Maximum Available Desk-to-Eye Distance for Students in Grades One and Two: Regional Norms and Statistical Comparison to Distance Used for Near Point Screening
Chapter IV

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Chapter IV:

Data Analysis and Results

Presentation and Analysis of Data

The primary purpose of this study was to establish normative tables of the maximum available desk-to-eye distance for students in Grades 1 and 2 who were less than 10 years of age. Additionally, this study analyzed the significant differences between the mean lengths of the Side or Across MA-DEDs and the target distances used in nearpoint vision screening. A second analysis was of significant differences between the diopter equivalent of the Side and Across MA-DED means (D_S, D_A) and the sum of D_S or D_A and each power of plus lens used as fogging lens (D_{FL}) to screen for hyperopia ($D_S + D_{FL} = D_{SFL}$, or ($D_A + D_{FL} = D_{AFL}$). A third analysis was of the significant differences between the means of the remeasured Side MA-DED and measured Side MA-DED and between the means of the remeasured Across MA-DED and measured Across MA-DED. The multiple analysis of variance (MANOVA) procedure examined the interaction between the variables of age, grade, and sex for the measure and remeasure Side and Across MA-DEDs (8 x 4 x 2 design). Univariate procedures were completed to determine which variables contribute to the overall differences.

The measured sample included both males and females whose parents had returned correctly completed forms granting permission for the child's participation. There was a total of 1,135 subjects in Grades 1 and 2. Of these, 510 were males and 625 were females. Their ages ranged from 6 years, zero months (6-0, young 6 = 0-5 months) through 9 years, 11 months (9-11, old 9 = 6-11 months). One district had subjects older than 9-11: In 2^2 there was one boy 10 years old, one girl 11 years old, and one girl 12 years old. These subjects were excluded from the study by the age limitations.

No data were available on the registration cards to indicate a student's age at time of entry into school, that is, Grade 1 or kindergarten, nor were there any data to indicate that a student had been retained. There were, however, subjects in both Grades 1 and 2 whose ages were within the Old 9 age span of 9 years, 6 months (9-6) through 9 years, 11 months (9-11). The youngest subjects in first grade, first semester (Grade 1^1) were within the Young 6 age span of 6 years, zero months (6-0) through 6 years, 5 months (6-5). The youngest subject in Grade 2 was in the Old 6 age span, 6 years, 6 months (6-6) through 6 years, 11 months (6-11). The oldest students in Grades 1^1 were within the Old 8 age span (8-6 through 8-11).

The subjects in one district (C-FBISD) were described by the administration as being all students enrolled in mainstream classes. In addition to regular students, the mainstream classes included mildly and moderately

handicapped special education students who were mainstreamed with assistance given as direct service to them or as support service to their teachers on a demand basis, slow learners (IQ between 70 and 85) who had the same assistance as the mainstreamed special education students, students in special classes for the gifted and talented (IQ of 140 or higher, plus other qualifying criteria), and students in classes for intensive language development (ILD) to acquire the English language. Other districts included all students enrolled in classes designated as Grades 1 and 2. There was no exclusion of any category of educational placement, but there was no indication that self-contained, severely handicapped students were among the subjects.

There was a pool of 1,712 subjects enrolled in Grades 1 and 2 in the 13 schools. Of these students, 1,135 became subjects in the study. The percentages of the subjects in grade levels 1^1 and 2^1 were almost equal, each being between 17% and 18%. The percentages of subjects in grade levels 1^2 and 2^2 were also close in value, being 33.57% and 31.98% (see Table 5).

Table 5:
Subject's Ages, Grade Levels, and Ethnic Origins

Subject Group	**Percentage of the Sample**
	N = 1,135
Age	
6 years old	23.61
7 years old	48.11
8 years old	26.17
9 years old	2.11
Grade Level	
1st Grade	
1st Semester	17.36
2nd Semester	33.57
Total	50.93
2nd Grade	
1st Semester	17.09
2nd Semester	31.98
Total	49.07
Ethnic Origin	
Anglo	78.02
Hispanic	10.86
Black	7.06
Asian/Oriental	3.71
Aleut/Native American	0.35

There was representation of each of the five ethnic groups: Anglo, Asian/Oriental, Hispanic, Aleut/Native

American, and Black. The percentage of the sample in minority, non-anglo groups was 21.98%, ranging from 0.35% (Aleut/Native American) to 10.86% (Hispanic). The incidence of representation was based on the ethnicity of the students who participated in the study and were present during the time of measurement at their schools.

