# Article ▸ The Effect of Low Plus Lenses on Reading Rate and Comprehension

Janna Iyer, OD, Roswell, Georgia

Paul Harris, OD, Southern College of Optometry, Memphis, Tennessee

## ABSTRACT

**Background:** Behavioral optometrists prescribe low plus or anti-stress lenses much more often than their medically oriented counterparts. Though optometrists prescribe low plus lenses to help children with reading difficulties, few studies have compared the effect of these lenses to plano lenses. This study was designed to investigate the effect of low plus lenses on reading in non-presbyopes.

**Methods:** Using the ReadAlyzer, an objective eye movement recording device, reading rate and comprehension of 67 first year optometry students were analyzed. Each subject read one long story through plano spectacles and one through low plus spectacles. The amount of plus worn matched the findings of his/her fused-cross cylinder test (FCC). The order of the stories and spectacles was randomized.

**Results:** Low plus lenses had a significant positive effect on reading comprehension for all subjects ($p<0.001$). Reading speed also improved when subjects wore low plus lenses, however, this effect was only significant for those who had an FCC result of +0.50 D or greater. For those with an FCC result of less than +0.50 D, low plus lenses may be detrimental to reading speed. This study also showed that low plus lenses have a greater effect on reading speed for myopic than for hyperopic subjects.

**Conclusion:** This study showed the possibility of low plus lenses having more than a placebo effect on reading efficiency. Further studies will be aimed at comparing the effect of low plus lenses on children who are poor readers.

**Keywords:** accommodation, low plus lenses, ReadAlyzer, reading, study glasses

## Background

Many optometrists prescribe low plus lenses, typically defined as +0.50 to +1.00DS, for children with accommodative and/or convergence difficulties, particularly if the child is symptomatic. Some eye care practitioners regard these lenses as unnecessary because they feel that the power is too low to have any meaningful effect, other than placebo. However, studies have shown that low plus lenses can have a significant effect on reading efficiency.[1-3]

Sohrab-Jam measured reading efficiency in 38 4th and 5th grade males who were all at least one year behind in reading. Distance retinoscopy for all subjects measured between plano and +0.50DS. The children were divided into two groups: those who had a lag of accommodation of +0.25 D or more as measured by book retinoscopy and those who did not have at least +0.25 D lag. Eye movements were measured objectively with an Eye-Trac II recording device, and subjects read one passage through plano lenses and one through +0.50 lenses. The results showed that in the group with at least +0.25D lag, wearing low plus lenses showed a significant improvement on reading rate (mean through plano lenses = 105.8 words per minute (wpm); mean through +0.50 = 117.5 wpm; difference = 11.7 wpm faster through low plus). Wearing low plus showed improvement in comprehension for all subjects (mean difference of 4.7% improvement for subjects with at least +0.25 D lag and 8.9% improvement for those with less than +0.25 D lag).[1]

Pierce conducted a study with 24 subjects (ages 17-30) with no visual symptoms and 20/20 distance visual acuity. The subjects were divided into two groups of twelve. The first group read half of a standard reading test through plano lenses first and the other half through +0.50 lenses. The second group performed in the reverse order. While reading, electrophysiological activity (electrocardiogram, electromyogram, and respiration rate) was recorded. Pierce found reading rate significantly improved, by 4.5%, when subjects wore +0.50 lenses (mean time to complete one-half of reading task through plano lenses = 442.5 seconds and 423.3 ecs. through +0.50). Heart rate and respiration rate also significantly decreased (heart rate: 77 beats per minute (bpm) with plano lenses and 73 bpm with +0.50; respiration rate: 23 cycles per minute (cpm) with plano and 21 cpm with +0.50). Furthermore, posture and working distance improved when subjects wore +0.50 lenses. Though the subjects' comprehension

scores were not statistically significantly better through +0.50, there was a tendency for higher comprehension with +0.50 than with plano lenses.[2]

A 1988 study by Wildsoet and Foo investigated whether there was a difference in reading performance in children when wearing prescribed low plus lenses versus plano lenses. All children in this study had a mild hyperopic refractive error (+0.25 to +1.00 DS). In this randomized trial, 13 school children, age 9-13 years, read two standard grade-level passages (one with plano lenses and one with their prescribed low plus lenses). According to the investigators, these children had been wearing their prescription low plus lenses for at least six months prior to the study.

