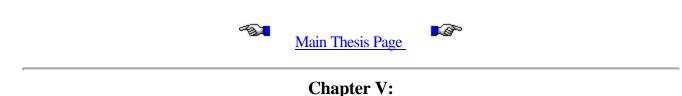Maximum Available Desk-to-Eye Distance for Students in Grades One and Two: Regional Norms and Statistical Comparison to Distance Used for Near Point Screening
Chapter V

Chapter V:

Summary, Findings, Discussion, Conclusion, Implications, and Recommendatations

Summary

This study investigated the maximum available desk-to-eye distance (MA-DED) for students in Grades 1 and 2 while seated in best-fit chairs at best-fit desks with storage beneath the desk top at the side or across. The study established normative tables for the Side and Across MA-DEDs for Grades 1 and 2 and for the ages of the subjects, 6 through 9 years. Relationships between the MA-DEDs and age, grade, and gender were analyzed.

The study is significant in that it provides criteria of near viewing distance available to students in Grades 1 and 2 or age 6 through 9 years while seated to work at desks. This criteria can be used to examine the generalizability of findings in reading and vision studies to a child's classroom situation. The criteria also allow examination of past studies to determine the appropriateness of generalizing these past findings of vision screening and vision examination to a classroom situation.

The study analyzed data from 1,135 students enrolled in Grades 1 and 2 in 13 public schools and 1 parochial school within the geographic boundaries of Education Service Center Region X in Texas.

To obtain the maximum available desk-to-eye distance (MA-DED) data, each subject was measured from the bridge of the nose to the pencil point placed on the target while assuming a good writing posture at each of the two styles of desks. The target point was in the center of the desk area above the leg space. The best-fit chair and best-fit desk (both side and across) were established for each student prior to measurement.

The remeasure and measure of Side and Across MA-DEDs were taken in adjacent semesters. Time 1 was for 4 months, fall to spring; Time 2 was for 8 months, spring to fall.

The data analyses utilized the student's $\underline{t}$-test (two-tailed, independent samples, $\underline{p} < .05$) for Hypotheses 1 and 2 and the student's $\underline{t}$-test (two-tailed, paired samples, $\underline{p} < .05$) for remeasure/measure for Hypothesis 3. The Multivariate Analysis of Variance (MANOVA) procedures of SPSS-X were utilized to determine significant interaction among age, grade, sex, and desk style factor on the MA-DED. MANOVA simultaneously tests the interaction between the age spans, grade levels, and sex, and measure and remeasure MA-DEDs.

The following hypotheses were tested:

- **H1:** 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).
- **H2:** 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 accommodation [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.
- **H3:** 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.

Findings

The following findings resulted from the study:

1. There were significant differences between the means of the Side and Across MA-DED and each of the target distances used in screening nearpoint vision (TDNPVS) for 92.169% of the tests at $p < .05$. The linear means of the Side and Across MA-DEDs varied from the TDNPVS distances of 10 and 12 to 18 inches in that the means were equal to some and shorter or longer than others. The high percentage of tests of differences that were significant support Hypothesis One.
2. There were significant differences between the diopter equivalent of the means of the Side and Across MA-DEDs and each sum of a standard plus lens and a Side or Across MA-DED diopter (D_{SFL}, D_{AFL}) for 95.080% of the tests at $p < .05$. The high percentage of tests of differences that were significant support Hypothesis Two.
3. There were significant differences between the means of the remeasure Side and Across MA-DEDs and the measure Side and Across MA-DEDs across time for 98.368% of the tests at $p < .05$. Hypothesis Three is supported.

Further statistical analysis of the interaction between the MA-DED measure and remeasure, age spans, grade levels, and sex were made using the MANOVA procedures of SPSS-X. The F-ratios for grade and age span were significant at $p < .05$. Examination of the means shows that the MA-DED values, both Side and Across, increase with age and by grade.

The results of the second analysis show a significant F-ratio only on three-way interaction among age span, grade level, and MA-DED type (Side versus Across). This effect was investigated by tests of simple main effects. Grades were found to differ significantly across age span, from young 6-year olds (6-0 through 6-5) through young 9-year-olds (9-0 through 9-5). The interaction is significant because the mean difference between Side and Across MA-DEDs is not consistent between grades when viewed across ages spans. Using D_A - D_S, the resulting mean differences were negative in value, indicating that the Side MA-DED is larger in value than the Across MA-DED.

Discussion

Commentary

A review of the data reveals the following additional outcomes:

1. The mean value of the Side and Across MA-DEDs for boys is shorter than that of the total sample, although the standard deviation for boys is greater than that for the total sample or for girls.