Measurements were made during 7 of the 9 school months. No measurements were made in December or May. The times of measurement were scheduled by the principals.

The design of the study set the upper age limit at 9 years, 11 months. There was no lower age limit set. There was, however, no subject younger than 6 years, zero months (6-0) at the time of measurement. The resulting age span was from 6-0 through 9-11.

The analyses involved two types of standards: linear target distance used in nearpoint screening and plus diopter power. The diopter standards (D_{SFL} and D_{AFL}) utilized the sum of the diopter equivalent of the MA-DED means and the diopter power used to screen for hyperopia. The near target distances as reported by the states (10 and 12 to 18 inches) and their frequencies of use are shown in Table 6. The powers of plus lens used to screen for hyperopia and the grades at which they are used as reported by the states (+1.00 D through +2.25 D) are shown in Table 7. Not all states screen for near vision, nor do all screen for hyperopia. Near tests and the distances reported as being used for each test are shown in Table 16, Appendix Q.

Table 6:
Inquiry Responses, 1985-86,Target Distances and Tests Used to Screen Nearpoint Vision

Distance	Test Used	N (states)
12-13 "	Corneal Light Reflection	1
12-14 "	Near Acuity	1
12-18 "	Cover/Uncover	1
	Corneal Light Reflection	2
13-14 "	Corneal Light Reflection[a]	1
13-16 "	Near Acuity	1
	Near Point Convergence[b]	1
	Muscle Balance	1
	Worth Dot Test	1
14-16 "	Near Acuity	1
	Worth Dot Test	1
	Cover/Uncover[c]	2
15-18 "	Cover/Uncover	1
60 "	Worth Dot Test	1
Reading Position[d]	Cover/Uncover	1
Reading Distance[d]	Cover/Uncover	1

	Near Phoria	1
Average Reading Distance[d]	Cover/Uncover	1
	Straibsmus	1
At Arm's Length	Cover/Uncover[c]	1
	Corneal Light Reflection[a]	2
20'	Fogging Lens[e]	26
DNS	Vision Screening Machine[f]	23

NOTES:
[a] Arm's length defined as 13" to 14"
[b] And move inward
[c] Arm's length defined as 14" to 16"
[d] Measure distance not given
[e] Reported by some as a near vision score
[f] Reported by Lebensohn *(Lebensohn 1958)*: Telebinocular, 16 inches; Sight Screener, 14 inches; Ortho-rater, 13 inches

Table 7:
Inquiry Responses, 1985-86,
Power of Plus Diopter Lens Used to Screen for Hyperopia by Grade

Power of +D Lens	**Grade(s) Used**
1.00	9-12
1.25/2.25	K, 1-3, 4-8
1.50	6-8
1.50/1.75	K-12
1.50-2.50	1-4, 6, 8, 10, 12
1.75	K-1, 1-12, 3-UP, 4-UP, GNS
1.75/2.25	>7[b]
1.75-2.25	GNS
2.00	1/3, 1-5, 2-UP, GNS
2.25	K, K-2, K-3, 1, 1-12
VSM-PNS	GNS
NS	ANY-TWR, NS

NOTE: [a]Some states use more than one power. [b]Years of age.

/ = or; - = through; ANY = Any Grade; GNS = Grade Not Specified; NS = Not Specified: PNS = power not Specified; TWR = if Trouble With Reading; VSM = Vision Screening Machine

There were three sizes of chairs and two sizes of each style of desk used in the study. Table 8 presents data for the number of subjects for each desk and chair size. Descriptions of the criteria for fit of the furniture is given in Appendix M .

