Article: Oculomotor Training Using King-Devick Remediation and Elementary School Reading Fluency Outcomes

Jennifer Wethe, PhD

Danielle Leong, OD

Yi Pang, OD, MD, PhD

Rebecca Weil, BS

ABSTRACT

Background: Oculomotor training has been associated with improvements in reading fluency, but the physical act of reading is not typically taught in schools. The purpose of this retrospective study was to examine reading fluency outcomes in elementary students following oculomotor training.

Methods: Pre- and post-training Scholastic Reading fluency benchmarks were reviewed for nine students (Grade1 through 4) who had undergone 6-week in-school training using King-Devick(K-D) Remediation software.

Results: All students demonstrated improvement in reading fluency scores following training and this was statistically significant (p=0.008,Wilcoxon signed-rank).

Conclusion: Findings support prior research that oculomotor training results in improved reading fluency.

Jennifer V. Wethe, PhD
Phoenix, Arizona

Dr. Wethe completed a Bachelor of Arts degree in psychology, a Master of Science and Doctor of Philosophy degrees in clinical psychology at Purdue University. She trained as a pre-doctoral fellow at Wishard Health Services, Indiana University Medical Center; completed a neuropsychology internship at University of Texas Medical Branch at Galveston; and completed a post-doctoral fellowship in neuropsychology and rehabilitation at Barrow Neurological Institute, St. Joseph's Hospital and Medical Center. She currently is the neuropsychologist for the Mayo Clinic Sports Neurology and Comprehensive Concussion Program in Arizona.

INTRODUCTION

National assessments of education statistics have revealed that only a third of fourth grade students in the U.S. are proficient at reading. This highlights the need to implement programs to strengthen reading fundamentals for our youth. Oculomotor training has been correlated with improved reading fluency performance.[1-3] Eye movements are necessary for the physical act of reading which is a complex process involving the frontal eye fields, the lateral intraparietal region, and the superior colliculus among many other areas of the brain that control eye movements and visual attention.[4-6] The ability to perform these complex tasks may not be developed to adult levels at the age when children begin early reading.[7-10] When younger children read text they tend to make more regressions and need to reread text multiple times.[10] This may

lead to a slower reading rate and poorer overall performance.[11,12]

Practicing eye movements can lead to more accurate and efficient eye movement abilities and may improve reading fluency.[1-3] King-Devick (K-D) Remediation software presents numerical stimuli at variable speeds from left to right. Participants quickly read the numbers from left to right and the speed is increased with improvement. Previous studies have proposed that the K-D Remediation software may be helpful in improving reading fluency in early elementary aged students.[2,3] The purpose of this retrospective analysis was to further investigate the effect of a K-D Remediation software training regimen on reading fluency outcomes when added to a school curriculum for elementary students in grade 1 through 4.

METHODS

Reading assessments for all elementary students (n=9) in grades 1 through 4 from a small private school who had undergone in-school training on the K-D Remediation software were retrospectively analyzed.

Reading assessment:

The school's reading fluency assessment utilized the objective Scholastic Fluency Formula Assessment (Scholastic Press, New York, NY). The Scholastic Fluency Formula Assessment is an individually administered Oral Fluency Assessment measured in words read correctly per minute (WCPM). Participants read three grade-level passages aloud for one timed minute each. The total number of words read and the number of errors are recorded. The score is based on an objective average words read correctly per minute (WCPM) measurement. Baseline reading assessments using Benchmark Passages were completed one week before initiating the in-school training. Reading assessments using Progress Monitoring passages were completed one week after the in-school training. All reading assessments were administered by the school's teaching aides who were trained to administer the Scholastic Oral Fluency Assessment.

