King-Devick Reading Acceleration Program

The Effect of the King-Devick Reading Acceleration Program on Reading Fluency and Comprehension: A Summary of Randomized Clinical Trials

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Background: Reading performance is essential to a child's academic success. Reading is a complex task involving the integration of language, attention, information processing including eye movements. Efficient eye movements provide a physical foundation for proficient reading and these skills can be improved as multiple studies have reported successful outcomes following training. Data from these studies are summarized and presented to examine the effect of the training program across a wide demographic and large student population. Subgroup analyses further lend insight to ideal timing and length of training. **Methods**: Data from five investigations of in-school training programs were combined and analyzed. Study participants were randomized into treatment or control groups. Students 1st through 4th grade (n=611, 7.0 ± 0.8 years) underwent eighteen, 20-minute sessions utilizing King-Devick (K-D) Reading Acceleration Program (RAP). Reading fluency and comprehension was assessed pre- and post-treatment. **Results**: The treatment group had significantly greater improvement compared to the control group in fluency (8.9% vs. 5.9%, p<0.001) and comprehension (9.1% vs. 3.1%, p<0.001). A separate group of high-needs students (n=111) also improved significantly in fluency (p<0.001) and comprehension (p<0.001). An extra-training group, who received an average of 11 additional treatment sessions, improved significantly in fluency and comprehension following extra-training (p=0.003, p=0.013). There was a greater improvement in reading comprehension for students receiving intervention in the fall as compared to the spring (10.9% vs 8.1%, p<0.001). **Conclusions**: Improving reading skills in youth is essential to building foundations for future academic success. Efficient eye movements are one necessary component of proficient reading that integrate with visual processing, word decoding and attention span. K-D RAP improves aspects of reading that are not currently addressed in schools. Based on the positive reading outcomes there is increasing evidence supporting the inclusion of teaching the physical act of reading in the early education curriculum nation-wide.

Summary Points:
- ✓ The treatment group had significantly greater improvement compared to the control group in fluency (8.9% vs. 5.9%, p<0.001) and comprehension (9.1% vs. 3.1%, p<0.001).
- ✓ A separate group of high-needs students (n=111) also improved significantly in fluency (p<0.001) and comprehension (p<0.001).
- ✓ An extra-training group, who received an average of 11 additional treatment sessions, improved significantly in fluency and comprehension following extra-training (p=0.003, p=0.013).
- ✓ There was a greater improvement in reading comprehension for students receiving intervention in the fall as compared to the spring (10.9% vs 8.1%, p<0.001).
- ✓ During the training, out of 611 there were only 15 students (2.4% of the entire cohort) following treatment who did not improve in reading fluency and 60 students (9.8% of the entire cohort) who did not improve in reading comprehension.

The Effect of In-School Saccadic Training on Reading Fluency and Comprehension in First and Second Grade Students: A Randomized Controlled Trial

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Efficient eye movements provide a physical foundation for proficient reading skills. We investigated the effect of in-school saccadic training on reading performance. In this cross-over design, study participants (n=327, 165 males; mean age (SD): 7yrs-6mos (1yr-1mo)) were randomized into treatment and control groups then underwent eighteen, 20-minute training sessions over five weeks utilizing King-Devick Reading Acceleration Program Software. Pre- and post-treatment reading assessments included: fluency, comprehension, and rapid number naming performance. The treatment group had significantly greater improvement compared to the control group in fluency (6.2% vs. 3.6%, p=0.0277) and comprehension (7.5% vs. 1.5%, p=0.0002). The high-needs student group significantly improved in fluency (p<0.001) and comprehension (p<0.001). We hypothesize these improvements to be attributed to the repetitive practice of reading-related eye movements, shifting visuospatial attention, and visual processing. Consideration should be given to teaching the physical act of reading within the early education curriculum.

Summary Points:

✓ Students in 1st and 2nd grade were enrolled in 6 weeks of King-Devick Reading Acceleration training.

✓ The treatment group had significantly greater improvement compared to the control group in fluency and comprehension.

✓ A subgroup analysis was performed on high needs students, who were students with an active IEP or in reading recovery programs. Overall, high needs students went from 26th to 40th national percentile rank in reading fluency and from 40th to 56th in comprehension after RAP.

✓ The King-Devick Test, an eye movement test used for reading screening, may be used to predict below-average reading performance.