Table 8:
Frequency Distribution of Furniture Sizes Used as Best Fit for MA-DED Measurements

Furniture Size	**Number of Students**	**per Size:**
Chair	**Measured**	**Remeasured**
11 1/2 inches	214	15
13 1/2 inches	461	60
15 1/2 inches	460	76
Total	1,135	151
Side Desk		
19 3/4 inches	801	99
22 inches	334	52
Total	1,135	151
Across Desk		
23 5/8 inches	669	75
26 1/4 inches	466	76
Total	1,135	151

During the measure trial, fit for the best-fit chair was low for 0.53% of the subjects, high for 3.08% of the students, and appropriate for 96.39% of the children. For the best-fit side desks, the resulting fit was short for 0.97%, tall for 78.18%, and appropriate for 20.85% of the children. For the best-fit across desks, the resulting fit was short for 0.09%, tall for 83.17%, and appropriate for 16.74% of the subjects. During the remeasure trial, the percentages for best fit were: (a) chair, 0.00% low, 1.34% high, and 98.66% appropriate; (b) side desk, 0.00% short, 91.39% tall, and 8.61% appropriate; and (c) across desk, 0.00% short, 91.39 % tall, and 8.61% appropriate (see Table 31 in the Addendum). Intervening factors which might affect fit, such as body build, physique or posture, were not investigated.

Retention of Subjects for Data Analysis

From a sample pool of 1,712 students, 1,135 subjects met all criteria for inclusion in the analysis of data for this study. The criteria for retention were that the parent return a properly completed consent form, the

student be present at the time of measurement, the student be under 10 years of age, and data entry be complete for the variable being analyzed. The data entry error rate was < 1%. Of the pool of 1,712 subjects, 75.18% returned consent forms by the deadline (see Table 9). Three students were excluded by the upper age limit set in the study design. In Grade 2[2], one boy was 10 years old, one girl was 11 years old, and one girl was 12 years old. There was no lower age limit. Data are complete for 1,135 subjects.

Data were collected on the number of students who took home parent packets for measure and remeasure phases of the study. Table 9 shows the number of students retained for data analysis in each phase.

Table 9:
Retention of Subjects for Data Analysis

Criterion	Measure		Remeasure	
	Total N=1,172		Total N=173	
	n	%	n	%
Parent Packets				
Not returned	425	42.82	18	10.40
Incorrect	5	0.29	0	0.00
Consent				
Yes	1,159	67.70	153	88.44
No	123	7.18	2	1.16
Over-age	3	0.18	0	0.00
Attendance on day of measurement				
Measured	1,139[a]	66.53	152[b]	87.86[c]
Absent	17	0.99	1	0.58

NOTES
[a] Data incomplete on 4
[b] Includes one retainee
[c] is 13.35% of measured subjects

Follow-up letters and duplicate forms were sent to parents who did not return the initial packet. After follow-up letters were sent, 24.82% of the measure pool did not have returned packets. There was a wide variation across classrooms and teachers in the percentage of forms returned and consent granted. These ranged from 100% return and 100% consent granted to less than 25% of each. The contributing variables were not investigated, but among the variables would be teacher influence and clarity of communication to the parents. The clarity of communication could be influenced by the reading levels of the parents, as well as a limited ability to communicate in English. The pool included students in classes to learn English, whose home language was not English.

Subjects were remeasured at two schools. Of the possible remeasure pool of 194 measured subjects, 173 (89.18%) were still enrolled and became the pool of remeasured subjects. This loss of measured subjects is accentuated by the lapse of time (4 and 8 months). The adjacent semesters for Time 1 were over a long holiday at the end of the calendar year. The adjacent semesters for Time 2 were over the summer and end of a school year.

Subjects were classified within five ethnic categories: Anglo, Asian/Oriental, Hispanic, Aleut/Native American, and Black (see Table 5). The number in each category is not controlled but is a result of student enrollment, parental consent, and student presence on the day of measurement.

Results

Subjects' Side and Across MA-DED individual scores (viewing distances) were determined and ranked for each style of desk. The range of individual MA-DEDs and the upper and lower limits of the MA-DEDs and the near screening target distances for the measured and remeasured trials are shown in Table 10.

