1969

Reliability and Validity of Arm Extension Testing in Diagnosing Reading Disorders

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RELIABILITY AND VALIDITY OF ARM EXTENSION TESTING IN DIAGNOSING READING DISORDERS

A Thesis

Presented to

the Graduate Faculty

Central Washington State College

In Partial Fulfillment

of the Requirements for the Degree

Master of Education

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by

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June, 1969

APPROVED FOR THE GRADUATE FACULTY

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ACKNOWLEDGMENTS

The writer would like to express his thanks to the following people for their interest and cooperation in this study: Mr. Lee Colby, Sunnyside, Washington, Superintendent of Schools; Mr. Robert Young, Principal, Chief Kamiakin Elementary; Mr. Clyde Henry, Principal, Washington Elementary; Dr. Donald N. VonPein, Yakima Coordinator for Special Education; Dr. George Kelley, Yakima County School Psychologist; Mr. Ernest Fisher, Yakima County School Psychologist; and Archie A. Silver, M.D., Bellevue Medical Center, New York University, New York.

CHAPTER I

INTRODUCTION

The purpose of this study was to investigate the reliability and validity of an arm elevation technique employed in the diagnosis of reading disability. Clinical observations (Schilder, 1936; Silver, 1963; Silver & Hagin, 1964) suggested that cerebral hemispheric dominance was indicated by the patient's arm muscle tone. When the patient indicated greater arm muscle tone for one side of the body, it was assumed this reflected neurological dominance in the contralateral brain hemisphere from that side of the body. Further, these observations indicated that established hemispheric dominance, when determined by arm elevation testing, was positively correlated with reading achievement while the lack of established dominance was negatively correlated with reading achievement.

Silver (1963) found that 92 per cent of the children with specific reading disabilities attending New York third and fourth grade classrooms showed a lack of cerebral hemispheric dominance when arm elevation was the criterion. Using the same criterion, Silver found no like problem among normal reading achievers from the same population of children.

An extensive body of research supports the relationship between cerebral dominance and reading disability. Orton (1937) established a

precedent for the cerebral dominance hypothesis when he proposed the concept of strephosymbolia or "twisted symbols." Orton observed a peculiar syndrome operating among children with notable reading problems. He observed a pattern of motor clumsiness, awkwardness, poorly established laterality and directional orientation, and other symptoms he felt were directly related to the reading process. He felt that these symptoms were related to an underlying hemispheric brain dominance problem. In his rationale, sensory engrams for printed words are stored in both hemispheres. The dominant hemisphere was to consistently issue forth the correct impressions of words upon recall. However, in cases of mixed hemispheric control, Orton felt the mirror image engram, stored in the nondominant hemisphere, was brought into recognition causing such characteristic reversal errors as <u>was</u> for <u>saw</u>, or <u>dog</u> for <u>god</u>. Further, since many of these children indicated difficulty in developing consistent handedness, this factor appeared to support the hypothesis of cerebral immaturity reflected in lagging motor preferences. Orton established the trend for investigators to study cerebral hemispheric dominance by motor preferences and to explore reading disability from this viewpoint.

Dearborn (1930) advocated a relationship between cerebral dominance and reading difficulty similar to Orton. Dearborn felt that poorly established lateral preferences set up conflicting tendencies in the mind that interfered with the prompt and accurate recall of printed words. This difficulty was witnessed in the reader's inability to order

vowel sounds and sequence letters in words. Dearborn felt that in the right-handed individual the left hemisphere was dominant for speech, while in the left-handed individual speech was subserved in the right hemisphere.

Harris (1957), in his evaluation of disabled readers and unselected public school students ages seven to eleven, concluded that the disabled reader had more difficulty in establishing orientation for left-right relationships and in establishing consistent handedness. He felt that this discrepancy suggested "a special kind of slowness, possibly neurological in nature" (Harris, 1957, p. 293).