2. In Grades 1^2 and 2^1, the remeasured means and standard deviations are in the same direction in terms of the relationship to the measured means and standard deviations for each desk style. That is, the shorter remeasured means are associated with smaller standard deviations (when compared to the measured means and standard deviations of the same grades), and the longer remeasured means are associated with larger standard deviations (when compared to the measured means and standard deviations of the same grades).

3. In grade 1^1, the remeasured means and standard deviations are in opposite directions in terms of the relationship to the measured mean and standard deviation for each desk style. That is, the shorter remeasured mean is associated with a larger standard deviation (when compared to the measured mean and standard deviation of the same grade).

4. The range of the Side MA-DED means is 1 5/8 inches larger than that of the Across MA-DED means. Examination of the data reveals that most of the difference is seen in the upper limit of the Side MA-DED means being longer than that of the Across MA-DED.

5. Examination of the grade-by-sex means of the Side and Across MA-DED means reveals that the means of the boys are shorter than those of the girls in 13 of the 14 cells in which there are both boys and girls to contrast. The lesser means for boys are in all 7 of the contrasted cells for Side MA-DED means, and in 6 of the 7 contrasted cells for the Across MA-DED means.

6. The values of the shortest Side and Across MA-DED means (by grade and desk style, and by grade by sex by desk style) range from 11.076 to 12.600 inches. The diopter equivalents of these shortest MA-DED means are +3.50 D and +3.00 D (rounded to the nearest +0.25 D). The shortest MA-DED means found are for 6-year olds at side desks in Grade 1^1 and at across desks in Grade 1^2.

7. The values of the longest Side and Across MA-DED means (by grade and desk style, and by grade by sex by desk style) range from 14.654 to 12.691 inches. The diopter equivalents of these longest MA-DED means are +2.75 D and +3.00 D (rounded to the nearest +0.25 D). The longest MA-DED means found are for 8-year olds at side desks in Grade 2^2, and for 9-year olds at across desks in Grade 2^2. (It should be noted that all desks at all schools were of the Across style.)

8. The diopter equivalents of the shortest MA-DED means at either style of desk are greater than the strongest +D lens reported as being used to screen for hyperopia by +0.50 D and +1.00 D.

9. The diopter equivalents of the longest MA-DED means at either style of desk are greater than the strongest +D lens reported as being used to screen for hyperopia by +0.25 D and +0.50 D.

10. The pattern of boys having MA-DED means shorter than those of girls should be coupled with Michaels's *(Michaels 1985)* statement that the expected change in refractive status toward being less hyperopic is seen 2 to 3 years later in boys than it is in girls.

Observations

It was observed during the testing that the type of footwear had an effect on the distance of the thigh and knee from the floor, thus influencing the height of the chair and desk that were the best fit. The footwear differed as to thickness of sole when jogging or athletic shoes were compared to the thinner leather or plastic soles of nonathletic shoes. Cowboy boots have higher heels than do other styles of footwear, and have enough heel height to affect the knee and thigh height to a greater degree than do the thick soles of athletic shoes. There were no data kept as to the style of footwear worn by the subjects, and all subjects had the

best-fit chair and desk established without removing footwear. All types of footwear were observed being worn by both boys and girls.

Conclusions

The following major conclusions result from an analysis of the findings of this study. These conclusions, it is felt, can be generalized to students in Grades 1 and 2 or of ages 6 through 9 years for both boys and girls.

1. Tables of maximum available desk-to-eye distance means (MA-DEDs) are now available as normative tables to serve as criteria of the near viewing distance of students while working at school desks.
2. The maximum available desk-to-eye distance at side and across desks for most students are different from the target distances used in nearpoint vision screening, and are usually shorter than the target distances reported as being used.
3. The strength of plus lens appropriate to use when screening for hyperopia should be related to the individual's maximum available desk-to-eye distance for the desk style being used in the classroom. When the individual's measured MA-DED is not available, a MA-DED mean may be used. The means appropriate, in descending order, are:
   - age-by-grade-by-sex-by-desk style;
   - grade-by-sex-by-desk style;
   - age-by-grade-by-desk style;
   - age-by-desk style; or
   - grade-by-desk style.

   The desk style of the means used should match the desk style used in the classroom.

