of the Census, 1997) for the entire school-aged population. The comparison of those percentages demonstrates that the sample is almost entirely representative.

TABLE 4.1
Demographic Information for the TGMD–2 Sample (N = 1,208)

Characteristics	Percentage of Sample	Percentage of School-Aged Population[1]
Geographic Area		
Northeast	21	18
Midwest	25	24
South	35	35
West	19	23
Gender		
Male	50	51
Female	50	49
Race		
White	77	79
Black	17	16
Other	6	5
Residence		
Urban	77	75
Rural	23	25
Educational Attainment of Parents		
Less than Bachelor's Degree	73	74
Bachelor's Degree	20	18
Master's, Professional, Doctoral Degree	7	8
Disability Status		
No disability	91	85
Learning Disability	2	8
English as a Second Language	2	
Other Handicap	2	2
Age		
3 (N = 115)	NA	NA
4 (N = 114)	NA	NA
5 (N = 103)	NA	NA
6 (N = 146)	NA	NA
7 (N = 165)	NA	NA
8 (N = 207)	NA	NA
9 (N = 179)	NA	NA
10 (N = 179)	NA	NA

NA = not applicable.

[1]Data from *Statistical Abstract of the United States* (117th ed.), by U.S. Bureau of the Census, 1997, Washington, DC: U.S. Department of Commerce.

To further demonstrate the representativeness of the sample, the demographic information was stratified by age (see Table 4.2). Data reported in this table show that the stratified variables conform to national expectations at each age covered by the test's norms.

Normative Scores

Information relating to the three types of normative scores that accompany the TGMD–2 is presented in this section. Specifically discussed are standard scores for the subtests and the composite, per-

TABLE 4.2
Stratification by Age of Selected Sample Characteristics (Geographic Region, Gender, Race, Residence) for TGMD–2

Geographical Region and Age	Northeast		Midwest		South		West	
Age	*n*	%	*n*	%	*n*	%	*n*	%
3	21	18	33	29	35	30	26	23
4	16	14	33	29	45	39	20	18
5	18	18	20	19	37	36	28	27
6	27	19	38	26	54	37	27	18
7	34	21	37	22	67	41	27	16
8	48	23	42	20	79	38	38	19
9	43	24	48	27	53	30	35	19
10	46	25	50	28	53	30	30	17
Total	253	21	301	25	423	35	231	19
U.S. Population	—	18	—	24	—	35	—	23

Gender and Age	Male		Female	
Age	*n*	%	*n*	%
3	54	47	61	53
4	65	57	49	43
5	51	50	52	50
6	69	47	77	53
7	86	52	79	48
8	104	50	103	50
9	90	50	89	50
10	85	48	94	52
Total	604	50	604	50
U.S. Population	—	51	—	49

Race and Age	White		Black		Other	
Age	*n*	%	*n*	%	*n*	%
3	92	80	14	12	9	8
4	86	75	17	15	11	10
5	76	74	21	20	6	6
6	118	81	25	17	3	2
7	129	78	28	17	8	5
8	162	78	32	16	13	6
9	135	75	30	17	14	8
10	133	74	33	19	13	7
Total	931	77	200	17	77	6
U.S. Population	—	79	—	16	—	5

Residence and Age	Urban		Rural	
Age	*n*	%	*n*	%
3	88	77	27	23
4	90	79	24	21
5	84	82	19	18
6	98	67	48	33
7	124	75	41	25
8	170	82	37	18
9	138	77	41	23
10	140	78	39	22
Total	932	77	276	23
U.S. Population	—	78	—	22

centiles, and age equivalents. Particular attention is paid to how these scores are formulated.

Standard Scores

Norms for the TGMD–2 subtests are presented in terms of standard scores having a mean of 10 and a standard deviation of 3. The composite score is based on a distribution having a mean of 100 and a standard deviation of 15. The standard scores for the subtests are actually deviation standard scores based on the cumulative frequency distributions of the raw scores made by children of varying ages. That is, they come directly from the percentiles associated with the raw scores made by children in the standardization sample. The resulting data were smoothed somewhat to allow for a consistent progression across age levels.

These distributions were selected because they are already well known to examiners who test young children. For example, the following tests use this distribution: the *Kaufman Assessment Battery for Children* (Kaufman & Kaufman, 1983), the *Wechsler Preschool and Primary Scale of Intelligence–Revised* (Wechsler, 1989), and the *Developmental Assessment of Young Children* (Voress & Maddox, 1998). Standard scores are determined from raw scores using Appendix B for subtests and Appendix C for the composite. Separate norms are provided for females and males on the Object Control subtest because of the disparity between females and males on Object Control as reflected in Table 6.4 in Chapter 6. For every age on the Object Control subtest there was a 3- to 10-point difference between the two genders, whereas on the Locomotor subtest there was a maximum difference of only 2 points for all ages.

Percentiles

Percentiles also are provided for the TGMD–2 subtests. Percentile ranks were derived from the standard scores. Although percentiles are convenient and popular, examiners should be familiar with their advantages and disadvantages as explained by Aiken (1994), McLoughlin and Lewis (1994), Salvia and Ysseldyke (1998), and Wallace, Larsen, and Elksnin (1992). Percentiles for the subtests are shown in the tables found in Appendix B. Examiners locate the examinee's raw score in the appropriate normative table (Table B.1 through Table B.3) based on subtest, gender, and age, and then locate the corresponding percentile in the leftmost column of the table. Percentiles for the quotient are found in Appendix C.

Age Equivalents

Age equivalents also are provided for the TGMD–2 raw scores. These values indicate the developmental level or age that corresponds to a raw score made by an individual. To determine these equivalents, we computed the average scores of all individuals in each age interval between 3-0 and 10-11 and plotted them on a graph that had raw scores on the *x*-axis and age in months on the *y*-axis. Lines were drawn connecting these average scores. After these lines were smoothed and interpolated, one could easily determine the age levels that corresponded to each possible raw score by reading the graph. The age equivalents are found in Appendix D.

The use of age equivalents has come under close scrutiny in recent years, so much so that the American Psychological Association (1985), among others, has advocated the discontinuance of these scores. In fact, the organization encourages test publishers not to report test scores as age equivalents. Nevertheless, age equivalents are currently mandated by many educational agencies and school systems. Because these scores are often required for administrative purposes, we provide them (reluctantly).

Because interpolation, extrapolation, and smoothing were used to create age equivalents, these scores should be interpreted with caution. TGMD–2 users are urged to read the concerns expressed by Aiken (1994), Anastasi and Urbina (1997), Linn and Gronlund (1995), and Salvia and Ysseldyke (1998) regarding age equivalents. We prefer use of percentiles or standard scores whenever possible.

5
Test Reliability

The concept of reliability refers to the consistency with which any measuring instrument (e.g., a test, a scale, a clock) estimates various attributes of something. It is a key concept in measurement theory because it relates to the practical usefulness of all types and systems of measurement. Whether time, weight, height, distance, texture, achievement, feelings, or aptitude is being measured, reliability of measurement is important and has to be considered.

With regard to psychometric measurement, tests that have adequate reliability will measure "true"; that is, they will yield more or less the same scores across periods of time and across different examiners. Tests that have poor reliability will yield markedly different scores when given at different times or when administered by different people. Obviously, reliability has considerable relevance when tests are used to identify individuals with gross motor problems and to diagnose their specific areas of difficulty.

When an examiner uses an unreliable test, an examinee can be tested with it on one day and be "diagnosed" as having a particular deficiency. The examinee can be tested again the next day, only to find that the problem has "vanished." Of course, the problem did not really vanish; it may never have existed in the first place. It could have been a statistical false-positive by-product of the test's inadequate reliability.

Needless to say, the use of unreliable tests can cause considerable embarrassment to examiners who, on the basis of the initial examination, have informed teachers about the presence and seriousness of "the problems," planned remedial programs for individuals, and scheduled interviews with their parents. Examiners can considerably lessen the chances of encountering embarrassment by choosing tests that have good reliability because such tests have little error associated with their scores.

The study of a test's reliability centers on estimating the amount of error associated with its scores. When error variance is investigated, results are usually reported in terms of a reliability coefficient, a specific use of a common correlation coefficient. For a test such as the *Test of Gross Motor Development–Second Edition* (TGMD–2) to be considered minimally reliable, its reliability coefficients must approximate or exceed .70 in magnitude; coefficients of .90 or above are considered to be the most desirable (Aiken, 1994; Nunnally & Bernstein, 1994; Salvia & Ysseldyke, 1998). The status of the TGMD–2 subtest and quotient scores relative to three sources of error variance—content sampling, time sampling, and interscorer differences—is discussed in this chapter.

Content Sampling

Error associated with content sampling reflects the degree of homogeneity among items within a test or subtest. Because the purpose of the test is to measure a certain characteristic, ability, or content, the more items relate to each other, the smaller the error in the test will be. If the items are unrelated to each other, they are most likely measuring different qualities, and the amount of test error due to content sampling would be great.