Table 10:
Range of Measured and Remeasured Side and Across MA-DED Scores and Target Distances for Nearpoint Vision Screening (TDNPVS)

Desk Type /Trial		**MA-DED**	**(inches)**	**TDNPVS**	**(inches)**
	Range	**Upper Limit**	**Lower Limit**	**Upper Limit**	**Lower Limit**
Side Desk					
Measured (N = 1,135)	11.500	19.875	8.375	18	10
Remeasured (N = 151)	7.375	16.375	9.000	18	10
Across Desk					
Measured (N = 1,135)	9.875	16.500	6.625	18	10
Remeasured (N = 151)	8.00	15.250	7.250	18	10

The individual MA-DED scores subsequently were used to establish the Side and Across MA-DED means. The TDNPVS of 10 to 18 inches, in increments of 1 inch, became the set of standards used in testing for significant differences between MA-DED means and the standard distances (Hypothesis One). The means of the MA-DED at each style desk are also used to test for significant differences between the means of the measured and remeasured MA-DEDs (Hypothesis Three).

Diopter differences were used to test Hypothesis Two. Individual MA-DED scores were converted to diopter equivalents by first changing inches to metric distance (1 inch = .0254 m) and then applying the formula D = 1/metric distance. The range of individual diopter equivalents is shown in Table 11.

Table 11:
Range of Diopter Equivalents (+D) of Individual MA-DEDs

Desk type		**Diopter**	**equivalents**
(N = 1,135)	**Range**	**Upper Limit**	**Lower Limit**
Side desk	+2.27 D[a]	[4.70]	[1.98]
Across desk	+3.55 D[a]	[5.94]	[2.39]

NOTES
[a] Range equals upper limit minus lower limit.
(Reciprocity limits application of D = 1/m to a single point of viewing distance.)

The display of the range of individual diopter equivalents shows greater variation than is apparent when only means are displayed.

In developing the diopter equivalents of the MA-DED means, the means were first rounded to the nearest 1/8 inch and converted to metric measurement. This number was then converted to diopter equivalents by utilizing the formula D = 1/metric distance. The set of standards used in the test of significant differences for Hypothesis Two were unique for each cell. Each set was created by summing a D_S or D_A and the incremental powers (+0.25 D), in turn, across the range of plus fogging lenses (D_{FL}) reported by the states as being used to screen for hyperopia ($D_{SFL} = D_S + D_{FL}$; $D_{AFL} = D_A + D_{FL}$). The reported +D fogging lens ranged from 1.00 D through 2.50 D. The range of diopter equivalents and the range of the MA-DED scores cannot be shown on the same table giving upper and lower limits because reciprocity results in the upper limit of the MA-DEDs converting to the lower limits of the diopter equivalents, and the lower limit of the MA-DEDs converting to the upper limit of the diopter equivalents.

Presentation of the mean scores of the MA-DED at each style of desk for the different age spans (6-month, 1-year, 2-year, 3-year, and 4-year) are shown in Table 12. The presentation includes the means of the MA-DED, standard deviations, and number of subjects for the described cells, and may be used as a norm table. The remainder of the norms are presented in Table 22, Table 23, Table 24, Table 25, Table 26, and Table 27, in Appendix Q.

Table 12:
Maximum Available Desk-to-Eye Distance (MA-DED) Means by Age Span and Desk Style

Age Span		**Side Desk**			**AcrossDesk**	
	n	**mean**	**SD**	**N**	**Mean**	**SD**
				Six-month		

Young 6[a]	41	12.948	1.745	41	11.415	1.890
Old 6[b]	227	12.905	1.563	227	11.231	1.617
Young 7[a]	281	13.398	1.681	281	11.832	1.525
Old 7[b]	265	13.730	1.646	265	12.052	1.607
Young 8[a]	230	14.320	1.768	230	12.404	1.659
Old 8[b]	67	14.349	1.454	67	12.598	1.551
Young 9[a]	18	14.097	2.559	18	12.729	1.757
Old 9[bc]	---	---	---	---	---	---
				One-year		
6 years	268	12.911	1.589	268	11.259	1.659
7 years	546	13.559	1.671	546	11.939	1.568
8 years	297	14.327	1.700	297	12.447	1.653
9 years	24	13.797	2.623	24	12.266	2.000
				Two-year		
6-7 years	814	13.347	1.671	814	11.715	1.629
8-9 years	321	14.287	1.785	321	12.434	1.662
				Three-year		
6-8 years	1,111	13.608	1.659	1,111	11.932	1.608
7-9 years	867	13.829	1.707	867	12.150	1.603
				Four-year		
6-9 years	1,135	13.612	1.756	1,135	11.919	1.669

