

# LITERATURE REVIEW

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## Current Eye & Vision Science Literature

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**Vedamurthy I, Harrison WW, Liu Y, Cox I, Schor CM. The influence of first near-spectacle reading correction on accommodation and its interaction with convergence. *Investigative Ophthalmology and Visual Science* 2009;50:4215-4222.**

This study was undertaken to examine adaptations in accommodation and vergence to the first pair of reading glasses worn by the subjects. The 30 subjects in the study all wore spectacles or contact lenses for distance vision, had best corrected visual acuity of 20/20 or better, stimulus gradient AC/A ratios of 2 to 6  $\Delta$ /D, anisometropia of 1 D or less, astigmatism of 1.25 D or less, normal ocular health, and normal "eye alignment." Thirteen of the subjects had myopia in the range of -0.50 to -6.00 D. Two subjects had hyperopia of more than 0.5 D, and fifteen subjects had refractions in the range of -0.25 to +0.50 D. The subjects were in two age groups. Fifteen were between 21 and 30 years of age (average age, 25.1 years), and fifteen were 38 to 44 years old (average age, 40.3 years). The subjects in the older age group all had an amplitude of accommodation of at least 3 D by the monocular minus lens to blur procedure.

The subjects received single vision reading glasses with +1.50 D adds over their distance correction. They were asked to wear the spectacles at least three hours

a day for all near vision tasks for two months. Daily logs kept by the subjects indicated an average wearing time of 3.5 hours per day. Accommodative response / accommodative stimulus functions, response AC/A ratios, and CA/C ratios were measured three times: once before wear of the reading spectacles began (pre-treatment), once immediately after the reading glasses were worn for two months (post-treatment), and another set of measurements two months after the discontinuation of the wear of the reading glasses (recovery). The subjects wore their distance vision glasses during these measurements. Accommodation and convergence measurements were obtained with a Wheatstone mirror haploscope outfitted with a pair of Badal optometer stigmatoscopes.

The linear portion of the plot of accommodative response (y) as a function of accommodative stimulus (x) was used to determine slopes and y-intercepts. The slope did not change with reading lens wear in either group. The y-intercept showed a hyperopic shift (less accommodative response) after reading lens wear for two months. This shift averaged about 0.3 D in both groups, and it did not change from the post-treatment measurement to the recovery measurements two months later.

The maximum accommodative response on the accommodative response / accommodative stimulus function was taken as a measure of the near point of accommodation. The minimum accommodative response on the accommodative response / accommodative stimulus function was taken as a measure of the far point of accommodation. The difference between the maximum accommodative response and the minimum accommodative response was taken as a measure of the amplitude of accommodation. The near point and the far point of accommodation both showed an outward (hyperopic) shift, corresponding to the hyperopic shift in the y-intercept, after wear of the reading glasses. The magnitude of the shift was similar in the two age groups. The amplitude of accommodation did not

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change after wearing the reading spectacles in either age group.

The response AC/A ratios were not significantly different in the two groups prior to the wear of the reading glasses. Response AC/A ratios did not change significantly in either group with reading lens treatment. CA/C ratios did not change significantly with the two months of reading lens wear in either group.

The authors noted that their results “showed that the near and far points of accommodation recede after reading spectacles are worn and do not recover after 2 months of discontinued treatment.” The magnitude of the change was small, being about 0.3 D on average. They also observed that their findings “suggest that there is no long term impact of wearing the reading spectacles intermittently for a short-term on the accommodation and vergence cross-links.” (p. 4221)

**Palomo-Álvarez C, Puell MC. Relationship between oculomotor scanning determined by the DEM test and a contextual reading test in schoolchildren with reading difficulties. Graefe’s Archive for Clinical and Experimental Ophthalmology 2009;247:1243-1249.**

This study, conducted at the Complutense University School of Optometry in Madrid, Spain, investigated the relationship of DEM test results to reading speed on a standardized reading test in children identified as poor readers. The 81 study subjects were from 11 elementary schools in Madrid, and were “identified as non-dyslexic poor readers by their respective psycho-educational school teams.” (p.1244) Subjects were 8 to 11 years of age, and were in third (n=44), fourth (n=22), and fifth (n=15) grades. There were 51 boys and 30 girls. Inclusion criteria for the subjects were: normal IQ, less than 2.00 D of myopia or hyperopia, less than 1.00 D of astigmatism, no strabismus, and best corrected visual acuity of 20/20.