K-D Remediation:

The K-D Remediation software (King-Devick Test, Oakbrook Terrace, IL) presents numerical stimuli at variable speeds in a left to right, line by line manner. While binocularly viewing the numerical stimuli at a normal computer working distance, the student's task is to read aloud the 16 point font, approximately equivalent to 20/100 letter size, numbers from left to right as the numerical targets are presented. This task requires the eyes to accurately and efficiently move from target to target and simulates the eye movements required during reading. An initial Quick Assessment within the K-D Remediation software times the student as they read the 40 number set on the Demonstration Card. The K-D Remediation software calculates an estimated recommended starting speed in numbers per minute based on this initial performance. As students improve in efficiency of the task, the speed of the number target presentation increases by 5 numbers per minute. Previous work has demonstrated improvements in reading fluency following a 6-week training program.[3] K-D Remediation is available on a computer and iPad. The computer based K-D Remediation was utilized in these cases. The illumination of the computer screen was kept consistent across training sessions. Students in Grades 1 and 2 completed 20 minutes of training, 3 days a week for 4 weeks, and then due to school time constraints, completed 10 minutes of training 3 days a week for 2 weeks. Students in Grade 3 and 4 completed 20 minutes of training 3 days a week for 6 weeks. The K-D Remediation was administered by the school's teachering aides in the school computer lab which was fully illuminated with overhead lights during the training sessions.

Statistical Analysis:

Statistical analyses were performed using STATA 12.0 software (StataCorp, College Station,

TX). Non-parametric statistical tests were used given the small sample size (n=9). Differences in reading fluency WCPM from pre- and post-training were calculated and compared using the Wilcoxon signed-rank sum test. Descriptive statistics of median and range were used to summarize the continuous measures.

Table 1: Student Characteristics

|	
Age, *mean yrs* ±SD	8.4 ± 1.2
Race, *Caucasian*, %	100
Male, %	67
Grade 1, *n*	3
Grade 2, *n*	3
Grade 3, *n*	1
Grade 4, *n*	2

RESULTS

Characteristics of the students are shown in Table 1. Pre- and post-training reading fluency scores for individual students are shown in Table 2. All students demonstrated improvement in Scholastic reading fluency scores following KD

Table 2: Reading Fluency Scores

| Student	Grade	Words Correct Per Minute (WCPM)		Change in WCPM
		Pre	Post	
1	1	22	29	+7
2	1	29	41	+12
3	1	91	109	+18
4	2	29	53	+24
5	2	48	109	+61
6	2	201	221	+20
7	3	144	186	+42
8	4	124	154	+30
9	4	204	216	+12

Remediation and this was statistically significant (p=0.008, Wilcoxon signed-rank test). There was an average increase of 20 WCPM (Range: 7 to 61 WCPM) among all students (Figure 1). Reading fluency scores by grades are shown in Table 3. The greatest average increase in reading fluency scores was seen in second and third grade with 61 WCPM and 42 WCPM improvements respectively (Figure 2).
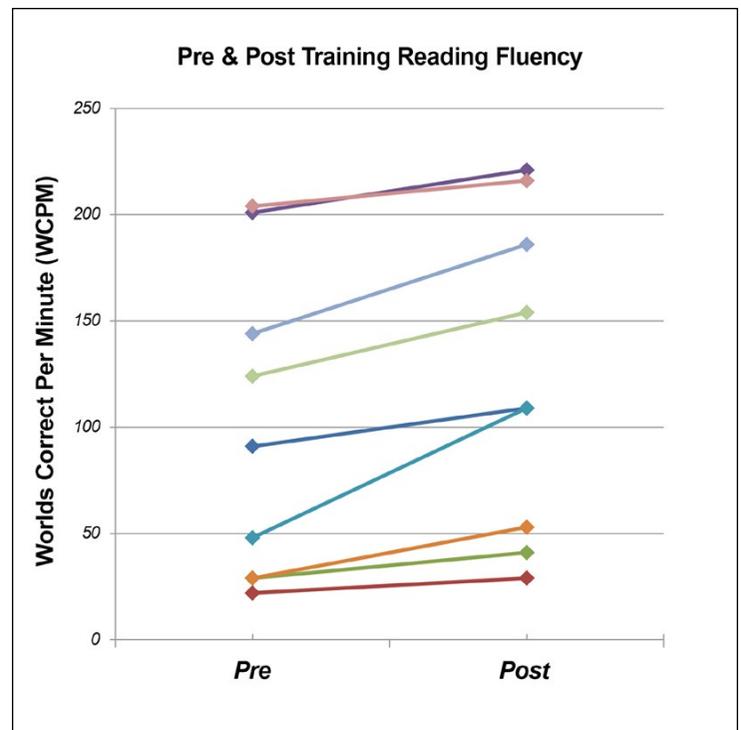
Figure 1: Pre & Post-training Reading Fluency by Student