The Effect of Saccadic Training on Early Reading Fluency

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Background: Eye movements are necessary for the physical act of reading and have been shown to relate to underlying cognitive and visuoattentional processes during reading. The purpose of this study was to determine the effect of saccadic training using the King-Devick remediation software on reading fluency. **Methods:** In this prospective, single-blinded, randomized, crossover trial, a cohort of elementary students received standardized reading fluency testing pre- and posttreatment. Treatment consisted of in-school training 20 minutes per day, 3 days per week for 6 weeks. **Results:** The treatment group had significantly higher reading fluency scores after treatment (P < .001), and posttreatment scores were significantly higher than the control group (P < .005). **Conclusions:** Saccadic training can significantly improve reading fluency. We hypothesize that this improvement in reading fluency is a result of rigorous practice of eye movements and shifting visuospatial attention, which are vital to the act of reading.

Summary Points:

✓ Students in grades 1st through 3rd enrolled in a 6-week long Reading Remediation program to train reading-related eye movements.

✓ King-Devick Reading Remediation significantly improved reading fluency.

✓ At the 1-year follow-up reading fluency scores remained significantly higher than before K-D Remediation.

✓ K-D Remediation shows promising results in improving early reading fluency.

Oculomotor Training using King-Devick Remediation Elementary School Reading Fluency Outcomes

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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.

Summary Points:
- ✓ Students, grade 1st through 4th participated in 6 weeks of King-Devick Reading Remediation, and underwent pre- and post- standardized reading fluency testing in this pilot study.
- ✓ All students improved in reading fluency during the course of the training
- ✓ The improvement in reading fluency may be attributed to the rigorous practice of eye movements (saccades) and shifts in visuospatial attention, which are necessary for proficient reading.

King-Devick Computerized Neurocognitive Test Scores in Professional Football Players with Learning and Attentional Disabilities

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Objective: This study examined outcomes from the King Devick (K-D) in athletes with Learning Disabilities (LD) and attention disorders (ADHD). **Methods**: A total of 574 professional football players from the Canadian Football League (CFL) completed baseline evaluations with computerized neurocognitive testing (CNT) prior to the 2016 competitive season. Player age, education, history of concussion, LD, and ADHD were analyzed for K-D and Immediate Post Concussion Assessment and Cognitive Testing (ImPACT) performance. A series of analyses of co-variance (ANCOVA's) were used to compare participants with a history of LD and ADHD with history of concussion as a co-variate. **Results**: Approximately 5% of participants reported a diagnosed history of LD and 13% with ADHD. Performance on the K-D test was not significantly correlated with age, education, or history of concussion but was significantly correlated with history of LD and ADHD. Participants with LD performed approximately 6.9 seconds slower on the K-D test (t[563] = 4.70, p. = 0.0003) and participants with ADHD were approximately 2 seconds slower (t[572] = 2.04, p. = 0.04). **Conclusions**: Results indicated that players with a history of diagnosed LD and ADHD performed slower on the K-D test in comparison to athletes with no history of diagnoses. The results of this study underscore the importance of recognizing individualized outcomes when using the K-D.

Summary Points:
- ✓ Performance on the K-D test was significantly correlated with history of LD and ADHD.
- ✓ Participants with a history of LD performed approximately 6.9 seconds slower on the K-D test, a result consistent with findings of slower K-D scores in LD samples.
- ✓ Players with a history of ADHD presented with statistically significant slower performance (1.9 seconds slower) when compared to the non-ADHD group.
- ✓ There was no significant effect for history of concussion on K-D baseline score.

✓ The K-D Test was significantly correlated with Visual Motor Processing, Visual Memory, and Reaction Time.

The Effect of the King-Devick Reading Acceleration Program on Reading Fluency and Comprehension in Grade School Students: A Randomized Controlled Trial

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Objective. The King-Devick Reading Acceleration Program (RAP) is an eye movement training program aimed at improving reading performance for grade school students. King-Devick RAP was implemented in the fall season in the first grade curriculum in order to evaluate its effectiveness on reading performance.

Methods. In this randomized, controlled, cross-over design, study participants (n=134, 76 males) were allocated into treatment and control groups in a two-to-one ratio and underwent eighteen, 20-minute training sessions over six weeks utilizing King-Devick Reading Acceleration Program Software. The treatment group read aloud single, randomized numerical targets zero through nine that were presented in a left to right direction. The control group read aloud single, randomized numeric targets, positioned in the center of the screen which did not change position. The speed of presentation was gradually increased over time as the subject progressed through training. Pre- and post-treatment reading assessments were performed, including the Wechsler Individual Achievement Test Third Edition (WIAT) Reading Fluency and Comprehension Tests and the King-Devick Test.