4. There are significant differences in the MA-DEDs across time. At each grade level, the style of desk and the child's age are correlated with differences in the value.
5. The visual demand of the Side and Across MA-DEDs is greater for younger students, or students in the lower grades, than it is for older students or students in the higher grades, due to the relationship of viewing distance and the dioptric accommodation for a given distance.
6. The maximum available desk-to-eye distance (MA-DED) is shorter at the across desk than at the side desk, resulting in a greater near visual demand while working at the across desk.
7. The shorter means of the Side and Across MA-DEDs for boys (as compared to those for girls) is associated with a greater variance in the individual MA-DEDs for boys than in those of girls.
8. The length of the Side and Across MA-DEDs are expected to increase as students become older and advance in grade level, resulting in decreased visual demand while working at a desk.
9. It is appropriate to compare the viewing distance available to a student while seated to read or write at a desk in the classroom to the target distance used in nearpoint vision screening, in order to determine the appropriateness of generalizing a nearpoint screening pass/fail to the classroom situation.
10. The style of desk and fit of chair and desk have an effect on a child's viewing distance while working at a desk.

Implications

Specific implications exist for individual professionals and professional organizations who advise or establish the content of vision screening practices for a state or school district, who design or create new screening

instruments, who screen the vision of school children, or who examine children's vision. There are also specific implications which exist for teachers and reading professionals who instruct reading, investigate elements of reading, or develop methods of reading instruction for students in Grades 1 and 2 or for ages 6 through 9 years.

1. When near vision screening is part of a routine vision screening, near target distance less than or equal to the maximum available desk-to-eye distance for the student when seated at his or her own school desk should be employed.
2. When vision screening includes the use of +D (convex) lens, the power used should be related reciprocally to the near viewing distance as determined by individual measurement or by use of an appropriate MA-DED measure.
3. State vision advisory committees should be aware of the mean MA-DED for the different styles of desks for different grades and ages in conjunction with the visual refractive status that is considered to be normal, or is expected, at a given grade or age. They should base their recommendations upon the visual demands which result from these factors.
4. Eye care professionals should not assume that the results of past investigations which have become the basis for vision screening standards and the distances used in vision examinations are appropriate in terms of the minimum visual demand made upon children in Grades 1 and 2, or ages 6 through 9 years.
5. Eye care professionals should not assume that investigative findings will be the same at the traditional near distances and at a mean MA-DED or an individual MA-DED distance.
6. The maximum available desk-to-eye distance is not necessarily the work distance of students in these grades or of these ages. Work distances are likely to be shorter than the MA-DEDs and to vary during a task.
7. Teachers should not assume that all children learn to read equally well at all distances. Some children may need a greater distance than the desk environment allows.
8. Schools should not assume that size and fit of chair and desk do not affect the visual demand of a near task while the student is working at a desk. It is important for each student to be working at a best-fit chair and desk all of the school year.

Recommendations

Recommendations for future studies are as follow:

1. investigation of the ability of primary-age children to utilize different visual distances as a developmental aspect of vision as established by means at given ages and grades, and by longitudinal studies of individuals over the age span commonly found in the primary grades;
2. determination of working or vocational distances for various tasks involving reading, writing, or both, under various conditions. The conditions should include those of varying work surfaces or no work surface, such as holding a book to read when not at a work surface. The conditions should also include the stress of various academic tasks in which a student has varying levels of achievement and skill, such as handwriting during a spelling test as compared to handwriting during composition or a formal writing lesson, or drawing;
3. investigation of the interaction or correlation of the various factors in the determination of working distances, whether of main effects or of intervening variables such as gender, age, posture, or physique;
4. replication of earlier investigations by eye care professionals of the visual elements directly involved in

near school tasks, such as facility and amplitude of accommodation and contrast sensitivity at the original, MA-DED, and Hurst's working distances, as well as when working at these distances for varied lengths of sustained time;

5. correlative studies of complete individual refractive status (utilizing rounding to the nearest ± 0.25 diopter) and academic achievement and facility or ease of academic performance, as well as intervening variables such as sex, age, and grade;

6. determination of the individual's ability to sustain working on academic tasks at the various distances or the effect of forced maintenance of various working distances on academic output, as well as effect on the individual's attitude toward completing the work;

7. investigation of different rates of learning, especially in areas of lowered academic achievement, when working under varied conditions of working distance (even far distance for reading), illumination (such as spot-lighted reading material), and various time exposures which do not involve covering/uncovering or blurring/ focusing of the stimulus;

8. determination of the pass/fail rate for vision screening when the targets used for tests of nearpoint vision screening are at distances equal to or shorter than the appropriate age, grade, and sex means of the MA-DED (Side or Across) which match the desk style used in the child's classroom;

9. determination of the hyperopia screening pass/fail rate when the power of +D lens is the diopter equivalent of the child's measured MA-DED, an appropriate MA-DED mean, or the child's habitual working distance; and

10. studies in which the findings of the earlier described determinations, studies, and investigations are correlated with the child's academic mastery, when academic mastery equates to the grade level at which the child ranks in the 50th percentile or higher.

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