Subriana (1961) presented a comprehensive survey of neurological research and medical findings concerning loss of speech (aphasia) and specific reading disability (dyslexia). Subriana noted that "dominance, laterality, and their disorders, per se, do not cause a disorder of language; rather, they are concomitant symptoms, reflecting on a parallel level the basic deviation of brain function that is responsible for both the disorders of language and laterality" (1961, pp. 63-64). Subriana's survey supported Orton's concepts in that he observed that delayed language was represented in slow lateral preference development and both factors suggested cerebral immaturity.

Delacato (1959; 1963) developed a comprehensive cerebral dominance theory related to language and reading development. He outlined remedial procedures for improving neurological functioning through patterned

activities in creeping, crawling, and tonic neck reflex positioning. One of Delacato's major remediation goals has been to promote full lateralization for one side of the body. He felt that promoting exclusive right-sidedness or left-sidedness aided in establishing cortical hemispheric dominance. Physical training programs based upon similar premises have gained acceptance and popularity in public elementary school curricula. The research, however, does not entirely support the practices of Delacato and others. Robbins (1966) reported accepting seven null hypotheses concerning Delacato's treatment for disabled readers. The American Academy of Pediatrics and the American Academy of Neurology (Cruickshank, 1968, pp. 365-366) has made a joint statement that advised the educational and medical professions to wait for further research by recognized experts before employing Delacato's programs.

Gessell and Ames (1947) established that early tonic neck reflex behavior was a significant indication of the infant's eventual handedness. Further, handedness was felt to be gradually established over time in an orderly age specific, developmental, sequence. They felt that "faulty ontogenic timing accounts for various forms of transient physiological awkwardness and also for more permanent sensorimotor handicaps. Faulty timing, cerebral injury, and constitutional deviations genetic in origin likewise account for mixed and poorly defined dominances which come to ultimate expression in visual inadequacies, reading and speech disabilities, and neurological symptoms" (Gessell and Ames, 1947, p. 175). Their

findings were supportive of a relationship between tonic neck reflex maturation and arm elevation phenomena.

Research has indicated that when nonclinical populations were studied, the cerebral dominance or lateral preference theory could not be defended. Among the numerous examples, Witty and Kopel (1936) and Gates and Bond (1936) turned in early null hypotheses when children from first, third, fourth, fifth, and sixth grades were examined with laterality and reading achievement measures similar to those of Harris (1957). Balow (1963) similarly failed to establish any relationships operating between reading and laterality in a randomly selected midwestern first grade population.

Coleman and Deutsch (1964) could not find any pattern of mixed dominance to be operating in ten-year-old disabled readers selected at random from the public schools. They felt that lateral preferences may not indicate neurological organization, and they supported experimentation with other techniques, the arm elevation test among those mentioned.

Isom (1966) summarized that Silver's findings were highly questionable, particularly the high incidence of abnormal arm elevation found in disabled readers from a public school sample. Isom indicated the need for more careful investigation employing Silver's methods.

John Money (1967) cast further doubt upon the cerebral dominance hypothesis by summarizing that "when the final verdict can be given, it may well appear that all of today's talk about cerebral dominance in

reading disorder is only a red herring. It is not a question of whether the language function becomes established in one side of the brain, or the other, or both, but whether it becomes established or properly mature at all. The problem of reading disorder is really a problem of developmental impedance and maturational lag" (Money, 1967, Ch. 14).

Silver, however, found that shifts in hemispheric dominance may be reflected in arm elevation testing. His research on disabled readers from a third and fourth grade New York school population demonstrated the following pattern of arm behavior: When asked to raise both arms straight in front of them with eyes closed, disabled readers elevated the arm opposite their writing hand, failed to elevate either arm, or alternated in elevations in both arms. Normal reading controls elevated their writing hand and arm. Silver reported that disabled readers showed patterns of either shifted dominance, or lack of clearcut dominance. Those children whose elevated arm was opposite the writing hand were felt to have shifted dominance, while those who failed to elevate either hand or alternately elevated both hands were felt to demonstrate a lack of clearcut dominance.