The internal consistency reliability of the items on the TGMD–2 subtests was investigated using Cronbach's (1951) coefficient alpha, a generalization of the Kuder–Richardson Formula #20 for dichotomously scored items. The scores of the entire normative sample served as subjects for these analyses. Internal consistency for the composite quotient was derived using Guilford's (1954, p. 393) formula designed for this purpose. Reliability coefficients for the TGMD–2 subtests are presented in Table 5.1. The associated standard errors of measurement (*SEM*s) for the standard scores and quotient are given in Table 5.2. According to Table 5.1, all but one of the coefficients for the TGMD–2 subtests exceed .80, which indicates that the test is reliable and the results can be used with confidence. The alphas for the TGMD–2 quotients are even larger. In fact, the coefficients for the quotients all reach or exceed .87 in magnitude.

The alphas in Table 5.1 were averaged using the *z*-transformation method for averaging correlation coefficients. The averaged coefficients, provided in the bottom row of that table, represent the overall reliability of the TGMD–2 subtests and quotient regardless of age. Inspection of the averaged coefficients in the column indicates that both subtests have coefficient alphas above .85. The averaged alpha for the quotient score is .91. The standard errors of measurement in Table 5.2 provide a confidence interval that surrounds a particular test score. For example, consider Justin's Gross Motor Quotient score of 64. Because the associated *SEM* is 5 (see Table 5.2 for the *SEM* for 8-year-olds), we can say with 68% confidence that Justin's true score lies in a range from 59 through 69, 95% confidence that it lies between 54 and 74 (1.96 × 3), and 99% confidence that it lies between 49 and 79 (2.58 × 3). The smaller the *SEM,* the more confidence one can have with the test results. Inspection of Table 5.2 shows that the *SEM*s for the TGMD–2 subtests and quotient are uniformly low, which supports the high degree of test reliability associated with the TGMD–2 scores.

One cannot always assume that because a test is reliable for a general population it will be equally reliable for every subgroup within that population. Therefore, those persons who build tests should demonstrate that their tests are indeed reliable for subgroups, especially those subgroups that are likely to be tested or that, because of racial, ethnic, or linguistic differences, might experience test bias. The alphas for six selected subgroups within the normative sample are reported in Table 5.3. The subgroups studied are males, females, European Americans, African Americans, Hispanic Americans, and Asian Americans. The subgroups represent a broad spectrum of identifiable groups within the U.S. population, embracing gender, racial, and ethnic categories.

TABLE 5.1
Coefficient Alphas for TGMD–2 Scores at Eight Age Intervals (Decimals Omitted)

Age	Subtest		
	Locomotor	Object Control	Gross Motor Quotient
3	89	92	94
4	90	88	93
5	88	90	93
6	82	86	89
7	82	87	90
8	76	85	87
9	83	89	91
10	83	87	90
Avg.	85	88	91

TABLE 5.2
Standard Errors of Measurement for TGMD–2 Scores at Eight Age Intervals (Rounded Values)

TGMD–2 Value	Age							
	3	4	5	6	7	8	9	10
Locomotor Subtest	1	1	1	1	1	1	1	1
Object Control Subtest	1	1	1	1	1	1	1	1
Gross Motor Quotient	4	4	4	5	5	5	5	5

The large alphas in Table 5.3 demonstrate that the TGMD–2 is about equally reliable for all the subgroups investigated and support the idea that the test contains little or no bias relative to those groups.

Time Sampling

Error due to time sampling refers to the extent to which a child's test performance is constant over time and is usually estimated by the test–retest method. In this procedure, the test is given to a group of children, a period of time (generally 2 weeks or less) is allowed to pass, and the same children are tested again. Then the results of the two testings are compared. The TGMD's stability-over-time reliability was investigated using the test–retest method. Seventy-five children residing in Illinois were tested twice, with a 2-week period between testings. The youngest group of examinees, ages 3 through 10 (n = 75), were either in day care or elementary school. Ten of the children tested in the youngest age range were enrolled in a special program, which accounts for the low standard score means (see Table 5.4). Raw scores for the two testings were converted into standard scores and quotients to control for any effects of age in the sample. The values were then correlated. The resulting coefficients are reported in Table 5.4, along with the means and standard deviations for each testing. As can be seen, these values are of sufficient magnitude to allow confidence in the test scores' stability over time.

Interscorer Differences

A third type of reliability refers to the amount of test error due to examiner variability in scoring. Unreliable scoring is usually the result of clerical error or improper application of standard scoring criteria on the part of an examiner. Scorer error can be reduced considerably by the availability of clear administration procedures, detailed guidelines governing scoring, and opportunities to practice scoring.

Nevertheless, test constructors should demonstrate statistically the amount of error in their tests due to different scorers. To do this, Anastasi and Urbina (1997) recommended that two trained individuals score a set of tests independently. The correlation between scorers is a relational index of agreement.

In the case of the TGMD–2, two staff persons in PRO-ED's research department independently scored a set of 30 completed protocols. The protocols were randomly selected from the normative sample. The raw scores were converted to standard scores, and then correlated and reported by age intervals. The size of the resulting coefficients, listed in the Scorer

TABLE 5.3
Coefficient Alphas for Selected Subgroups in TGMD–2 Sample (Decimals Omitted)

Subgroup	N	Subtest		
		Locomotor	Object Control	Gross Motor Quotient
Male	775	93	94	96
Female	592	93	93	95
European American	758	93	93	95
African American	256	91	93	95
Hispanic American	171	93	92	95
Asian American	48	95	95	97

TABLE 5.4
Test–Retest Reliability for the TGMD–2

TGMD–2 Values by Sample	First Testing		Second Testing		
	M	*SD*	*M*	*SD*	*r*
Ages 3–5 (N = 32)					
Locomotor Subtest	8	1	8	1	88
Object Control Subtest	7	1	7	1	89
Gross Motor Quotient	86	6	87	6	91
Ages 6–8 (N = 13)					
Locomotor Subtest	9	1	9	1	94
Object Control Subtest	10	2	10	2	96
Gross Motor Quotient	96	9	95	9	95
Ages 9–10 (N = 30)					
Locomotor Subtest	9	2	9	2	86
Object Control Subtest	11	2	11	2	84
Gross Motor Quotient	99	10	101	10	94
Total Sample Ages 3–10 (N = 75)					
Locomotor Subtest	9	2	9	2	88
Object Control Subtest	9	2	9	2	93
Gross Motor Quotient	93	10	94	11	96

column of Table 5.5, provides convincing evidence of the test's scorer reliability.

Summary of Reliability Results

The overall reliability of the TGMD–2 is summarized in Table 5.5. The content of this table shows the test's status relative to Anastasi and Urbina's (1997) three sources of test error: content, time, and scorer. The coefficients displayed are drawn from those reported in previous sections of this chapter.

As can be seen from viewing the figures listed in the table, the TGMD–2 evidences a high degree of reliability. This reliability is consistently high across all three types of reliability. The magnitude of these coefficients strongly suggests that the TGMD–2 possesses little test error and that users can have confidence in its results.

TABLE 5.5
Summary of TGMD–2 Reliability Related to Three Sources of Error (Decimals Omitted)

TGMD–2 Scores	Source of Test Error		
	Content Sampling	Time Sampling	Scorer
Subtest			
Locomotor	85	88	98
Object Control	88	93	98
Quotient			
Gross Motor	91	96	98

6

Validity of Test Results

In the most basic of terms, tests are said to be valid if they do what they are supposed to do. Unfortunately, it is far easier to define validity than it is to demonstrate conclusively that a particular test is indeed valid. In part, this is because validity is at heart a relative rather than an absolute concept. A test's validity will vary according to the purpose for which its results are being used and the types of individuals tested. Therefore, a test's validity must be investigated again and again until a conclusive body of research has accumulated. The analysis and interpretation of the results of this entire literature are necessary before the status of a test's validity can be known with any degree of certainty. Consequently, the study of any test's validity is an ongoing process.

Most authors of current textbooks dealing with educational and psychological measurement—for example, Aiken (1994), Anastasi and Urbina (1997), Linn and Gronlund (1995), Salvia and Ysseldyke (1998), and Wallace, Larsen, and Elksnin (1992)—suggest that those who develop tests should provide evidence of at least three types of validity: content description, criterion prediction, and construct identification. The particular terms used here are from Anastasi and Urbina (1997). Other sources refer to content validity, criterion-related validity, and construct validity. Although the terms differ somewhat, the concepts they represent are identical.

Content-Description Validity

"Content-description validation procedures involve the systematic examination of the test content to determine whether it covers a representative sample of the behavior domain to be measured" (Anastasi & Urbina, 1997, pp. 114–115). Obviously, this kind of validity has to be built into the test at the time that subtests are conceptualized and items constructed. Those who build tests usually deal with content validity by showing that the abilities chosen to be measured are consistent with the current knowledge about a particular area and by demonstrating that the items hold up statistically.

Two demonstrations of content validity are offered for the TGMD–2. First, a detailed discussion of the rationale that underlies the selection of items and the choice of test formats is provided. Second, the validity of the items is reinforced by the results of conventional item analysis.