The children in the study took the PROLEC (third and fourth grades) or the PROLEC-SE (fifth grade) test, the standard reading test in Spain, at their school. The test evaluates ability to read words or pseudo-words, reading speed, and text comprehension. Those who scored below the 30th percentile on any of the reading subtests were eligible for the study. Children were included in the study if their scores “could

not be explained by dyslexia or other psycho-socio-educational or neurological problem (e.g., attention deficit hyperactivity disorder) reported by their parents.” (p. 1244) The DEM test was performed in the recommended manner.

A significant correlation of longer horizontal DEM time with slower reading time on the reading test was found ( $r = -0.53$ ,  $p < 0.0001$ ). The regression line for reading speed in words per minute as a function of horizontal DEM time in seconds was similar for each of the three grades. The similarity of the three regression lines suggests that the relationship of reading speed and horizontal DEM time did not vary with grade, despite the fact that DEM scores (horizontal time, vertical time, and horizontal to vertical ratio) improved significantly with age and grade.

The horizontal DEM times were longer for the study subjects than for normative data by 20 seconds for third graders, 12 seconds for fourth graders, and by 3 seconds for fifth graders. The horizontal to vertical ratios were higher than normative data by 0.36 for third graders, 0.15 for fourth graders, and 0.07 for fifth graders. The authors compared their results to other studies in both English-speaking and Spanish-speaking children. The horizontal times and the horizontal to vertical ratios in the current study were generally worse than in other studies for 8 and 9 year olds, but close to other studies for 10 year olds. The vertical DEM time scores in the current study were similar to norms and to findings from other studies for all three ages.

The authors noted that Garzia et al.<sup>1</sup> described four categories of performance on the DEM test:

Type I – horizontal time, vertical time, and horizontal to vertical ratio all normal for age.

Type II – normal vertical time, long horizontal time, high horizontal to vertical ratio, suggesting horizontal eye movement difficulties.

Type III – long horizontal and vertical times, normal horizontal to vertical ratio, suggesting difficulty in automaticity in naming numbers.

Type IV – long horizontal and vertical, high horizontal to vertical ratio, suggesting both eye movement problems and automaticity problems.

For the whole sample, there were 45.7% with a Type II pattern of results, 30.9% with Type IV, 19.8% with Type I, and 3.7% with Type III. For the third grade, over half (56.8%) were in the Type

II category. For the fourth and fifth graders, categories II and IV were closer in number.

This study showed a longer horizontal time score on the DEM test than normative data for a group of poor readers. Poor horizontal DEM time scores were related to poor reading speed on a standard reading test. The authors suggested that a clinical implication of their study findings is “that oculomotor scanning should be assessed by an optometric clinician using the DEM test as a screening tool to help identify poor reading skills in school children at an early stage.” (p. 1248) They also recommended further study of optometric vision therapy incorporating work on saccadic eye movements as a means of improving reading performance.

**Antona B, Barra F, Barrio A, Gonzalez E, Sanchez I. Repeatability intraexaminer and agreement in amplitude of accommodation measurements. Graefes Archive for Clinical and Experimental Ophthalmology 2009;247:121-127.**

This study examined the repeatability of three methods of measuring amplitude of accommodation and the agreement between the three methods. The three testing methods were push-up, push-away, and minus lens method. The study incorporated three examiners, one for each method of amplitude testing.

The subjects in the study were 61 first year optometry students in Madrid, Spain. They ranged in age from 18 to 32 years, with a mean age of 19.7 years. Inclusion criteria were: best corrected visual acuity of at least 0.9 in each eye at both distance and near; no ocular disease; no history of refractive surgery, strabismus, nystagmus, or amblyopia; no medications or disease that could affect accommodation, fusional vergence ranges, or ocular motility; and asymptomatic state with no accommodation or vergence disorder.

Each subject attended two separate testing sessions, which were at least 24 hours apart. All three test procedures were performed at each of the testing sessions. The order of the test procedures was random, determined by drawing numbered balls. For each of the test procedures, only the right eye was tested, the left eye being occluded during the testing.

For the push-up method, a test card was first held at 40 cm. The fixation target was a letter with a visual acuity demand of 1.0 (presumably the acuity demand at 40 cm). The examiner moved the card toward the subject at a rate of about 5 cm per second. Movement

of the card was stopped when the subject reported the first sustained blur. The examiner measured the distance of the card from the spectacle plane. The reciprocal of that distance in meters was taken as the measurement of the amplitude of accommodation in diopters.