The Biometric Eye-Trac Recorder calculated the number of fixations, regressions, reading rate, and comprehension rate after each passage was read. The average reading speed with low plus was 128.45 wpm and with plano was 123.32 wpm, an improvement of 4.2%. Although there was an increase in average reading speed through low plus lenses, there was no statistically significant difference in reading performance, reading rate, or comprehension when measured through low plus lenses or plano lenses. The authors noted several possible reasons for the absence of improvement through the prescribed reading lenses, including the possibility that plus lenses may have been inappropriately prescribed to some children in this study.[3]

Many practitioners simply rely on visual acuity to determine whether a prescription is warranted. However, when prescribing low plus lenses for non-presbyopes, some practitioners, including Press and Apell, advocate using a model of performance against which the effects of low plus lenses may be measured. Press stated "accommodation can be tiring, thus sustained near point tasks result in visual stress." Low plus lenses alleviate visual stress so the effect should be performance-based.[4]

Apell described ways to measure performance, including whether low-plus lenses improved the patient's pursuits, saccades, and stereopsis.[5] Apell also noted, "the tendency to focus more than half diopter beyond the page when reading can lead to print blurring, day-dreaming, and short attention span."[6] Therefore, the appropriate near-point lens prescription is equal to, or in some cases, +0.25 to +0.50 diopters less than the magnitude of the lag of accommodation measured by monocular estimation method (MEM). Accommodative response is assumed to decrease when plus lenses reduce the accommodative stimulus. The position of the head is then adjusted for a greater working distance since a lesser accommodative response is typically related to a great working distance. However, if the plus lens is too strong, then the effects tend to be unfavorable.[7]

The following study uses methods similar to those used in previously published studies comparing low plus to plano lenses. This study shows the effect of low plus lenses, and how in certain cases, too much plus can be detrimental.

## Methods

The Institutional Review Board at Southern College of Optometry approved the study protocol. Sixty-seven first-year optometry students at the Southern College of Optometry participated in this study. The average age of participants was 23.5 years (range 22-37 years). The ReadAlyzer served to track eye movements using goggles containing infrared sensors. The repeatability of the Visagraph II (similar to the ReadAlyzer) in the analysis of children's eye movements[8] has been documented and is a valuable tool in assessing the effect of low plus on reading performance in children. Once the subject completes either a short or long story passage (grade levels 1-12) , their performance is compared with statistically measured expected rates of performance for reading rate, comprehension, fixations, regressions, and fixation duration.[9] Subjects qualified if they had vision correctable to 20/20 in each eye and no strabismus.

Reading performance was assessed through both low plus and plano lenses. The powers of the low plus lenses were +0.50, +0.75, and +1.00DS. Subjects were asked to wear contact lenses if they normally read and studied with their contact lenses. Due to mechanical restrictions of wearing the low plus and plano spectacles over their habitual spectacles, only subjects that wore contact lenses or did not wear any compensation were included in this study.

Prior to reading the passages, each participant's accommodative responses were measured via the standard optometric phoropter test, the fused-cross cylinder (FCC). Accommodation was relaxed with +1.00 over the subject's habitual prescription prior to beginning the FCC test. The FCC target was placed at 40cm and the test was stopped when the subjects saw the vertical and horizontal lines equally dark, or the point where they looked most equal. The results of the FCC test determined what power of low plus lens each participant wore for the reading task. Subjects wore lenses that equaled the endpoint of their FCC test: +0.50 (n=17), +0.75 (n=20), or +1.00 (n=19). If the FCC test result was less than +0.50 (n=9), the subject wore +0.50 for the reading task. Two participants' FCC test result was greater than +1.00; these subjects wore +1.00 for the reading task. Whether the subjects read through low plus or plano first was randomized, and subjects were not told the power of the lenses they wore. The passage each subject read was also randomized; they chose from three different stories.

Subjects first read a short passage, without lenses, to familiarize them with the procedure. A minimum score of 70% on comprehension was required to qualify for the study. Each subject then read two long passages (average 800 words). Each reading task was performed silently. To record reading performance, each subject was aligned in the ReadAlyzer goggles. They were asked to look at the circle at the top of the passage for approximately three seconds to ensure accuracy of the recording. The examiner told each subject when to start, and the subjects indicated when they were finished reading

**Table 1: A comparison of reading speed and comprehension (mean and standard deviation)**

| | Plano | Low plus | Difference |
|---|---|---|---|
| Reading speed | 238.3 ± 63.6 wpm | 243.9± 66.88 wpm | 5.6 wpm |
| Comprehension | 75.1% ± 9.3% | 80.8% ± 9.98% | 5.7% |

each passage. After reading the long stories, subjects had to answer 20 true/false comprehension questions. Results of the reading rate and comprehension were recorded for each lens set, per subject. Data was analyzed using a two-tailed paired t-test.