Rationale Underlying the Selection of Formats and Items

Content validity is established by showing that the test covers a representative sample of behaviors in the desired performance domain (Anastasi & Urbina,

1997). In reference to tests of psychomotor skills, Safrit (1981) suggested that "when a skill test incorporates and directly measures the important components of the skill being evaluated, logical validity, which may be considered a special case of content validity, may be claimed" (p. 53).

Content validity was established by having three content experts judge whether the specific gross motor skills selected represented skills that are frequently taught to children in preschool and early elementary grades. They were also asked to judge whether the skills were representative of the gross motor skill domain. The criteria for selection of these content experts were a minimum of (a) 18 semester hours of credit in motor development beyond the master's degree, (b) 3 years of experience teaching physical education to children, and (c) 3 years of experience observing and evaluating children's gross motor development. These criteria were used to help ensure that judgments were made by persons knowledgeable about the research literature in gross motor development and reflect the opinion of the practitioner. The results of the independent judgments were unanimous in declaring the skills as representative of the gross motor domain and frequently taught to this age group.

Conventional Item Analysis

Previous sections provided qualitative evidence for the TGMD–2's content validity. This section provides quantitative evidence for content validity, specifically the results of traditional, time-tested procedures used to select good (i.e., valid) items for a test. These procedures focus on the study of an item's discriminating power and its difficulty. Item discrimination (sometimes called discriminating power or item validity) refers to "the degree to which an item differentiates correctly among test takers in the behavior that the test is designed to measure" (Anastasi & Urbina, 1997, p. 179). The item discrimination index is actually a correlation coefficient that represents a relationship between a particular item and the other items on the test.

Over 50 different indexes of item discrimination have been developed for use in building tests. In regard to selecting an appropriate index, Anastasi and Urbina (1997), Guilford and Fruchter (1978), and Oosterhof (1976) have observed that, for most purposes, it does not matter which kind of coefficient is used because they all provide similar results.

In the past, test builders have preferred the point-biserial index (probably because it is fairly easy to calculate). Since the development of high-speed computers, however, the item–total-score Pearson correlation index has become increasingly popular and was the method used to select items for the TGMD–2.

Ebel (1972) and Pyrczak (1973) suggested that discrimination indexes of .35 or higher are acceptable; Anastasi and Urbina (1997) and Garrett (1965) pointed out that indexes as low as .20 are all right under some circumstances. The value of using the discrimination index to select good items cannot be overemphasized. A test comprised of too many items that have low indexes of discrimination will likely have low reliability as well, and a test having low reliability is unlikely to be valid.

Item difficulty (i.e., the percentage of examinees who pass a given item) is determined to identify items that are too easy or too difficult and to arrange items in an easy-to-difficult order. Anastasi and Urbina (1997) wrote that an average difficulty should approximate 50% and have a fairly large dispersion. Items distributed between 15% and 85% are generally considered acceptable. Based on item discrimination and item difficulty statistics, all items in the TGMD–2 can be identified as "good" items (i.e., they satisfied the item discrimination and item difficulty criteria). To demonstrate that the item characteristics of these items were satisfactory, an item analysis was undertaken using its entire normative sample as subjects. The resulting item discrimination coefficients (corrected for part–whole effect) and item difficulties are reported in Tables 6.1 and 6.2, respectively. In accordance with accepted practice, the statistics reported in these tables are computed only on items that have some variance. On the average, the test items satisfy the requirements previously described and provide evidence of content validity.

TABLE 6.1
Median Discriminating Powers for TGMD–2 Scores at Eight Age Intervals (Decimals Omitted)

Age	Locomotor Subtest	Object Control Subtest
3	58	46
4	56	48
5	58	48
6	46	40
7	39	39
8	38	42
9	41	42
10	43	44

TABLE 6.2
Median Item Difficulties for TGMD–2 Scores at Eight Age Intervals (Decimals Omitted)

Age	Locomotor Subtest	Object Control Subtest
3	36	32
4	60	46
5	75	59
6	86	71
7	87	79
8	92	83
9	91	88
10	91	90

Criterion-Prediction Validity

In the latest edition of their book, Anastasi and Urbina (1997) state, "criterion-prediction validation procedures indicate the effectiveness of a test in predicting an individual's performance in specific activities" (p. 118). They explain that performance on a test is checked against a criterion that can be either a direct or an indirect measure of what the test is designed to predict. Thus, if it is indeed valid, a test such as the TGMD–2, which is presumed to measure gross motor development, should correlate well with other tests that are also known to be related to these abilities.

The correlations may be either concurrent or predictive depending on the amount of time between the administration of the criterion test and the test being validated. For example, two tests given one after the other on the same day could be used for a study of concurrent validity, whereas two tests given 4 weeks apart could be used in a study of predictive validity.

The criterion-prediction validity of the TGMD–2 was assessed by administering the Basic Motor Generalizations subtest of the *Comprehensive Scales of Student Abilities* (CSSA) (Hammill & Hresko, 1994) to a sample of 41 students in an elementary school in Austin, Texas, more than 2 weeks after they were given the TGMD–2. Girls made up 44% of the sample. Seventy-eight percent of the sample was Caucasian, 15% was African American, and 7% represented other minority groups. Partial correlations controlling for age between the TGMD–2 subtests and the CSSA subtest were .63 for Locomotor and .41 for Object Control. The correlation between the composite and the CSSA subtest was .63. The moderate to strong correlations between the TGMD–2 subtests and the criterion variable support the criterion-prediction validity of the test.

Construct-Identification Validity

"The construct-identification validity of a test is the extent to which the test may be said to measure a theoretical construct or trait" (Anastasi & Urbina, 1997, p. 126). As such, it relates to the degree to which the underlying traits of the test can be identified and the extent to which these traits reflect the theoretical model on which the test is based. Linn and Gronlund (1995) offered a three-step procedure for demonstrating this kind of validity. First, several constructs presumed to account for test performance are identified. Second, hypotheses are generated that are based on the identified constructs. Third, the hypotheses are verified by logical or empirical methods. Five basic constructs thought to underlie the TGMD–2 and five related testable questions are discussed in the remainder of this chapter:

1. Because motor functioning is developmental in nature, performance on the TGMD–2 should be strongly correlated to chronological age.
2. Because the TGMD–2 measures gross motor development, its results should differentiate between groups of people known to be average and those known to be low average or below average in gross motor ability.
3. Because the items of both subtests measure similar traits, the items of each subtest should be highly correlated with the total score of their subtest.
4. Because the TGMD–2 subtests measure gross motor development (but in different ways), they should correlate significantly with each other, but only to a moderate degree.
5. Because the TGMD–2 gross motor skills were built to conform with specific aspects of a model, a factor analysis of the subtest skills should confirm the relationship of the skills to the constructs inherent in the model.

Age Differentiation

The raw score means and standard deviations for the TGMD–2 subtests at eight age intervals are presented

in Table 6.3. Coefficients showing the relationship of age to performance on the subtests are also found in that table. The contents of the table demonstrate that the TGMD–2 subtests are strongly related to age in that their means become larger as the subjects grow older up to age 10. This observation is verified by the coefficients in the bottom row of the table, which, according to MacEachron's (1982) rule of thumb interpretations, are in the high to very high range. These coefficients are high enough to demonstrate the developmental nature of the subtests' contents. Because a relationship with age is a long-acknowledged characteristic of most gross motor abilities, the data found in this table support the construct validity of the TGMD–2.

Group Differentiation

One way of establishing a test's validity is to study the performances of different groups of individuals on the test. Each group's results should make sense, given what is known about the relationship of the test's content to the group. Thus, in the case of the TGMD–2, a test of gross motor development, one would expect that the groups would perform equally, except that experience might be a factor in the case of Object Control. Also, it would be expected that a subgroup with developmental disabilities would perform substantially lower than other subgroups without developmental disabilities.

The mean standard scores for six subgroups of the total sample used to norm the TGMD–2 are listed in Table 6.4. Included are two gender groups (males, females), three ethnic groups (European Americans, African Americans, Hispanic Americans), and one disability group (Down syndrome). The mean standard scores for each gender and ethnic group are all within the "average" range, according to Table 3.2 in Chapter 3. As expected, the mean standard scores for the individuals with Down syndrome was in the "very poor" range, which is substantially lower than the other groups. The mean standard scores reported for the subgroups in Table 6.4 provide support for the TGMD–2's construct-identification validity.

TABLE 6.3
Raw Score Means (and Standard Deviations) by Age and Gender for TGMD–2 Subtests

	Locomotor		Object Control	
Age	Male	Female	Male	Female
3	19(7)	21(9)	20(11)	17(9)
4	27(9)	29(9)	25(9)	22(7)
5	33(9)	32(7)	30(10)	25(8)
6	39(6)	38(5)	39(5)	31(7)
7	40(6)	40(5)	41(6)	36(7)
8	42(5)	43(4)	43(5)	39(5)
9	43(5)	43(4)	44(5)	40(6)
10	43(6)	43(3)	44(6)	40(5)
Correlation with Age	.69	.72	.71	.75

Item Validity

Guilford and Fruchter (1978) pointed out that information about a test's construct validity can be obtained by correlating performance on the items with the total score made on the test. (The procedure is also used in the early stages of test construction to select items that have good discriminating power.) Strong evidence of the TGMD–2's validity is found in the discriminating powers reported in Table 6.1. Tests having poor construct-identification validity would unlikely be composed of items having coefficients of the size reported in that table.