Silver's research posed some serious limitations that precluded acceptance of his findings. Silver did not discuss the reliability of the arm elevation test. Secondly, he relied upon visual impressions of arm elevation. No objective form of measurement was reported in the literature. Third, Silver did not define or control his sample in an objective manner.

The present study attempted to investigate arm elevation while controlling limitations from Silver's earlier research. Arm elevation observations made on a visual inspection basis were compared for inter-examiner agreement. Stability of the visual impression method was determined by retesting at the end of a one-week period. Objective estimates of arm elevation were made by plotting arm elevation graphically on a glass charting device that allowed full view of the position of the child's outstretched hands and fingertips. Sampling for the study was based on stratified random sampling utilizing group intelligence and reading achievement test score criteria.

This study explored the following six null hypotheses: (a) there is no agreement among three examiners concerning visually estimated arm elevations of children; (b) there is no stability in visually rated arm elevations over a one-week period; (c) there is no stability in measured arm elevations over a one-week period; (d) there is no agreement between three examiners' visual ratings of arm elevations and those ratings obtained by measurement; (e) there is no difference between normal and retarded readers in arm elevation ratings obtained by the visual inspection method; (f) there is no difference between normal and retarded readers in arm elevation obtained through measurement.

CHAPTER II

METHOD

Subjects

The subjects (Ss) were forty-eight fourth grade children from the Sunnyside, Washington, School District. Selection of Ss into normal and retarded reading achievement groups was accomplished by reading achievement grade placement scores and mental age scores derived from group tests. Those Ss whose reading achievement grade placement scores (Metropolitan Reading Test, 1959) were within one standard error of measurement of their predicted grade placement scores (Lorge-Thorndike Intelligence Test, Verbal Battery, 1962) comprised the normal reading group (N = 25). Those Ss whose reading achievement grade placement scores were one standard error of measurement below the grade level predicted by their mental age scores comprised the retarded reading group (N = 25).

A certified school psychologist, who had no acquaintance with these children, examined the test data for the entire fourth grade population and randomly selected both groups from the subpopulation of seventy-four Ss who met the psychometric criteria. The examiners (Es) were given the list of Ss in mixed order so the group identification of each S was not known.

The Sunnyside School District's nurse examined the health records of both groups to screen out children with peripheral orthopedic or neurologic defects as this procedure was followed in Silver's research.

Examiners

The Es were a certified school psychologist and two certified elementary school teachers. The two elementary school teachers were trained in theory, observation, and scoring techniques. Safeguards were taken at the outset of testing to avoid comments or comparisons concerning the Ss' arm elevations to control interexaminer bias. In several cases, the Ss were acquainted with one of the Es, so that bias from this source was not controlled.

Apparatus

A transparent observation apparatus was built consisting of a 30" by 48" plate glass suspended in a standing wood frame. The glass surface had grease pencil parallel lines across its surface at one-half inch spacings to facilitate measurement.

Procedure

The S stood before the Es with a standard width table separating them during the visual inspection testing. The S, eyes closed, arms outstretched, counted aloud from the number thirty backward to the number one (see Appendix A). The Es observed the S's outstretched hands and rated the arm elevation of the S as either right elevation, left elevation,

equal elevation, or alternating elevation. An estimated quarter inch leeway in observation was observed in determining equal elevations of the arms in both the visual inspection and measurement trials.

The Ss were examined by the visual inspection procedure on the first day and then were recalled on the second day for observations employing measurement. This same procedure was followed after a one-week time lapse from the initial examinations.

To obtain measurement of the S's arm elevation, the S stood at such a distance from the apparatus that his outstretched fingertips were within one-quarter inch of the glass surface. One E stood at the side of the apparatus instructing the S and controlling the positioning of the S so that his fingertips were within one-quarter inch of the apparatus. Two Es marked the S's middle fingertip position in blue, black, and red simultaneously when the S pronounced the numbers twenty-five, fifteen, and five. The Es measured the differences between the elevations of both arms and entered the differences on a sheet of paper with the S's name.