NOTES
[a] Year plus zero to 5 months
[b] Year plus 6 to 11 months
[c] Fewer than 10 subjects per cell

All hypotheses were subjected to statistical analyses. Hypotheses One and Two were tested utilizing an independent-samples student's t-Test (two-tailed, $p < .05$). Hypothesis Three was tested utilizing a paired-samples student's t-Test (two-tailed, $p < .05$). Table 13 illustrates the analysis of data for each student's t-Test.

Table 13:
Student's T-Tests: Expected and Actual Percentages

Hypothesis/Number of Tests Run	**Expected %**	**Actual %**

Independent Samples (two-tailed, $\underline{p} < .05$):		
H_1 Side and Across MA-DED Means ($\underline{N}$ = 376, Grades 1-2)	89.00	92.169
H_2 + Diopters (Equivalent of Side and Across MA-DED means) ($\underline{N}$ = 2,632, Grades 1-2)	89.00	95.080
Paired Samples (two-tailed, $\underline{p} < .05$):		
H_3 Remeasure/Measure MA-DED Mean Differences (Side and Across) Time 1 and Time 2 ($\underline{N}$ = 151, Grades 1^1, 1^2, 2^1	89.00	98.368

The basis for decisions regarding rejection or failure to reject Hypotheses One, Two, and Three is the relationship of the expected proportion of the tests that are significant and the actual proportion of the tests that are significant.

Hypothesis One states:

> There is a significant difference between the mean of the MA-DED for each cell as described and each standard distance used as target distance for nearpoint vision screening (TDNPVS).

The actual proportion of student's $\underline{t}$-Tests that were significant (two-tailed, Independent Samples, $\underline{p} < .05$) is 92.169%, which is greater than the expected 89% significant proportion. Therefore, Hypothesis One is supported.

Hypothesis Two states:

> There is a significant difference between the mean MA-DED diopters (the mean of the MA-DED for each cell as described when converted to plus diopters of accomodation [D_S, D_A]) and the summed diopters (D_{SFL}, D_{AFL}) of the given plus diopters fogging lens and MA-DED diopters for a given cell.

The actual proportion of student's $\underline{t}$-Tests that were significant (two-tailed, independent samples, $\underline{p} < .05$) is 95.080%, which is greater than the expected 89% proportion. Therefore, Hypothesis Two is supported.

Hypothesis Three states:

> There is a significant difference between the remeasure/measure means of the MA-DED across time for the children in Time 1, Grades 1^1 and 2^1 and Time 2, Grade 1^2 .

The actual proportion of student's $\underline{t}$-tests that are significant (two-tailed, paired samples, $\underline{p} < .05$) is 98.368%, which is greater than the expected 89% proportion. Therefore, Hypothesis Three is supported.

Results of tests of significance in the MANOVA procedures must be statistically significant before there is cause to examine univariate results. The univariate results determine the variables which contribute the most to

overall differences *(NoruÆis 1985)* .

Two analyses of variance (ANOVAs) were performed for effects of age, grade, and sex (8 x 4 x 2 design) for the Side and Across MA-DED means using MANOVA procedures (SPSS-X). The first analysis includes the repeated measure factor, retesting on both the Side and Across MA-DEDs, thus being a true multivariate analysis of variance. The second analysis deletes the measurement factor and examines the difference between the Side and Across MA-DED measures, thus being a univariate analysis of variance (see Table14).