Subtest Correlations

The TGMD–2 subtest standard scores for the entire normative sample were correlated. The resulting coefficients are presented in Table 6.5. Authorities are understandably reluctant to specify precisely how large a correlation coefficient should be in order to serve as evidence of a test's validity. In the case where coefficients representing relationships among subtests of a battery are being evaluated for validity purposes, one would want them all to be statistically significant and "acceptably" high (but not too high). If the TGMD–2 subtest coefficients are too high, it means that the subtests are measuring the same ability in the same degree and therefore are redundant. If the coefficients are too low, it means that the subtests are measuring unrelated abilities rather than differing aspects of gross motor development.

In discussing validity coefficients, Anastasi and Urbina (1997) indicated that under certain circumstances validities as small as .20 or .30 may justify inclusion of a subtest on some battery. The coefficient reported for the entire sample (.41) in Table 6.5, therefore, can be accepted as evidence supporting the validity of the TGMD–2 subtests.

The question remains, however, as to whether the subtests bear the same degree of relationship to each other when different subgroups are used as

TABLE 6.4
Standard Score Means and Standard Deviations (*SD*s) by Subgroup for TGMD–2

Subgroup	Locomotor		Object Control		Gross Motor Quotient	
	Mean	*SD*	Mean	*SD*	Mean	*SD*
Male	10	3	10	3	99	15
Female	10	3	10	3	100	14
European American	10	3	10	3	99	16
African American	11	3	10	3	101	15
Hispanic American	10	3	10	3	100	13
Down Syndrome	2	1	1	1	49	4

subjects. If the range varies appreciably according to which subgroup is tested, the possibility would exist that the nature of the test also varies from group to group and the validity of the test could be challenged. Thus, the TGMD–2 subtests were correlated using five different subgroups as subjects. The correlation coefficient for each subgroup is reported in Table 6.5. The numbers of subjects within subgroups are the same as those listed in Table 5.3.

As shown in Table 6.5, the coefficients are all within .07 of the .41 associated with the entire normative sample. These results provide additional support for the TGMD–2's construct-identification validity and its value when used with a wide variety of subgroups.

Factor Analysis

Construct-identification validity also relates to the degree to which the underlying traits of a test can be identified and the extent to which these traits reflect the model on which the test is based. To empirically investigate the validity of the TGMD–2 skill assignments to either the Locomotor or the Object Control subtest, two factor extraction techniques—exploratory factor analysis and confirmatory factor analysis—were used. Individual scores on each of the 12 skills measured by the TGMD–2 were used for these analyses. These 12 skills were analyzed using principal components exploratory factor analysis (with and without rotation) and maximum-likelihood confirmatory analysis on the entire normative sample.

Exploratory Factor Analysis. Two principal components exploratory factor analyses were performed. Several of the widely accepted criteria for factor extraction were used in the interpretation of these analyses. The criteria included the Kaiser–Guttman method of extracting factors with eigenvalues greater than 1 criterion (Kaiser, 1974) and the scree test (Cattell, 1966). The results of the exploratory factor analyses are reported in Table 6.6.

Because the TGMD–2 subtests were constructed to measure two aspects of gross motor development, we expected that the 12 skills would load on two factors. The first analysis (without rotation) yielded two factors with eigenvalues above 1. The 12 skills measured by the TGMD–2 subtests loaded highly on the first factor, which had an eigenvalue of 3.80. Because all the skills loaded on this factor, one may presume that the factor measures "gross motor ability" and that the TGMD–2 Gross Motor Quotient is a valid indicator of this ability. Next, a two-factor solution was specified and rotated using the Promax rotation method. This resulted in object control skills (i.e., Striking a Stationary Ball, Stationary Dribble, Catch, Kick, Overhand Throw, and Underhand Roll) loading

TABLE 6.5
Subtest Correlation Coefficients for the Entire TGMD–2 Normative Sample and Five Subgroups (Decimals Omitted)

Subgroup	Correlation Coefficient
Entire Sample	41
Males	45
Females	39
European Americans	41
African Americans	45
Hispanic Americans	48

Note. All *ps* < .05.

TABLE 6.6
Principal Components Factor Loading (Promax Rotation) for TGMD–2

Eigenvalues/ Skill	Unrotated		Rotated	
	Factor 1	Factor 2	Factor 1	Factor 2
Eigenvalues	3.80	1.31	3.21	2.92
Subtest Skill				
Object Control				
Striking a Stationary Ball	.62	–.42	.75	.25
Stationary Dribble	.65	–.08	.61	.48
Catch	.55	–.19	.57	.33
Kick	.62	–.21	.65	.37
Overhand Throw	.61	–.46	.75	.21
Underhand Roll	.58	–.33	.67	.27
Locomotor				
Run	.47	.24	.30	.52
Gallop	.46	.48	.17	.66
Hop	.59	.39	.33	.70
Leap	.43	.25	.25	.49
Horizontal Jump	.59	.20	.41	.59
Slide	.53	.44	.24	.69

on the first factor and locomotor skills (i.e., Hop, Slide, Gallop, Horizontal Jump, Run, and Leap) loading on the second factor. These analyses appear to confirm the model on which the TGMD–2 was based.

Confirmatory Factor Analysis. Maximum-likelihood confirmatory factor analyses were performed to test the goodness-of-fit of the TGMD–2 skill assignment to the Object Control and Locomotor subtests. Six indexes of data goodness-of-fit were computed and are recorded in Table 6.7. These include chi square (χ^2), degrees of freedom (*df*), Wheaton, Muthén, Alwin, and Summers's (1977) "relative chi square" (indicated in Table 6.8 as χ^2/df), Jöreskog and Sörbom's (1984) goodness-of-fit index (GFI) and their (1989) adjusted goodness-of-fit index (AGFI), and Tucker and Lewis's (1973) index of fit (TLI). The criterion for an acceptable fit varies among the different types of indexes. For χ^2 and *df*, there is no standard for interpretation, but the general rule is that smaller values indicate a better fit. The χ^2/df index should be between 2 and 5 to be taken as a reasonable fit (Marsh & Hocevar, 1985; Wheaton et al., 1977). The GFI has to be .90 or higher and the AGFI and TLI have to be at or above .80 to indicate a satisfactory model fit. The results of the confirmatory factor analysis indicate that the model postulated is supported by the data. The goodness-of-fit indexes were good: relative chi square was 5.29 and GFI, AGFI, and TLI ranged from .90 to .96 (see Table 6.7). Therefore, one can conclude that the skills representing the subtests on the TGMD–2 are valid indicators of object control and locomotor ability and that the skills were properly assigned to subtests.

Summary of Validity Results

Based on information provided in this chapter, one may conclude that the TGMD–2 is a valid measure of gross motor ability, and examiners can use the TGMD–2 with confidence. I encourage professionals to continue to study the test using different samples, statistical procedures, and related measures. I also encourage these researchers to send their results to me in care of the publisher so that their findings can be included in subsequent editions of the manual. The accumulation of research data will help further clarify the validity of the TGMD–2 and provide guidance for future revisions of the test.

TABLE 6.7
Goodness-of-Fit Statistics for Maximum Likelihood Confirmatory Factor Analyses of TGMD–2

Model	Fit Index					
	χ^2	*df*	χ^2/df	GFI	AGFI	TLI
TGMD–2	280.3	53	5.29	.96	.95	.90

Note. χ^2 = chi square; *df* = degrees of freedom; χ^2/df = relative chi square (Wheaton et al., 1977); GFI = goodness-of-fit index (Jöreskog & Sörbom, 1984); AGFI = adjusted goodness-of-fit index (Jöreskog & Sörbom, 1989); TLI = Tucker–Lewis index (Tucker & Lewis, 1973).