Table 3: Average Reading Fluency Scores by Grade

Grade	Pre Median (range)	Post Median (range)	Change
1 (n=3)	29 *(22-91)*	41 *(29-109)*	12
2 (n=3)	48 *(29-201)*	109 *(53-221)*	61
3 (n=1)	144 *(144)*	186 *(186)*	42
4 (n=2)	164 *(124-204)*	185 *(154-216)*	21
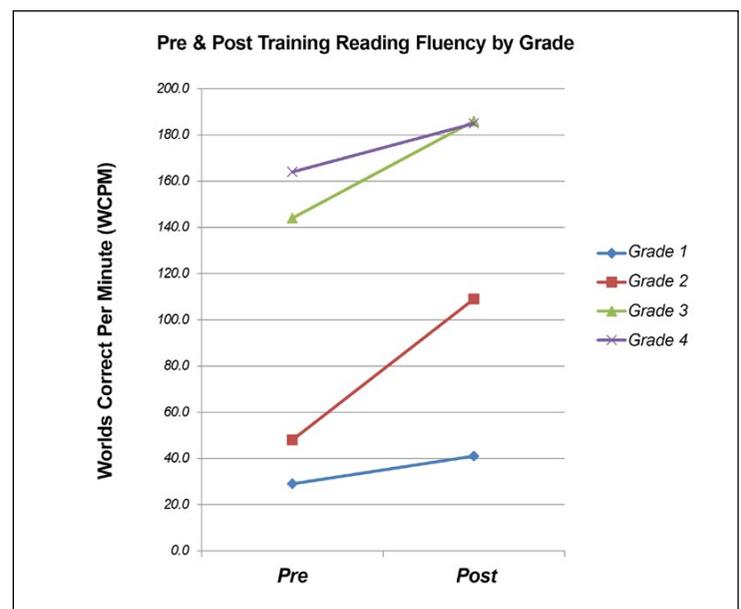
Figure 2: Pre & Post-training Reading Fluency by Grade

DISCUSSION

In this pilot study, oculomotor training using K-D Remediation resulted in significant reading fluency improvement in all students. According to normative reading fluency data, average normal weekly improvements in reading fluency in the absence of intervention can range from 0.4 to 2.2 WCPM depending on grade and initial reading fluency performance[13] which across six weeks should result in an expected improvement of 2.4 to 13.2 WCPM. Students in this investigation had greater improvements (25.1 WCPM) than this expected normal. We hypothesize that, similar to previous study,[3] this improvement in reading fluency is a result of rigorous practice of eye movements, saccades and shifting visuospatial attention all of which are necessary to efficient and accurate reading.

Previous study has proposed a possible critical learning period for brain development finding greater improvement in reading fluency at younger ages, for example grade 2 and 3 compared to grade 4.[2] This was not observed in the current study, although the greatest improvement was similarly seen in students in grade 2.

Limitations of this study include the limited number of subjects due to the small school size, limited race demographics and the wide range of initial reading fluency ability as pre-training WCPM ranged from 22 to 204. Also there was a wide representation of academic levels from Grade 1 to 4 however even in the sub-analysis of each grade there was widespread starting reading fluency levels. For example Grade 2 students' pre-training reading fluency measures ranged from 29WCPM to 209 WCPM. When translated to percentile rank standings, levels ranged from below 10th percentile for the grade to above 90th percentile rank. Additionally, students across Grade 1 to 4 did not receive the same amount of training (i.e. Grade 1 and 2 students were reduced to 10 minutes per day for the last 3 weeks as compared to 20 minutes completed for all 6 weeks by students in Grade 3 and 4) which makes comparison between grades difficult. Furthermore, reading assessments specifically measured oral reading fluency and therefore may not be able to be extrapolated to silent reading fluency. Additionally, formal visual assessments were not completed as part of this study as this reading program was implemented into the in-school reading program and all students underwent training. Lastly, no control students were available to be included in this analysis limiting the inference of the results. It is recommended that future study include an assessment of silent reading to determine what affect eye movement training may have on silent reading fluency. Furthermore, inclusion of an initial visual screening will be helpful to determine the visual status of participants and how that may play a role in eye movement deficits and subsequent changes following training. It should be noted that despite high performing students included in this study, all students showed improvement in reading fluency scores. Previous studies have reported a correlation between students with lower reading fluency and higher overall improvements following KD Remediation training, however this was not observed in this study. This is likely due to the low number of students included in this study for which a significant correlation is difficult to determine.