Results. The treatment group improved significantly compared with the control group in reading fluency (14% vs 11%, p=0.015) and reading comprehension (12% vs 5%, p<0.001). The high needs student subgroup was analyzed as a separate group and consisted of students with an Individualized Educational Plan, enrolled in reading assistance programs, or were English-Language Learners. The high-needs student group (n=25) significantly improved in pre- to post-treatment assessments in both reading fluency (14%, p<0.001) and comprehension (10%, p<0.001).

Conclusion. The K-D RAP program significantly improved reading fluency and comprehension over the course of six weeks of in-school training. This study further supports teaching the physical act of reading in the early education curriculum.

Summary Points:
✓ The King-Devick Reading Acceleration Program significantly improved reading fluency and comprehension over the course of 6 weeks (6 hours) of in-school training, which was flexibly incorporated into the daily classroom schedule.
✓ Efficient eye movements are one necessary component of proficient reading that integrate with visual processing, word decoding, and attention span; cognitive processing also contributes to successful reading.
✓ King-Devick Reading Acceleration Program improves aspects of reading that are not currently addressed in schools.
✓ Based on the positive reading outcomes found in this study and prior studies, there is increasing evidence to support the inclusion of teaching the physical act of reading in the early education curriculum.

The King-Devick Test as a Reading Fluency Training Program For Students in Elementary Schools

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The King-Devick Test is an established eye movement test that has been used historically to detect reading disorders related to poor visual-motor skills. Seventeen students in grades 2-4 from the St. Elizabeth School in Chicago Illinois, a predominantly African American K-8 school, were screened for reading inefficiency using the King-Devick Test (K-D Test) and assessed in reading fluency using the Scholastic Fluency Test pre- and post-treatment. The control group had a mean-word improvement of

13.11 words as compared to a 30.02 mean word improvement in the treatment group (p = 0.0413). Sub- group analysis of grades 2 and 3 showed a mean word improvement of 31.94 among the treatment group as compared to 13.11 for the

placebo group (p = 0.0267). Reading fluency measures significantly improved following eye movement training.

<u>Summary Points:</u>
- ✓ Reading fluency significantly improved following 6 weeks of Rapid Number Naming training in 2nd and 3rd grade students.
- ✓ 4th grade student's reading performance improved slightly, but not as much as 2nd and 3rd grade indicating there is likely an optimal time to implement eye movement training.
- ✓ Eye movement training programs should be considered as a part of the reading curriculum in schools.

Poster Presentation at American Academy of Neurology 2015 Annual Meeting
Visual Performance Testing in Children with Attention Deficit Hyperactivity Disorder
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BACKGROUND: ADHD is the most prevalent pediatric neurodevelopment disorder. In the United States, it is estimated that 5.4 million children 6 and 17 years of age (or 9.5% of U.S. children) have received an ADHD diagnosis. The King-Devick (K-D) test is a vision-based test of rapid number naming that requires saccades and visual processing. In sideline studies of youth and collegiate athletes with concussion, the K-D test consistently demonstrates higher (worse) time scores post-injury compared to pre-season baseline scores. There is growing evidence that, like concussion and mild traumatic brain injury, ADHD may be associated with visual pathway dysfunction. **PURPOSE:** Using the King-Devick (K-D) test, a vision-based test of rapid number naming that requires saccades and visual processing. We investigated whether children with ADHD has worse scores compared to similar aged controls. **METHODS:** Design: Prospective study of children with ADHD (diagnosed by Conners Scale and NYU pediatric neurologist) and age-matched controls. Participants: Patients diagnosed with ADHD (5-21 years of age) seeking care from the NYU Neurology Faculty Group Practice and Child Study Center. Analyses compared K-D scores of patients with ADHD to those of pre-season baseline scores for student-athletes controls category matched for age and gender. King-Devick Test: a vision-based measure of rapid number naming that varies the spacing between numbers on successive cards. **RESULTS:** Among 134 participants in this study, ADHD vs. control status was significantly associated with higher K-D test time scores (p<0.001, logistic regression models, accounting for age). K-D showed a greater capacity to distinguish ADHD vs. control groups in youths older than 11 years of age (ROC curve areas from logistic regression models was, 0.55 for youths ≤11 years of age and 0.79 for youths ≥11 years of age). Patients with ADHD took an average of 14 seconds longer to complete the K-D test, compared to control youth (p<0.001, two-sample t-test). Use of stimulant medications was not associated with differences in K-D time scores within the cohort of patients with ADHD (p > 0.05, best KD trial of ADHD on Rx vs. best KD trial of ADHD off Rx). **CONCLUSIONS:** Visual pathways may perform or be utilized differently in youths with ADHD compared to controls. This alteration in visual performance on the K-D test in youths with ADHD is likely due to the widespread distribution of brain pathways devoted to vision (approximately 50% of the brain's circuits). The limited capacity of the K-D to distinguish ADHD in youths younger than 11 years of age may be due to variations in reading ability in this age group. Use of stimulant medication was not associated with altered K-D test performance.