Appendix A
Illustrated Guide for Administering and Scoring the TGMD–2

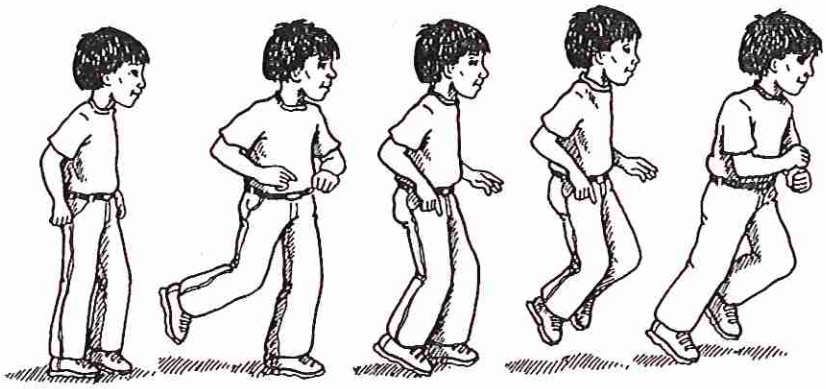
Locomotor Subtest

Skill	Materials	Directions	Performance Criteria
1. Run	60 feet of clear space, and two cones	Place two cones 50 feet apart. Make sure there is at least 8 to 10 feet of space beyond the second cone for a safe stopping distance. Tell the child to run as fast as he or she can from one cone to the other when you say "Go." Repeat a second trial.	1. Arms move in opposition to legs, elbows bent 2. Brief period where both feet are off the ground 3. Narrow foot placement landing on heel or toe (i.e., not flat footed) 4. Nonsupport leg bent approximately 90 degrees (i.e., close to buttocks)

Skill Illustration

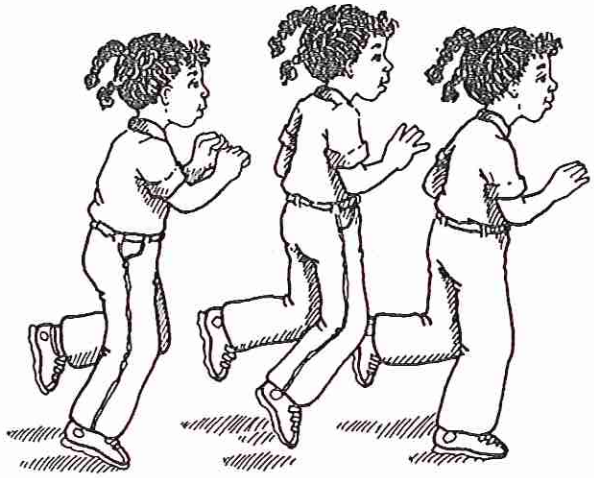
Skill	Materials	Directions	Performance Criteria
2. Gallop	25 feet of clear space, and tape or two cones	Mark off a distance of 25 feet with two cones or tape. Tell the child to gallop from one cone to the other. Repeat a second trial by galloping back to the original cone.	1. Arms bent and lifted to waist level at takeoff 2. A step forward with the lead foot followed by a step with the trailing foot to a position adjacent to or behind the lead foot 3. Brief period when both feet are off the floor 4. Maintains a rhythmic pattern for four consecutive gallops

Skill Illustration



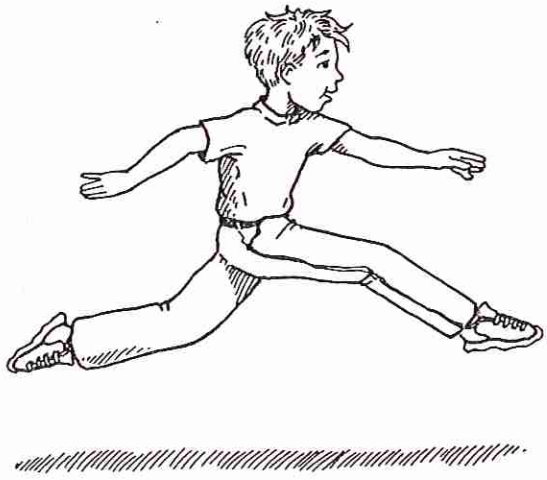
Skill	Materials	Directions	Performance Criteria
3. Hop	A minimum of 15 feet of clear space	Tell the child to hop three times on his or her preferred foot (established before testing) and then three times on the other foot. Repeat a second trial.	1. Nonsupport leg swings forward in pendular fashion to produce force 2. Foot of nonsupport leg remains behind body 3. Arms flexed and swing forward to produce force 4. Takes off and lands three consecutive times on preferred foot 5. Takes off and lands three consecutive times on nonpreferred foot

Skill Illustration



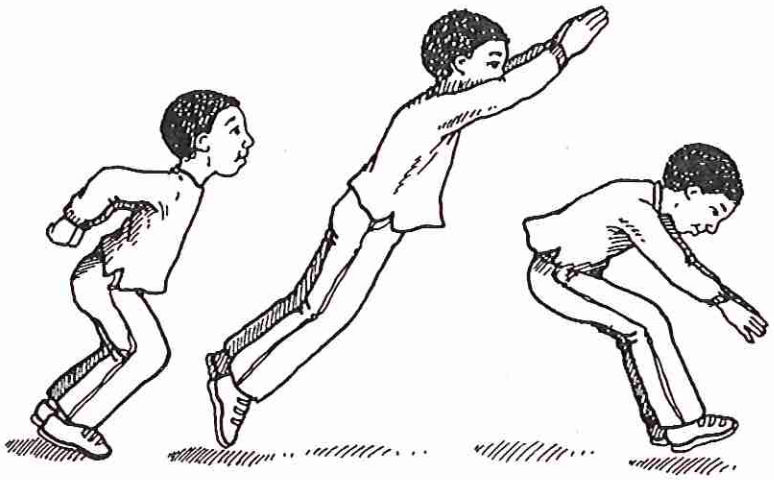
Skill	Materials	Directions	Performance Criteria
4. Leap	A minimum of 20 feet of clear space, a beanbag, and tape	Place a beanbag on the floor. Attach a piece of tape on the floor so it is parallel to and 10 feet away from the beanbag. Have the child stand on the tape and run up and leap over the beanbag. Repeat a second trial.	1. Take off on one foot and land on the opposite foot 2. A period where both feet are off the ground longer than running 3. Forward reach with the arm opposite the lead foot

Skill Illustration



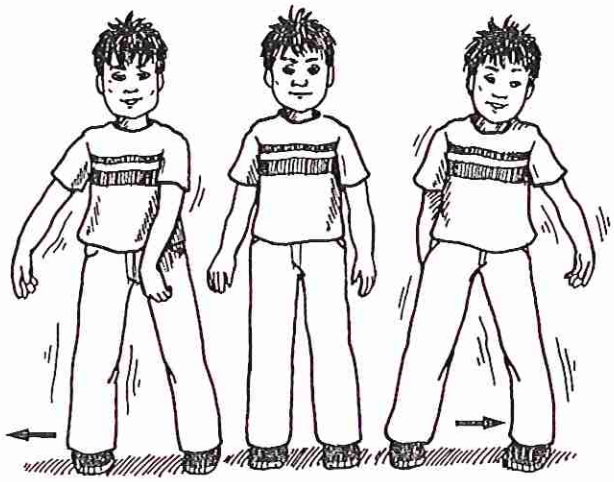
Skill	Materials	Directions	Performance Criteria
5. Horizontal Jump	A minimum of 10 feet of clear space and tape	Mark off a starting line on the floor. Have the child start behind the line. Tell the child to jump as far as he or she can. Repeat a second trial.	1. Preparatory movement includes flexion of both knees with arms extended behind body 2. Arms extend forcefully forward and upward reaching full extension above the head 3. Take off and land on both feet simultaneously 4. Arms are thrust downward during landing

Skill Illustration



Skill	Materials	Directions	Performance Criteria
6. Slide	A minimum of 25 feet of clear space, a straight line, and two cones	Place the cones 25 feet apart on top of a line on the floor. Tell the child to slide from one cone to the other and back. Repeat a second trial.	1. Body turned sideways so shoulders are aligned with the line on the floor 2. A step sideways with lead foot followed by a slide of the trailing foot to a point next to the lead foot 3. A minimum of four continuous step–slide cycles to the right 4. A minimum of four continuous step–slide cycles to the left

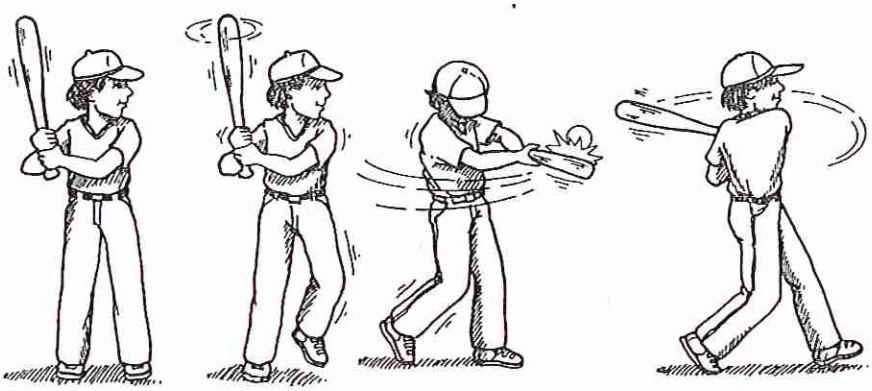
Skill Illustration



Object Control Subtest

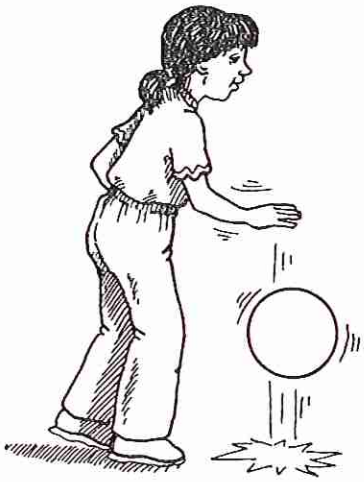
Skill	Materials	Directions	Performance Criteria
1. Striking a Stationary Ball	A 4-inch lightweight ball, a plastic bat, and a batting tee	Place the ball on the batting tee at the child's belt level. Tell the child to hit the ball hard. Repeat a second trial.	1. Dominant hand grips bat above nondominant hand 2. Nonpreferred side of body faces the imaginary tosser with feet parallel 3. Hip and shoulder rotation during swing 4. Transfers body weight to front foot 5. Bat contacts ball