After the S had been seen for four separate tests over the two-week period, the E took the data from the four separate cardboard boxes, in which it had been confidentially stored, for analysis.

Measurement data was transformed into the arm elevations right, left, equal, or alternating by obtaining mean elevations. In each transformation, right, left, and alternating, the differences had to exceed one-quarter of an inch. Equal was designated for those mean elevations

remaining within one-quarter of an inch. The measurement data was transformed to right, left, equal, and alternating to stay within the framework of Silver's study.

The S's writing hand was later determined by the classroom teacher. Consistent with Silver's classifications, the S's arm elevation was classified normal if it agreed with his writing hand. The arm elevation was classified abnormal if the S elevated the arm opposite the writing hand or demonstrated equal or alternating elevations (Appendix B).

All the arm elevation ratings (left, right, alternating, or equal) determined through visual inspection and measurement were converted into normal and abnormal ratings for statistical treatment. Interexaminer and test-retest agreement were determined by the relative frequencies of normal or abnormal ratings received by the Ss. Likewise, normal and abnormal ratings were considered in determining the statistical association of arm elevation to reading achievement.

The data collected from the two visual inspections and the two measurement sessions were transformed to the two categories--normal and abnormal--and were treated statistically by use of Chi-Square. The Contingency Coefficient (C) was determined for the values of Chi-Square (X^2). Divergencies in the chi-square cell frequencies were treated by the Yate's Correction Formula (Siegel, 1956). The confidence level for the rejection of the null was established at the .01 level.

CHAPTER III

RESULTS

Independent visual inspection of fourth grade Ss' arm elevations by three Es was sufficiently consistent to warrant rejection of the null hypothesis. This finding suggested that when Es' classifications for arm elevations are transformed to Silver's normal and abnormal classifications, significant interexaminer agreement was found (Table 1).

TABLE 1

INTEREXAMINER RELIABILITY OF SILVER'S ARM ELEVATION TEST

Examiner	Agree	Disagree	X^2	P	C	Df
1 vs. 2	78	18	37.32	.01	.51	1
2 vs. 3	75	21	32.53	.01	.50	1
1 vs. 3	69	27	19.33	.01	.40	1

Test-retest stability of the arm elevation ratings was determined for each E for the ratings normal and abnormal. Agreement was sufficient to reject the null hypothesis for two of the Es but not for the third. The results for the third E were in the direction of agreement but the chi-square value and the Contingency Coefficient were too low to be acceptable (Table 2).

TABLE 2

TEST-RETEST STABILITY FOR THREE EXAMINERS FOR SILVER'S ARM ELEVATION TEST

Examiner	Agree	Disagree	X^2	P	C	Df
1 vs. 1	37	11	13.11	.01	.46	1
2 vs. 2	36	12	9.48	.01	.40	1
3 vs. 3	31	17	3.26	.10	.24	1

When arm elevation was measured in inches and transformed into Silver's normal and abnormal classifications, the test-retest results were insufficient for the rejection of the null at the confidence level established for the study. However, the results closely approached the required level of significance (Table 3). This is discussed in the following chapter.

TABLE 3

TEST-RETEST STABILITY OF MEASURED ARM ELEVATION RATINGS

	Agree	Disagree	X^2	P	C	Df
Test 1 vs. Test 2	34	14	5.60	.02	.32	1

When Es' visual ratings of normal and abnormal arm elevations were compared with ratings obtained by measurement, there was insufficient agreement of ratings for two of the three Es to warrant rejection of the null hypothesis. This finding indicated that ratings obtained by visual techniques and those obtained by measurement were not the same (Table 4).

TABLE 4

ARM ELEVATION RATINGS OBTAINED BY THREE EXAMINERS AND BY LINEAR MEASUREMENT

E Rating vs. Measurement	Agree	Disagree	X^2	P	C	Df
Examiner 1	63	33	6.97	.01	.26	1
Examiner 2	45	51	.03	.90	.01	1
Examiner 3	59	37	3.52	.10	.18	1

Subjects from both achieving and nonachieving reading groups did not differ in the frequencies of normal or abnormal arm elevation ratings obtained by the visual method. The null hypothesis was accepted. Abnormal arm elevation, determined visually, was not a symptom of retarded readers (Table 5).