Summary Points:
- ✓ Investigated if there was a difference in the King-Devick Test of rapid number naming in subjects (ages 5-21) with ADHD verses those without.
- ✓ Subjects with ADHD showed significantly worse K-D scores compared to the controls.
- ✓ The K-D Test demonstrated a greater capacity to distinguish ADHD vs. control groups in youths older than 11 years of age (ROC curve areas from logistic regression models was, 0.55 for youths ≤11 years of age and 0.79 for youths ≥11 years of age).
- ✓ Patients with ADHD took an average of 14 seconds longer to complete the K-D test, compared to control youth (p<0.001, two-sample t-test).
- ✓ ADHD medication was not associated with differences in K-D scores within the cohort.
- ✓ Since ADHD is a neuro-development disorder and more than 50% of the brain is devoted to vision, the K-D Test highlights aspects of vision which may be affected by ADHD.

Pre-season concussion testing in high school students with academic difficulties or attention deficit hyperactivity disorder

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Objective Learning disabilities and/or ADHD are considered to be important risk factors or modifiers for concussion assessment and management. The purpose of this study was to examine cognition and symptom reporting in high school students with academic difficulties or ADHD and compare to those without at baseline. **Design** Retrospective analysis of three measures routinely given as part of a high school yearly concussion baseline protocol. **Setting** The library of a high school in Westchester County, NY. **Participants** A sample of 143 high school students who participate in collision/contact sports [Age M (SD)=15.4 (1.2); Boys=78, 54.5%] completed baseline testing. **Main results** Non-parametric tests were used because of violations of normality. High school students with academic difficulties or ADHD (n=21) were compared to controls (n=122) on King- Devick, SAC, ImPACT Cognitive Composite scores, and Total Symptom ratings. Students with LD or ADHD performed significantly more poorly on King-Devick (p=0.003; d=0.79), Visual Motor Speed Composite of ImPACT (p=0.007; d=0.79), and reported more symptoms at baseline on the Post-Concussion Scale (p=0.005; d=0.59). No significant differences found between groups on SAC (p=0.11; d=0.36) or ImPACT Verbal Memory (p=0.54; d=0.16), Visual Memory (p=0.20; d=0.26), or Reaction Time (p=0.14; d=0.55) Composites. **Conclusions** To our knowledge this is the first study to examine performance on three different baseline measures. High school students with academic difficulties or ADHD performed more poorly on King-Devick, the Visual Motor Speed Composite of ImPACT, and reported more symptoms at baseline. Findings suggest these students need to be monitored for specific post injury changes. This study was approved by the Committee for Human Rights Research, Burke Rehabilitation Hospital, White Plains, NY, USA. Protocol # BRC-455.

Summary Points:

- ✓ High school athletes with learning disability and/or ADHD performed more poorly on the K-D Test at baseline compared to controls. This highlights the importance of establishing an individual pre-injury baseline for comparison during concussion screening and recovery monitoring.

Visual Performance Testing in Children and Adolescents with ADHD

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Purpose: In the United States, ADHD is estimated to affect 5.4 million children between 6-17 years old. It is the most prevalent pediatric neurodevelopmental disorder. The King-Devick (K-D) test is a vision-based assessment of rapid number naming that requires saccades and visual processing. In sideline testing of young athletes with concussions, the K-D test demonstrated higher score times after a concussive injury as compared to the baseline pre-season scores. ADHD, like concussion and mild TBI, has been linked with visual pathway dysfunction. Our investigation looked at whether children with ADHD scored worse or similar to age-matched controls. **Methods and Study Design**: Our prospective study looked at children with ADHD and their age-matched controls in patients diagnosed with ADHD between ages 5-21. Analysis compared K-D scores of patients with ADHD to those scores of student-athlete controls matched for age and gender. Data analysis was done with logistic regression, ROC curves and t-test. **Results**: Among 134 participants in this study, ADHD vs. control was significantly associated with higher K-D scores (p<0.001). K-D showed a greater capacity to distinguish ADHD in participants older than 11 years of age when compared to controls. Participants with a diagnosis of ADHD required an average of 14 seconds longer to complete the K-D test compared to controls. Stimulant medication use was not associated with differences in K-D scores within the ADHD group. **Conclusions**: This study illustrates that visual pathways might be utilized differently in children and young adults with ADHD compared to controls. **Significance of Findings:** Given the difference in baseline K-D scores of patients with ADHD, this study can have implications for assessing concussions. Different baseline norms may be needed in the management of concussions in athletes