Table 14:
MANOVA of the MA-DED

Source of Variation	Wilkes	Approximate F	Hypothesis df	Error df	Significance of F
Age Group	0.823	1.768	14.00	242.00	0.044
Grade	0.905	3.093	4.00	242.00	0.017
Sex	1.000	0.029	2.00	121.00	0.971
Age Group x Grade	0.910	0.976	12.00	242.00	0.472
Age Group x Sex	0.979	0.315	8.00	242.00	0.960
Grade x Sex	0.997	0.095	4.00	242.00	0.984
Age Group x Grade x Sex	0.982	0.363	6.00	242.00	0.902
Measure	0.993	0.423	2.00	121.00	0.656
Age Group x Measure	0.884	1.101	14.00	242.00	0.358
Grade x Measure	0.972	0.853	4.00	242.00	0.493
Sex x Measure	0.975	1.547	2.00	121.00	0.217
Age Group x Grade x Measure	0.884	1.279	12.00	242.00	0.232
Age Group x Sex x Measure	0.965	0.540	8.00	242.00	0.826
Grade x Sex x Measure	0.955	1.397	4.00	242.00	0.236
Age Group x Grade x Sex x Measure	0.935	1.376	6.00	242.00	0.225

The difference between the Side and Across MA-DEDs is computed as D_A - D_S. All of the resulting mean differences are of negative value. This indicates that the Side MA-DED is larger in value than is the Across MA-DED (see Table 15).

Table 15:
Cell Means: Difference Between Across and Side MA-DEDs

Age Group / Grade	Mean	SD	n
Young 6			
Grade 1[1]	-1.651	1.739	29
Grade 1[2]	-1.250	1.113	12
Old 6			

Grade 1^1	-0.895 *	1.402	82
Grade 1^2	-2.126 *	1.356	144
Grade 2^1	-3.250	0.000	1
Young 7			
Grade 1^1	-1.129 *	1.354	64
Grade 1^2	-1.873 *	1.751	154
Grade 2^1	-0.826 *	1.154	46
Grade 2^2	-2.434 *	1.414	17
Old 7			
Grade 1^1	-1.133 *	1.286	15
Grade 1^2	-1.530 *	1.617	42
Grade 2^1	-0.900 *	1.354	74
Grade 2^2	-2.215 *	1.207	134
Young 8			
Grade 1^1	-1.563 *	1.488	5
Grade 1^2	-2.244 **	1.724	22
Grade 2^1	-0.967 *	1.243	53
Grade 2^2	-2.194 *	1.722	150
Old 8			
Grade 1^1	-0.375	0.000	1
Grade 1^2	-2.854 *	1.530	6
Grade 2^1	-1.098 *	1.142	14
Grade 2^2	-1.837 **	1.368	46
Young 9			
Grade 1^1	-5.500	0.000	1
Grade 1^2	-1.000 *	0.835	4
Grade 2^1	-1.163 *	2.153	13
Old 9			
Grade 1^1	-1.938	1.503	2
Grade 1^2	-1.625 *	0.707	2
Grade 2^1	-2.500 *	1.061	2
Total Sample	-1.692	1.565	1,135

NOTES
Cells with n = 1 were not tested.
***** Means which differ significantly.
****** Means which differ from other means of smaller value but do not differ from each other.

The second analysis of variance shows a significant F-ratio only on the three-way interaction among age, grade, and desk style (Side or Across). This effect was investigated further by univariate tests. The grades means are found to differ significantly for the following age groups: Old 6 (6 years, 6 months through 6 years, 11 months) through Young 9 (9 years, zero months through 9 years, 5 months). The interaction significance is due to the mean difference between Side and Across MA-DEDs not being consistent between grades when viewed across age groups. Therefore, Hypothesis Three is accepted.

Summary:

Analysis of the data reveals that there are significant differences between the means of the Side and Across MA-DEDs and the target distances used for nearpoint vision screening (TDNPVS). Thus, Hypothesis One is not rejected. A mean may be shorter than some of the TDNPVS, or equal to or longer than others. There are significant differences between the diopter equivalents of the means of the MA-DED for each style of desk and the D_{SFL} and D_{AFL} (sum of each MA-DED diopter equivalent and each power of +D fogging lens used to screen for hyperopia). Thus, Hypothesis Two is not rejected. There are significant differences between the remeasure and measure means of the MA-DED involving the three-way interaction of age, grade, and style of desk. The means difference between the Side and Across MA-DEDs is not consistent between grades when viewed across the different age spans. Therefore Hypothesis Three is not rejected.


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