Although there are many aspects involved in overall reading success, the results of this pilot study further support that the K-D Remediation software may be effective in significantly improving reading fluency in a 6-week training program in children of grade 1 to 4. Future study should investigate the K-D Remediation methodology in a larger clinical trial.

REFERENCES

1. Rounds BB, M.C., Norris RH. The effect of oculomotor training on reading efficiency. J Am Optom Assoc, 1991. 62: p. 92-99.
2. Allen M, BR, Blanco S, et al. The King-Devick test as a reading fluency training program for students in elementary schools. 2012: Poster presented at: Meeting of the American Optometric Association—Optometry; June 28-29, 2012; Chicago, IL.

3. Leong DF, Master C, Messner LV, Pang Y, Smith C, Starling AJ. The Effect of Saccadic Training on Early Reading Fluency. Clinical Pediatrics, 2014. 53(9): p. 858-864.

4. Rayner K. Eye movements in reading and information processing: 20 years of research. Psychol Bull, 1998. 124: p. 372-422.

5. Puig SM, ZP, Aznar-Casanova JA, Supèr H. A role of eye vergence in covert attention. PLoS One, 2013. 8(e52955).

6. Doré-Mazars K, P.P. Beauvillain C, Attentional selection during preparation of eye movements. Psychol Res, 2004. 69(67-76).

7. Luna B, V.K., Geier CF, Development of eye movement control. Brain Cogn, 2008. 68: p. 298-308.

8. Fioravanti F, I.P. Pensiero S, Spanio M, Saccadic eye movement conjugation in children. Vision Res, 1995. 35: p. 3217-3228.

9. Seassau M, B.M. Reading and visual search: a developmental study in normal children. PLoS One, 2013. 8: p. e70261.

10. Rayner K. The role of eye movements in learning to read and reading disability. RASE, 1985. 6: p. 53-60.

11. Development, N.I.o.C.H.a.H., Reports of the National Reading Panel. Teaching Children to Read: An Evidence-Based Assessment of the Scientific Research Literature on Reading and Its Implications for Reading Instruction (NIH Publication No. 00-4769), 2000. Washington, DC: National Institutes of Health.

12. Goldstand S, K.K., Parush S. Vision, visual-information processing, and academic performance among seventh-grade school children: a more significant relationship than we thought? Am J Occup Ther, 2005. 59: p. 377-389.

13. Hasbrouck J, T.G. Oral reading fluency norms: A valuable assessment tool for reading teachers. The Reading Teacher, 2006. 59(7): p. 636-644.

Acknowledgements

Concluding Statement

COVD PSAs Available in High Definition

It is our goal to reach the individuals who are struggling needlessly with undiagnosed and untreated vision disorders that interfere with reading, learning, and other activities of daily living. Our HD PSAs cover a broad range of topics and are available in 30-second and 60-second prerecorded spots with captions available.

Please join our campaign by donating to COVD and airing these PSAs on your radio station or sharing them through social media.

- *With a donation of $150.00 you can receive all 6 of our 30-second HD PSAs.*

- *With a donation of $350.00 you can receive all 7 of our 60-second HD PSAs.*

- *With a donation of $400.00 you can request ALL of our PSAs PLUS a DVD that plays the PSA videos on a loop to be used in waiting rooms and offices.*