Skill Illustration



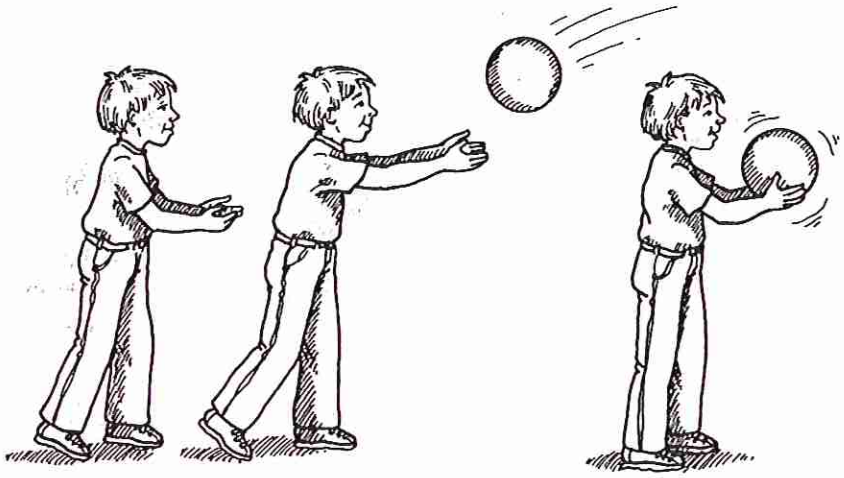
Skill	Materials	Directions	Performance Criteria
2. Stationary Dribble	An 8- to 10-inch playground ball for children ages 3 to 5; a basketball for children ages 6 to 10; and a flat, hard surface	Tell the child to dribble the ball four times without moving his or her feet, using one hand, and then stop by catching the ball. Repeat a second trial.	1. Contacts ball with one hand at about belt level 2. Pushes ball with fingertips (not a slap) 3. Ball contacts surface in front of or to the outside of foot on the preferred side 4. Maintains control of ball for four consecutive bounces without having to move the feet to retrieve it

Skill Illustration



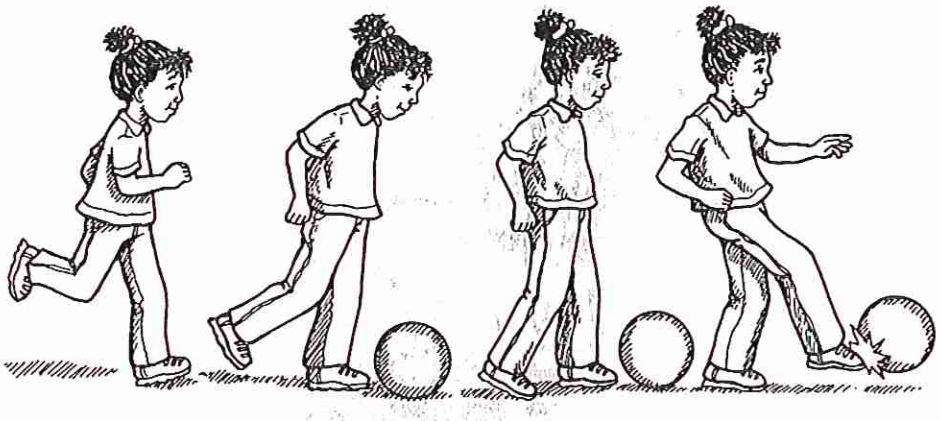
Skill	Materials	Directions	Performance Criteria
3. Catch	A 4-inch plastic ball, 15 feet of clear space, and tape	Mark off two lines 15 feet apart. The child stands on one line and the tosser on the other. Toss the ball underhand directly to the child with a slight arc aiming for his or her chest. Tell the child to catch the ball with both hands. Only count those tosses that are between the child's shoulders and belt. Repeat a second trial.	1. Preparation phase where hands are in front of the body and elbows are flexed 2. Arms extend while reaching for the ball as it arrives 3. Ball is caught by hands only

Skill Illustration



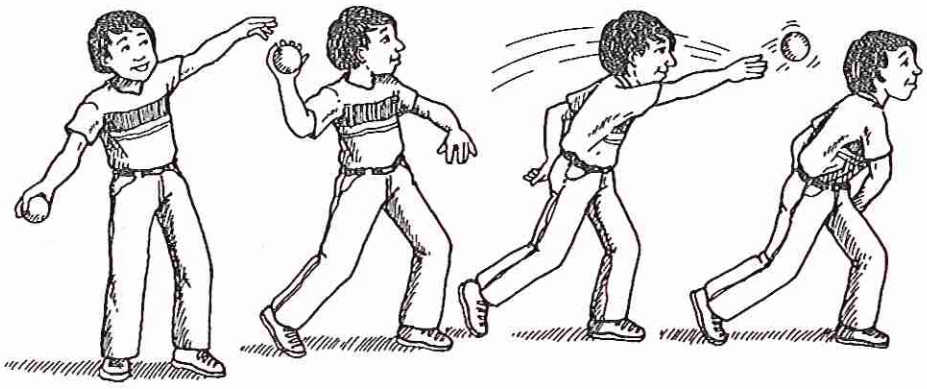
Skill	Materials	Directions	Performance Criteria
4. Kick	An 8- to 10-inch plastic, playground, or soccer ball; a beanbag; 30 feet of clear space; and tape	Mark off one line 30 feet away from a wall and another line 20 feet from the wall. Place the ball on top of the beanbag on the line nearest the wall. Tell the child to stand on the other line. Tell the child to run up and kick the ball hard toward the wall. Repeat a second trial.	1. Rapid continuous approach to the ball 2. An elongated stride or leap immediately prior to ball contact 3. Nonkicking foot placed even with or slightly in back of the ball 4. Kicks ball with instep of preferred foot (shoelaces) or toe

Skill Illustration



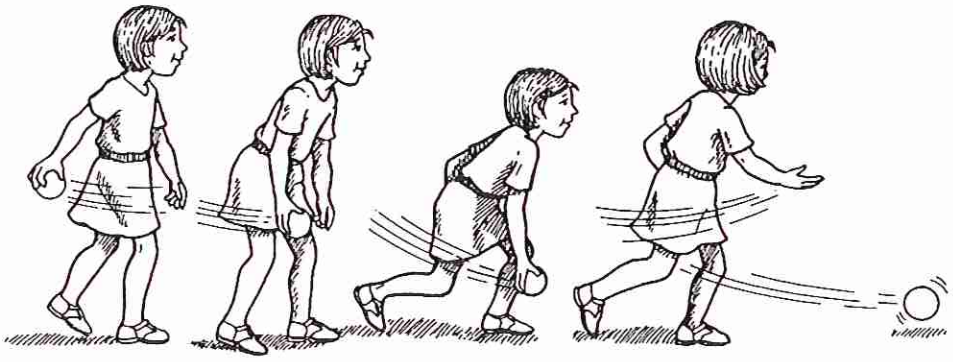
Skill	Materials	Directions	Performance Criteria
5. Overhand Throw	A tennis ball, a wall, tape, and 20 feet of clear space	Attach a piece of tape on the floor 20 feet from a wall. Have the child stand behind the 20-foot line facing the wall. Tell the child to throw the ball hard at the wall. Repeat a second trial.	1. Windup is initiated with downward movement of hand/arm 2. Rotates hip and shoulders to a point where the nonthrowing side faces the wall 3. Weight is transferred by stepping with the foot opposite the throwing hand 4. Follow-through beyond ball release diagonally across the body toward the nonpreferred side

Skill Illustration



Skill	Materials	Directions	Performance Criteria
6. Underhand Roll	A tennis ball for children ages 3 to 6; a softball for children ages 7 to 10; two cones; tape; and 25 feet of clear space	Place the two cones against a wall so they are 4 feet apart. Attach a piece of tape on the floor 20 feet from the wall. Tell the child to roll the ball hard so that it goes between the cones. Repeat a second trial.	1. Preferred hand swings down and back, reaching behind the trunk while chest faces cones 2. Strides forward with foot opposite the preferred hand toward the cones 3. Bends knees to lower body 4. Releases ball close to the floor so ball does not bounce more than 4 inches high

Skill Illustration



Appendix B
Converting Subtest Raw Scores to Percentiles and Standard Scores

TABLE B.1
Converting Subtest Raw Scores to Percentiles and Standard Scores
Locomotor Subtest
Female and Male