In the push-away method, also variously known as the pull-away method or the push-down method, the test card is moved away from the patient until a letter or letters can be read, which is thought to be a more understandable endpoint for small children.<sup>2</sup> In this study, a test card with a letter with an acuity demand of 1.0 was moved away from the subject at a speed of about 5 cm per second. The examiner stopped moving the card when the subject could correctly identify the letter. At that point the distance of the card from the spectacle plane was measured, and the reciprocal of that distance in meters was used as the amplitude of accommodation.

For the minus lens method, subjects viewed a test card placed at a distance of 40 cm. Subjects were instructed to look at a letter with an acuity demand of 0.9. The authors stated that a larger letter was used for this procedure “to try to compensate, at least in part, for the reduction in size induced by minus lenses.” (p. 123) Minus lenses were added in 0.25 D steps until the subject reported that the letter became and remained blurred. The amplitude of accommodation by this procedure was the sum of 2.50 D and the absolute value of the added minus lens power.

The mean values for amplitude of accommodation were 13.08 D (SD = 2.79) for the push-up method, 11.25 D (SD = 1.77) for the push-away method, and 8.56 D (SD = 1.72) for the minus lens method.

Repeatability was assessed by (1) finding the second measurement minus first measurement difference for each testing method and (2) finding a coefficient of repeatability. The coefficient of repeatability represents the range either side of the mean difference within which the repeat measurement would fall 95% of the time relative to the first measurement. Therefore, a lower coefficient of repeatability would indicate better repeatability. When the differences showed a normal distribution, the coefficient of repeatability was found by multiplying the standard deviation of the differences by 1.96. When the differences were not normally distributed, the coefficient of repeatability was the 95th percentile of the absolute differences. The mean differences were -0.61 D for the push-up method, -0.81 D for the push-away method, and

-0.08 D for the minus lens method. The coefficients of repeatability were 4.76 D for the push-up method, 4.00 D for the push-away method, and 2.52 D for the minus lens method. The minus lens method thus had the best repeatability.

Agreement between methods was assessed by (1) finding the mean differences between tests, (2) finding a coefficient of agreement, and (3) doing paired t-tests for statistical significance of the differences between each pair of tests. The coefficient of agreement represents the range either side of the mean difference within which a measurement with one test would fall 95% of the time relative to a measurement with another test. Therefore, a lower coefficient of agreement would indicate closer agreement between two tests. When the differences showed a normal distribution, the coefficient of agreement was found by multiplying the standard deviation of the differences by 1.96. When the differences were not normally distributed, the coefficient of agreement was the 95th percentile of the absolute differences. The push-up minus push-away difference averaged +1.82 D, with a coefficient of agreement of 4.73 D. The push-up finding minus the minus lens test finding averaged +4.52 D, with a coefficient of agreement of 5.65 D. The push-away finding minus the minus lens test finding averaged +2.69 D, with a coefficient of agreement of 4.51 D. The paired t-tests yielded statistically significant differences between each pair of tests, with each of the three pairs of tests showing a difference at the p

< 0.0001 level. These results indicate poor agreement between methods.

Results of studies on the repeatability of amplitude of accommodation measurements have been variable, but this study was the one with the largest sample size. The results of this study on agreement of methods were consistent with previous studies in finding the lowest amplitude measurements with the minus lens method and the highest amplitude measurements with the push-up method.

The authors discussed the relative merits of the three testing procedures irrespective of the repeatability. They observed that push-up and push-away methods may be more useful clinically than the minus lens method because the former tests “inform the clinician of the near point of clear vision.” (p. 126) However, they noted that push-up and push-away methods overestimate the amplitude of accommodation compared to objective measures of the maximum accommodative response. They concluded that: “Agreement between the three techniques was poor, indicating that the methods are not interchangeable.” (p. 127)

## References

1. Garzia RP, Richman JE, Nicholson SB, Gaines CS. A new visual-verbal saccade test: The Developmental Eye Movement test (DEM). *J Am Optom Assoc* 1990;61:124-135.
2. Woehrle MB, Peters RJ, Frantz KA. Accommodative amplitude determination: can we substitute the pull-away for the push-up method? *J Optom Vis Dev* 1997;28:246-249.

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