## Results

There was no statistically significant difference between plano and low plus lenses on reading speed ($p=0.08$), though subjects read 5.8 words per minute faster through low plus lenses. Fifty-eight percent of participants read faster with low plus, 39% read slower, and 3% read the same speed. One subject read 83 wpm faster through low plus lenses.

This study found a statistically significant difference in comprehension with low plus lenses ($p<0.001$). The average comprehension rate increased 5.7% through low plus lenses as compared to plano lenses. An increase in comprehension with plus lenses was found in 62.7%, while 22.4% showed a decrease, and 14.9% showed no difference.

Nine subjects had an FCC response less than +0.50, but their reading performance was measured through +0.50 lenses. If these nine participants were excluded, the results of the two-tailed paired t-test would be significant for reading rate as well. This possibly supports the argument that too much plus may be detrimental.

This study consisted of 51 myopes and 16 hyperopes. When comparing refractive error, our study showed myopic subjects read 6.8 wpm faster through low plus (compared to 5.6 wpm overall faster through low plus). Hyperopic subjects read only 2.25 wpm faster through low plus. Thus, myopes may benefit more from reduced minus (relative low plus) at near.

## Discussion

The results of this study were very similar to those found by Sohrab-Jam; low plus had a significant positive effect on comprehension for all subjects, but a positive effect on subjects' reading rate depended on their accommodative response. Many practitioners believe the use of low plus lenses for non-presbyopes has nothing more than a placebo effect. This study intended to show that low plus lenses could have a performance effect. Though most participants in this study did not have reading difficulties, typically, low plus lenses are prescribed to children and young adults who have trouble reading, near complaints, or who struggle academically. It is important to assess each patient to determine the proper near prescription.

After finding the potential near prescription, the practitioner should re-examine stereopsis, reading speed, and other tests such as the Developmental Eye Movement test through this prescription. Low plus lenses can help not only patients with accommodative difficulties, but also those with convergence excess/insufficiency and oculomotor dysfunction. Further studies will be looking at comparing low plus lenses versus plano lenses in children with reading difficulties, as determined by methods including patient, parent, and teacher symptom surveys.

## Conclusion

This study showed similar results to previous studies comparing low plus lenses to plano lenses. Most studies demonstrated that appropriately prescribed low plus lenses improve reading efficiency, that is, reading rate and/or comprehension, when compared to plano lenses. When the research on low plus lenses is considered, these lenses likely have more than a placebo effect on non-presbyopes. However, practitioners should be careful when prescribing low plus lenses, as too much plus may be detrimental to reading efficiency.

## References


1. Sohrab-Jam G. Eye movement patterns and reading performance in poor readers: Immediate effects of convex lenses indicated by book retinoscopy. Am J Optom Physiol Opt 1975;53:720-6.
2. Pierce J. Research reports and special articles (ser 1, no 9-10). Optometric Extension Program Courses 1967;57-66.
3. Wildsoet C, Foo K. Reading performance and low plus lenses. Clin Exper Optom 1988;71:100-5.
4. Press L. Physiological effects of plus lens application. Am J Optom Physiol Opt 1985;62:392-7.
5. Apell R. Performance test battery: A very useful tool for prescribing lenses. J Behav Optom 1996;7:7-10.
6. Apell R. Nearpoint visual acuity. J Am Optom Assoc 1973;44:168-70.
7. Greenspan S. Behavioral effect of children's nearpoint lenses. J Am Optom Assoc 1975;46:1031-7.
8. Borsting E, Rouse M, Shin S, Dold E, et al. Repeatability of the Visagraph II in the analysis of children's eye movements during reading. Optom Vis Devel 2007;38:67-73.
9. ReadAlyzer Users Guide. Stockholm: 2004.



*Correspondence regarding this article should be emailed to janna.iyer@gmail.com or sent to Janna Iyer OD, 12020 Etris Road, Suite B-100, Roswell, GA 30075, Tel. 678-256-3990. All statements are the authors' personal opinions and may not reflect the opinions of the the representative organizations, ACBO, COVD, or OEPF, Optometry & Visual Performance or any institution or organization with which the author may be affiliated.*




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