TABLE 5

VISUALLY DETERMINED ARM ELEVATION RATINGS OF NORMAL AND RETARDED READING ACHIEVERS

Reading Group	Abnormal Arm Elevation		Normal Arm Elevation		Total
	fo	fe	fo	fe	
Retarded	75	69	63	69	138
Normal	69	75	81	75	150
Total	144		144		288
Chi-square 2.00					
P .20					

When Es' measured ratings of Ss' arm elevations were compared with their reading achievement, the differences in the occurrence of normal and abnormal arm elevations were insufficient to warrant rejection of the null hypothesis. Children from both reading groups, normal and retarded, did not differ in the frequency of normal or abnormal arm elevation ratings obtained through measurement (Table 6).

TABLE 6

MEASURED ARM ELEVATION RATINGS OF NORMAL AND RETARDED READING ACHIEVERS

Reading Group	Abnormal Arm Elevation		Normal Arm Elevation		Total
	fo	fe	fo	fe	
Retarded	17	15.2	29	30.4	46
Normal	15	16.5	35	33.0	50
Total	32		64		96
Chi-square .26					
P .70 Df 1					

CHAPTER IV

DISCUSSION

Silver's (1963) theory developed largely from observations of brain-injured children with associated reading disability. The sample in this study was from a fourth grade, Sunnyside, Washington, population, and no generalizations beyond this population can be made.

Techniques described by Silver for the observation and rating of arm elevation were so generally described in the literature that differences in observational technique could have been operative in this study. It should also be observed that the technique developed as a measuring system for this study may have lacked the necessary precision to detect the salient characteristics of children's arm elevations. The measuring device in this study approached a level of significance. A more detailed method of measuring, possibly photographic in nature, might have provided the needed precision.

The highest reliabilities were reported for interexaminer agreement when the three examiners visually inspected the children's elevated arms. However, the stability of arm elevations must be questioned. Some agreement was found over a one-week period, but it was not unanimous. The stability of arm elevation should not be assumed on the basis of these findings.

Unlike Silver's (1963) and Silver and Hagin's (1964) findings, this study indicated that elevation of the arm opposite the writing hand, alternating arm elevation, and nonelevation were not found to be associated with fourth grade children who were retarded in reading achievement. The results of this study indicated that normal and abnormal arm elevations, determined by three examiners' ratings, were equally associated with both reading groups.

The findings of this study were consistent with Birch and Belmont's observations (1965). They felt that when clinical tests of lateral dominance were administered to nonclinical public school children, the trait of mixed dominance failed to be associated with reading success or failure.

Coleman and Deutsch (1964) indicated that differences in neurological development exist between clinical and public school populations. They found that differences observed between public school children and the clinical sample as most likely due to the severity of retardation; the clinical child representing a more clearcut pattern of neurological immaturity. This study appears in part to support their observations.

The results of this study suggested that if arm elevation indicates cerebral dominance, then cerebral dominance, as so determined, was unrelated to the reading achievement of a sample of Sunnyside, Washington, fourth grade children.

The findings of this study were not supportive of the theory or methodology underlying research that attempts to associate reading disability

with cerebral dominance. From the viewpoint of these findings, it seems advisable to avoid panacean formulations in attempting to discover a unity factor that operates in all reading disability cases. The present work suggests that if the arm elevation technique is pursued, it should be considered as only one diagnostic technique to be employed with others within a multidimensional diagnostic framework.

CHAPTER V

SUMMARY

Arm elevation was compared in forty-eight Sunnyside, Washington, fourth grade children, whose reading achievement was average or retarded according to intelligence expectancies. The arm elevation test, used on a conventional visual inspection basis, was found to be statistically reliable. Arm elevations of children were found to be consistent over a one-week period for only two out of three examiners, raising doubts concerning trait stability. Normal and abnormal arm elevations did not differentiate normal from retarded reading achievers in this fourth grade sample.