%iles	Age												Std. Scores
	3-0 through 3-5	3-6 through 3-11	4-0 through 4-5	4-6 through 4-11	5-0 through 5-5	5-6 through 5-11	6-0 through 6-5	6-6 through 6-11	7-0 through 7-5	7-6 through 7-11	8-0 through 8-11	9-0 through 10-11	
<1	•	•	•	•	1–6	1–9	1–12	1–14	1–16	1–19	1–20	1–23	1
<1	•	•	•	1–6	7–9	10–12	13–15	15–17	17–19	20–22	21–23	24–26	2
1	•	•	1–6	7–9	10–12	13–15	16–18	18–20	20–22	23–25	24–27	27–29	3
2	•	1–6	7–9	10–12	13–15	16–18	19–21	21–23	23–25	26–28	28–30	30–32	4
5	1–6	7–9	10–12	13–15	16–18	19–21	22–24	24–26	26–28	29–31	31–33	33–35	5
9	7–9	10–12	13–15	16–18	19–21	22–24	25–28	27–29	29–31	32–34	34–36	36–37	6
16	10–12	13–15	16–18	19–21	22–24	25–28	29–31	30–32	32–34	35–37	37–38	38–39	7
25	13–15	16–18	19–21	22–24	25–28	29–31	32–34	33–35	35–37	38–39	39–40	40–41	8
37	16–18	19–21	22–24	25–28	29–31	32–34	35–37	36–39	38–40	40	41–42	42–43	9
50	19–21	22–24	25–28	29–31	32–34	35–37	38–39	40–41	41–42	41–42	43	44	10
63	22–24	25–28	29–31	32–34	35–37	38–39	40–41	42	43	43	44	45	11
75	25–28	29–31	32–34	35–37	38–39	40–41	42	43	44	44	45	46	12
84	29–31	32–34	35–37	38–39	40–41	42	43	44	45	45–47	46–48	47–48	13
91	32–34	35–37	38–39	40–41	42	43	44	45	46–47	48	•	•	14
95	35–37	38–39	40–41	42	43	44	45	46–47	48	•	•	•	15
98	38–39	40–41	42	43	44	45	46–47	48	•	•	•	•	16
99	40–41	42	43	44	45	46–47	48	•	•	•	•	•	17
>99	42	43	44	45	46–47	48	•	•	•	•	•	•	18
>99	43	44	45	46–47	48	•	•	•	•	•	•	•	19
>99	44–48	45–48	46–48	48	•	•	•	•	•	•	•	•	20

TABLE B.2
Converting Subtest Raw Scores to Percentiles and Standard Scores
Object Control Subtest
Female

%iles	Age													Std. Scores
	3-0 through 3-5	3-6 through 3-11	4-0 through 4-5	4-6 through 4-11	5-0 through 5-5	5-6 through 5-11	6-0 through 6-5	6-6 through 6-11	7-0 through 7-5	7-6 through 7-11	8-0 through 8-11	9-0 through 9-11	10-0 through 10-11	
<1	•	•	•	•	•	1–5	1–8	1–9	1–12	1–15	1–18	1–19	1–19	1
<1	•	•	•	•	1–5	6–8	9–11	10–12	13–15	16–18	19–21	20–22	20–22	2
1	•	•	•	1–5	6–8	9–11	12–14	13–15	16–18	19–21	22–24	23–25	23–25	3
2	•	•	1–5	6–8	9–11	12–14	15–17	16–18	19–21	22–24	25–26	26–28	26–28	4
5	•	1–5	6–8	9–11	12–14	15–17	18–20	19–21	22–24	25–26	27–29	29	29–31	5
9	1–5	6–8	9–11	12–14	15–17	18–20	21–23	22–24	25–26	27–29	30	30–32	32–34	6
16	6–8	9–11	12–14	15–17	18–20	21–23	24–25	25–26	27–29	30	31–33	33–34	35–37	7
25	9–11	12–14	15–17	18–20	21–23	24–25	26–27	27–29	30	31–33	34–36	35–37	38–40	8
37	12–14	15–17	18–20	21–23	24–25	26–27	28–29	30	31–33	34–36	37–38	38–40	41	9
50	15–17	18–20	21–23	24–25	26–27	28–30	30–32	31–33	34–36	37–39	39–40	41	42	10
63	18–20	21–23	24–25	26–27	28–30	31–32	33–34	34–36	37–39	40–41	41	42	43	11
75	21–23	24–25	26–27	28–30	31–32	33–34	35–37	37–39	40–41	42–43	42–43	43–44	44	12
84	24–25	26–27	28–30	31–32	33–34	35–37	38–40	40–41	42–43	44	44	45	45	13
91	26–27	28–30	31–32	33–34	35–37	38–40	41–42	42–43	44–45	45–46	45–46	46	46	14
95	28–30	31–32	33–34	35–37	38–40	41–42	43–44	44–45	46	47	47–48	47–48	47–48	15
98	31–32	33–35	35–37	38–40	41–42	43–44	45	46	47	48	•	•	•	16
99	33–35	36–38	38–40	41–42	43–44	45	46	47	48	•	•	•	•	17
>99	36–37	39–40	41–42	43–44	45	46	47–48	48	•	•	•	•	•	18
>99	38–40	41–42	43–44	45	46	47–48	•	•	•	•	•	•	•	19
>99	41–48	43–48	45–48	46–48	47–48	•	•	•	•	•	•	•	•	20

TABLE B.3
Converting Subtest Raw Scores to Percentiles and Standard Scores
Object Control Subtest
Male

%iles	Age												Std. Scores
	3-0 through 3-5	3-6 through 3-11	4-0 through 4-5	4-6 through 4-11	5-0 through 5-5	5-6 through 5-11	6-0 through 6-5	6-6 through 6-11	7-0 through 7-5	7-6 through 7-11	8-0 through 8-11	9-0 through 10-11	
<1	•	•	•	•	1–6	1–8	1–11	1–14	1–17	1–19	1–22	1–26	1
<1	•	•	•	1–6	7–8	9–11	12–14	15–17	18–19	20–22	23–26	27–29	2
1	•	•	1–6	7–8	9–11	12–14	15–17	18–19	20–22	23–26	27–29	30–32	3
2	•	1–6	7–8	9–11	12–14	15–17	18–19	20–22	23–26	27–29	30–32	33–34	4
5	1–6	7–8	9–11	12–14	15–17	18–19	20–22	23–26	27–29	30–32	33–34	35–37	5
9	7–8	9–11	12–14	15–17	18–19	20–22	23–26	27–29	30–32	33–34	35–37	38–39	6
16	9–11	12–14	15–17	18–19	20–22	23–26	27–29	30–32	33–35	35–37	38–40	40–41	7
25	12–14	15–17	18–19	20–22	23–26	27–29	30–32	33–35	36–38	38–40	41	42	8
37	15–18	18–19	20–22	23–26	27–29	30–32	33–35	36–38	39–40	41	42	43	9
50	19–20	20–23	23–26	27–29	30–32	33–35	36–38	39–41	41–42	42–43	43–44	44–45	10
63	21–23	24–26	27–29	30–32	33–35	36–38	39–41	42–43	43–44	44–45	45–46	46	11
75	24–26	27–29	30–32	33–35	36–38	39–41	42–43	44–45	45–46	46	47	47	12
84	27–29	30–32	33–35	36–38	39–41	42–43	44–45	46	47	47	48	48	13
91	30–32	33–35	36–38	39–41	42–43	44–45	46	47	48	48	•	•	14
95	33–35	36–38	39–41	42–43	44–45	46	47	48	•	•	•	•	15
98	36–38	39–41	42–43	44–45	46	47	48	•	•	•	•	•	16
99	39–41	42–43	44–45	46	47	48	•	•	•	•	•	•	17
>99	42–43	44–45	46	47	48	•	•	•	•	•	•	•	18
>99	44–45	46	47	48	•	•	•	•	•	•	•	•	19
>99	46–48	47–48	48	•	•	•	•	•	•	•	•	•	20

Appendix C
Converting Sums of Subtest Standard Scores to Percentiles and Quotients

TABLE C.1
Converting Sums of Subtest Standard Scores to Percentiles and Quotients

Percentile Rank	Sum of Subtest Standard Scores	Quotient
>99	40	160
>99	39	157
>99	38	154
>99	37	151
>99	36	148
>99	35	145
>99	34	142
>99	33	139
>99	32	136
99	31	133
98	30	130
97	29	127
95	28	124
92	27	121
89	26	118
84	25	115
79	24	112
73	23	109
65	22	106
58	21	103
50	20	100
42	19	97
35	18	94
27	17	91
21	16	88
16	15	85
12	14	82
8	13	79
5	12	76
3	11	73
2	10	70
1	9	67
<1	8	64
<1	7	61
<1	6	58
<1	5	55
<1	4	52
<1	3	49
<1	2	46

Appendix D
Converting Raw Scores to Age Equivalents

TABLE D.1
Converting Subtest Raw Scores to Age Equivalents

Age Equivalent	Locomotor Female and Male	Object Control Female	Object Control Male	Age Equivalent
<3-0	<19	<15	<19	<3-0
3-0	19	15	19	3-0
3-3	20–21	16	20	3-3
3-6	22	17	21	3-6
3-9	23–24	18–19	22	3-9
4-0	25	20	23	4-0
4-3	26–27	21–22	24–25	4-3
4-6	28	23	26	4-6
4-9	29	24	27–28	4-9
5-0	30–31	25	29	5-0
5-3	32	26	30–31	5-3
5-6	33–34	27	32	5-6
5-9	35	28–29	33–34	5-9
6-0	36–37	30	35	6-0
6-3	38	31	36–37	6-3
6-6	39	32	38	6-6
6-9	40	33	39	6-9
7-0	—	34	40	7-0
7-3	41	35	41	7-3
7-6	—	36	—	7-6
7-9	—	37	42	7-9
8-0	42	38	—	8-0
8-3	—	39	—	8-3
8-6	43	—	43	8-6
8-9	—	40	—	8-9
9-0	—	—	—	9-0
9-3	—	—	44	9-3
9-6	—	41	—	9-6
9-9	—	—	—	9-9
10-0	44	—	—	10-0
10-3	—	—	—	10-3
10-6	—	42	45	10-6
10-9	—	—	—	10-9
>10-9	>44	>42	>45	>10-9