with ADHD.

Summary Points:
- ✓ Visual pathways might be utilized differently in children and young adults with ADHD compared to controls.
- ✓ Norms should not be used for sideline concussion screening as variables such as age and ADHD diagnosis can affect performance. Comparison against individual baseline should be used and is supported by the literature.
- ✓ Caution should be used when considering used of baseline norms in the clinical management of concussion.

Presentation at College of Optometrists in Vision Development 2014 Annual Meeting

Oculomotor Training using KD Remediation Improves Reading Fluency

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The purpose of this study was to determine if adding oculomotor training, using King-Devick (K-D) Remediation software, to an existing high school reading program would improve reading fluency outcomes. In this prospective, single-blinded, cross-over trial, of high school students (n=53) in grades 9 and 10 enrolled in the school's 12-week supplemental reading course, all students received reading intervention using Scholastic's Reading 180 system (New York, NY). Students were randomized by classroom into 3 groups based on their initial training condition (+K-D Remediation, +Placebo & Scholastic Only) and pre- and post-remediation measures were performed using the K-D Test and Reading Curriculum-Based Measurement (RCBM) reading fluency test. There was a significantly greater percentage improvement in reading fluency scores (WCPM) with combined +K-D Remediation compared to reading intervention with Scholastic Only (7.54% vs. 3.59%, p = 0.03). Over the entire training period there was an average increase of 9.88 WCPM during sessions with +K-D Remediation, 4.7 WCPM with Scholastic Only and 2.78 WCPM during +Placebo. Expected improvement of a successful reading program is an increase of 5 WCPM. In this study, reading intervention coupled with oculomotor training using K-D Remediation, resulted in nearly double the expected reading fluency improvement.

Summary Points:
- ✓ This investigation examined the effect of adding K-D Remediation to the Scholastic Reading 180 reading course for students (Grade 9 and 10) receiving supplemental reading instruction.
- ✓ Significant improvements in reading occurred with the addition of K-D Remediation to students' existing reading intervention.
- ✓ The greatest improvement occurred in the placebo to K-D Remediation cross-over group.

Presented at the American Academy of Optometry 2016 Annual Meeting

Reading Fluency Measures with Single Word Presentation Verses Left-to-Right Reading in Third Grade Students

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Objective. Accurate and efficient eye movements are an important aspect to a child's reading performance. Poor readers demonstrate higher rates of eye movement disorders, which may negatively impact reading. Saccadic eye movements direct the eyes to the next word while reading. Single word presentation reading presents each word centered in the screen. The purpose of this study was to measure reading fluency for students using single word presentation reading and traditional left-to-right reading.

Methods. In this randomized study, participants (n=22) read 3rd Grade Scholastic Reading Fluency Passages using single word presentation and left-to-right reading. Left-to-right reading was measured by adding the total number of words read correctly in one minute (WCPM). Reading fluency was measured using single word presentation by adjusting the speed of presentation to the maximum speed the student stated words clearly without errors for one minute (WCPM). Students answered three reading comprehension questions following each reading passage.

Results. Students achieved significantly higher reading fluency scores when reading with single word presentation compared with left-to-right reading (mean (SD), 154 (47) WCPM vs 125 (46) WCPM, p<0.001, Wilcoxon signed-rank test). Reading comprehension scores were slightly higher when reading with single word presentation verses left-to-right reading (92% (18)

vs 88% (17)), however this was not statistically significant (p=0.335). On average, students read 28.8 more words per minute while reading with single word presentation compared with left-to-right reading.

Conclusion. This study found that single word presentation reading may be a more efficient method of reading and maintain or improve reading comprehension. Single word presentation technology should be considered as an addition to current reading methods.

<u>Summary Points:</u>
- ✓ Single word presentation reading may be a more efficient method of reading and maintain or improve reading comprehension