A measurement system was explored to detect arm elevation more accurately but due to problems in the measurement system, failed to achieve statistical acceptance. The technique of measurement, however, closely approached the level of significance established for the study.

An attempt was made to resolve the differences of the findings with those obtained in other research. Differences in clinic and community populations appeared probable; the arm elevation test being considered as a diagnostic instrument more appropriate to a clinical sample than to a random selection from the public schools.

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APPENDIX A

INSTRUCTIONS TO STUDENTS

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(S's name) , I'd like you to pretend you're a sleepwalker. When I ask you, I'd like you to do these things: (a) close your eyes tightly so that you cannot see; (b) raise your arms straight in front of you with your palms down and fingers pointing straight; (c) keep both arms straight out in front of you while you count, out loud, backward from the number 30 to the number 1. Do you have any questions? Begin.

APPENDIX B

ARM ELEVATION SCORES

APPENDIX B

ARM ELEVATION SCORES
RETARDED READING ACHIEVEMENT GROUP

Child	Visual Ratings* Week 1	Visual Ratings* Week 2	Measured Ratings** Week 1	Measured Ratings** Week 2	Writing Hand
1	E R R	E R R	1/4R	15/16R	Right
			1/2R	11/16R	
			13/16R	19/16R	
2	E E R	L L L	OE	1/4R	Right
			3/8L	11/16R	
			OE	7/8R	
3	A A A	L A A	13/16R	21/16R	Right
			17/8R	29/16R	
			15/8R	32/16R	
4	R R R	R R R	1/4R	5/8R	Right
			1/8R	8/8R	
			9/8R	17/16R	
5	A R R	R R A	25/16R	3/8R	Right
			29/16R	1/16R	
			31/16R	1/2R	
6	A A A	E A R	9/16L	1/8R	Right
			1/8L	1/4R	
			1/2L	9/16R	
7	E E A	R E A	11/16L	13/8L	Right
			21/16L	11/8L	
			27/16L	45/16L	

* These scores signify Right (R), Left (L), Equal (E), or Alternating (A) arm elevation ratings by three examiners.

** These arm elevation scores are reported in fractions of inches and are arranged in the order in which they were obtained.

Retarded Reading Achievement Group (Continued)

Child	Visual Ratings* Week 1	Visual Ratings* Week 2	Measured Ratings** Week 1	Measured Ratings** Week 2	Writing Hand
8	A A A	E A R	5/8R 3/8L 1/2R	1/2L 1/16L 3/16R	Right
9	R R R	R R R	1/8L 1/2R 3/4R	31/16R 13/8R 23/16R	Right
10	A R R	R E L	OE 3/16R 5/16R	1/2R 5/8R OE	Right
11	R R R	R A R	15/16R 31/16R 29/16R	15/16R 1/2R 3/8R	Right
12	R E E	L A A	5/16R 1/8R 5/16R	7/8R 21/16R 9/8R	Right
13	E A A	E L L	3/8R 15/16R 9/16R	19/16R 5/4R 23/16R	Right
14	R R R	R R R	1/2R 3/8R 13/16R	13/16R 13/16R 19/16R	Right
15	L L L	R E R	7/16L 21/16L 23/16L	OE 7/8R 9/8R	Right
16	E E A	L E L	3/16L 7/8L 15/16L	7/8L 17/16L 23/16L	Left
17	L L L	L E E	1/8L 1/2R 13/16R	1/4 L 1/8 R 3/16 L	Right

Retarded Reading Achievement Group (Continued)