TGMD–2

Test of Gross Motor Development–Second Edition

Profile/Examiner Record Form

Section I. Identifying Information

Name _____

Male ☐ Female ☐ Grade _____

Date of Testing _____ _____ _____

Date of Birth _____ _____ _____

Age _____ _____ _____

School _____

Referred by _____

Reason for Referral _____

Examiner _____

Examiner's Title _____

Section II. Record of Scores

First Testing

	Raw Score	Standard Score	Percentile	Age Equivalent
Locomotor				
Object Control				
Sum of Standard Scores				
Gross Motor Quotient				

Second Testing

	Raw Score	Standard Score	Percentile	Age Equivalent
Locomotor				
Object Control				
Sum of Standard Scores				
Gross Motor Quotient				

Section III. Testing Conditions

A. Place Tested _____

	Interfering				Not Interfering
B. Noise Level	1	2	3	4	5
C. Interruptions	1	2	3	4	5
D. Distractions	1	2	3	4	5
E. Light	1	2	3	4	5
F. Temperature	1	2	3	4	5

G. Notes and other considerations _____

Section IV. Other Test Data

Name of Test	Date	Standard Score	TGMD–2 Equivalent

Section V. Profile of Standard Scores

Standard Scores	Locomotor	Object Control	Standard Scores	Quotients	Gross Motor Quotient	Quotients
20			20	150		150
19			19	145		145
18			18	140		140
17			17	135		135
16			16	130		130
15			15	125		125
14			14	120		120
13			13	115		115
12			12	110		110
11			11	105		105
10			10	100		100
9			9	95		95
8			8	90		90
7			7	85		85
6			6	80		80
5			5	75		75
4			4	70		70
3			3	65		65
2			2	60		60
1			1	55		55

8 9 10 11 12 13 12 11 10 09

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Section VI. Subtest Performance Record

Preferred Hand: Right ☐ Left ☐ Not Established ☐
Preferred Foot: Right ☐ Left ☐ Not Established ☐

Locomotor Subtest

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
1. Run	60 feet of clear space, and two cones	Place two cones 50 feet apart. Make sure there is at least 8 to 10 feet of space beyond the second cone for a safe stopping distance. Tell the child to run as fast as he or she can from one cone to the other when you say "Go." Repeat a second trial.	1. Arms move in opposition to legs, elbows bent			
			2. Brief period where both feet are off the ground			
			3. Narrow foot placement landing on heel or toe (i.e., not flat footed)			
			4. Nonsupport leg bent approximately 90 degrees (i.e., close to buttocks)			
					Skill Score	
2. Gallop	25 feet of clear space, and tape or two cones	Mark off a distance of 25 feet with two cones or tape. Tell the child to gallop from one cone to the other. Repeat a second trial by galloping back to the original cone.	1. Arms bent and lifted to waist level at takeoff			
			2. A step forward with the lead foot followed by a step with the trailing foot to a position adjacent to or behind the lead foot			
			3. Brief period when both feet are off the floor			
			4. Maintains a rhythmic pattern for four consecutive gallops			
					Skill Score	
3. Hop	A minimum of 15 feet of clear space	Tell the child to hop three times on his or her preferred foot (established before testing) and then three times on the other foot. Repeat a second trial.	1. Nonsupport leg swings forward in pendular fashion to produce force			
			2. Foot of nonsupport leg remains behind body			
			3. Arms flexed and swing forward to produce force			
			4. Takes off and lands three consecutive times on preferred foot			
			5. Takes off and lands three consecutive times on nonpreferred foot			
					Skill Score	
4. Leap	A minimum of 20 feet of clear space, a beanbag, and tape	Place a beanbag on the floor. Attach a piece of tape on the floor so it is parallel to and 10 feet away from the beanbag. Have the child stand on the tape and run up and leap over the beanbag. Repeat a second trial.	1. Take off on one foot and land on the opposite foot			
			2. A period where both feet are off the ground longer than running			
			3. Forward reach with the arm opposite the lead foot			
					Skill Score	

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
5. Horizontal Jump	A minimum of 10 feet of clear space and tape	Mark off a starting line on the floor. Have the child start behind the line. Tell the child to jump as far as he or she can. Repeat a second trial.	1. Preparatory movement includes flexion of both knees with arms extended behind body			
			2. Arms extend forcefully forward and upward reaching full extension above the head			
			3. Take off and land on both feet simultaneously			
			4. Arms are thrust downward during landing			
					Skill Score	
6. Slide	A minimum of 25 feet of clear space, a straight line, and two cones	Place the cones 25 feet apart on top of a line on the floor. Tell the child to slide from one cone to the other and back. Repeat a second trial.	1. Body turned sideways so shoulders are aligned with the line on the floor			
			2. A step sideways with lead foot followed by a slide of the trailing foot to a point next to the lead foot			
			3. A minimum of four continuous step–slide cycles to the right			
			4. A minimum of four continuous step–slide cycles to the left			
					Skill Score	
					Locomotor Subtest Raw Score (sum of the 6 skill scores)	

Object Control Subtest

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
1. Striking a Stationary Ball	A 4-inch lightweight ball, a plastic bat, and a batting tee	Place the ball on the batting tee at the child's belt level. Tell the child to hit the ball hard. Repeat a second trial.	1. Dominant hand grips bat above nondominant hand			
			2. Nonpreferred side of body faces the imaginary tosser with feet parallel			
			3. Hip and shoulder rotation during swing			
			4. Transfers body weight to front foot			
			5. Bat contacts ball			
					Skill Score	
2. Stationary Dribble	An 8- to 10-inch playground ball for children ages 3 to 5; a basketball for children ages 6 to 10; and a flat, hard surface	Tell the child to dribble the ball four times without moving his or her feet, using one hand, and then stop by catching the ball. Repeat a second trial.	1. Contacts ball with one hand at about belt level			
			2. Pushes ball with fingertips (not a slap)			
			3. Ball contacts surface in front of or to the outside of foot on the preferred side			
			4. Maintains control of ball for four consecutive bounces without having to move the feet to retrieve it			
					Skill Score	

Skill	Materials	Directions	Performance Criteria	Trial 1	Trial 2	Score
3. Catch	A 4-inch plastic ball, 15 feet of clear space, and tape	Mark off two lines 15 feet apart. The child stands on one line and the tosser on the other. Toss the ball underhand directly to the child with a slight arc aiming for his or her chest. Tell the child to catch the ball with both hands. Only count those tosses that are between the child's shoulders and belt. Repeat a second trial.	1. Preparation phase where hands are in front of the body and elbows are flexed			
			2. Arms extend while reaching for the ball as it arrives			
			3. Ball is caught by hands only			
					Skill Score	
4. Kick	An 8- to 10-inch plastic, playground, or soccer ball; a beanbag; 30 feet of clear space; and tape	Mark off one line 30 feet away from a wall and another line 20 feet from the wall. Place the ball on top of the beanbag on the line nearest the wall. Tell the child to stand on the other line. Tell the child to run up and kick the ball hard toward the wall. Repeat a second trial.	1. Rapid continuous approach to the ball			
			2. An elongated stride or leap immediately prior to ball contact			
			3. Nonkicking foot placed even with or slightly in back of the ball			
			4. Kicks ball with instep of preferred foot (shoelaces) or toe			
					Skill Score	
5. Overhand Throw	A tennis ball, a wall, tape, and 20 feet of clear space	Attach a piece of tape on the floor 20 feet from a wall. Have the child stand behind the 20-foot line facing the wall. Tell the child to throw the ball hard at the wall. Repeat a second trial.	1. Windup is initiated with downward movement of hand/arm			
			2. Rotates hip and shoulders to a point where the nonthrowing side faces the wall			
			3. Weight is transferred by stepping with the foot opposite the throwing hand			
			4. Follow-through beyond ball release diagonally across the body toward the nonpreferred side			
					Skill Score	
6. Underhand Roll	A tennis ball for children ages 3 to 6; a softball for children ages 7 to 10; two cones; tape; and 25 feet of clear space	Place the two cones against a wall so they are 4 feet apart. Attach a piece of tape on the floor 20 feet from the wall. Tell the child to roll the ball hard so that it goes between the cones. Repeat a second trial.	1. Preferred hand swings down and back, reaching behind the trunk while chest faces cones			
			2. Strides forward with foot opposite the preferred hand toward the cones			
			3. Bends knees to lower body			
			4. Releases ball close to the floor so ball does not bounce more than 4 inches high			
					Skill Score	
					Object Control Subtest Raw Score (sum of the 6 skill scores)	

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