Child	Visual Ratings* Week 1	Visual Ratings* Week 2	Measured Ratings** Week 1	Measured Ratings** Week 2	Writing Hand
18	L L L	R E R	1/8R 3/16L 8/8R	5/8L 5/8L 1/4L	Right
19	R E E	R R R	3/8R 5/8R 7/16R	17/16R 13/16R 7/16R	Right
20	L L L	E E R	5/16R 11/16R 1/2R	5/8R 1/16L 5/16R	Right
21	A R R	R R R	1/2R 11/16R 5/16R	1/4R 9/8R 5/8R	Right
22	R R R	R R R	9/16R 9/8R 17/16R	27/16R 27/16R 25/16R	Right
23	R R E	R A R	5/8R 29/16R 8/8R	1/4R 11/16R 1/2R	Right

ARM ELEVATION SCORES
NORMAL READING ACHIEVEMENT GROUP

Child	Visual Ratings* Week 1	Visual Ratings* Week 2	Measured Ratings** Week 1	Measured Ratings** Week 2	Writing Hand
1	E R R	A R R	3/8L OE 3/16L	5/16R 5/16L 1/4L	Right
2	E E E	R R R	8/8R 8/8R 5/4R	5/16R 13/16R 7/8R	Right
3	E E E	L L L	5/16L 7/8L 3/4L	5/16L 1/4R 1/8L	Right
4	E E R	R R A	1/4R 3/8R 1/8R	11/16R 15/16R 11/16R	Right
5	R R R	R R R	5/16R 3/4R 13/16R	3/4R 3/8R 9/16R	Right
6	R R R	R R R	7/16R 7/8R 3/8R	3/16R 5/16L 1/8R	Right
7	L E R	A R R	1/4R 1/2R 5/16R	1/2R 3/4R 15/16R	Right
8	R R R	E E R	OE 11/16R 7/8R	5/16R 3/8R 5/8R	Right
9	R R R	R R R	8/8L 3/4R 11/8R	11/16R 7/8R 19/16R	Right

Normal Reading Achievement Group (Continued)

Child	Visual Ratings* Week 1	Visual Ratings* Week 2	Measured Ratings ** Week 1	Measured Ratings ** Week 2	Writing Hand
10	L L L	L L L	3/2L 13/16L 29/16L	3/8L 7/8L 25/16L	Right
11	E E L	R R E	17/16R 3/4R 7/8R	7/16R 7/8R 7/8R	Right
12	A E E	E E R	11/8R 25/16R 13/8R	15/16R 7/16R 15/16R	Right
13	L L R	E R A	1/4R 5/8R 17/16R	9/16R 7/16R 7/16R	Right
14	E E R	R R R	17/16R 31/16R 31/16R	3/8R 9/16R 5/8R	Right
15	L E E	R R R	3/16R 9/16R 8/8R	1/2R 5/8R 3/4R	Right
16	R R R	L L L	1/4R 1/8R 3/8R	5/16R 1/8R 9/16R	Right
17	L L L	A A R	7/16R 13/16R 11/16R	1/8L 15/16R 5/4R	Right
18	E E E	R R R	1/4R 8/8R OE	1/4R 17/16R 17/16R	Right
19	R R R	R R R	1/8L 1/4R 1/16R	3/8R 17/16R 31/16R	Right

Normal Reading Achievement Group (Continued)

Child	Visual Ratings* Week 1	Visual Ratings* Week 2	Measured Ratings** Week 1	Measured Ratings** Week 2	Writing Hand
20	A A A	A A A	7/8L 3/16L OE	OE 9/16R 7/16R	Right
21	R R R	R R R	3/8L OE 3/8R	1/4R 1/4R 5/8R	Right
22	R R R	R R R	13/16R 5/8R 17/16R	11/16R 9/16R 7/16R	Right
23	R R R	R R R	1/16L 1/2L 5/16R	7/16R 13/16R 23/16R	Right
24	L L L	L L L	9/16L 8/8L 9/8L	3/8R 3/4R 3/4R	Right
25	R R R	E E E	1/16R 1/8R 1/8R	1/8R 5/8R 3/8R	Right

* These scores signify Right (R), Left (L), Equal (E), or Alternating (A) arm elevation ratings by three examiners.

** These arm elevation scores are reported in fractions of inches and are arranged in the order in which they were obtained.