Can Vergence Training Improve Reading in Dyslexics?

av
Christina Davidson
Mari Ljungblad
Marguerite Tjärnberg

Handledare: Rune Brautaset
Examinator: Maria Nilsson

Magisterprogrammet i klinisk optometri 2012-2013

Abstract

Background: Dyslexia affects 5-8 % of the population. While reading, different eye movements are required. Compared to other persons, dyslexics have more and longer fixations, shorter saccade amplitude, a higher percentage of regression and more fixation disparity when they read. In non-reading situations, dyslexics do not have more binocular problems than others. The aim of the present study was to investigate whether computerized orthoptic vergence training could improve reading ability for dyslexic children.

Methods: The study was conducted at Ängkärrskolan, Solna; an elementary school exclusively for dyslexic children. Twelve subjects, 13-14 years old, were trained with RetCorr, a computerized vergence training program. Reading speed was assessed before and after treatment. The results were compared with an age-matched control group.

Results: The dyslexic subjects conducted orthoptic training three times a week during five weeks (mean 11.75 times ±2.53 SD). On average the number of words read per minute before training were 87.83 (± 16.80 SD) and after training 95.58 words (±18.08 SD). The difference was statistically significant [p=0.0066]. In the control group the change was from 85.00 (±19.68 SD) words to 89.37 words (±19.71 SD) over the same time period. This difference was not significant [p= 0.1235].

Discussion: Most scientists agree that dyslexia is mainly a phonological impairment. Nevertheless, the results show that vergence treatment might help dyslexics. Larger studies are required to provide guidance in this area.

1. Introduction

Although we do not spend as much time reading printed text as before, reading is just as important in everyday life today as in the past since most modern technologies, such as computers, smart-phones etc., require the user to have a high level of reading skills. A large proportion of the population however, has reading deficits, among which dyslexia is one of the more pronounced.

The word dyslexia comes from Greek and means “difficulties with words”. Dyslexia was defined by The World Federation of Neurology in 1968 as “a disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence and sociocultural opportunity”.

Dyslexia is classified as a language biological functional impairment, and it affects 5-8% of the population (Vetenskapsrådet, 2007). Previously it was believed that boys were much more affected than girls, but this has been questioned among scientists. Shaywitz et al. (1990) found that schools seem to identify boys more often.

There are different degrees to which dyslexia affects reading and spelling. Many dyslexics also often have learning difficulties when it comes to things such as multiplication and months of the year. Furthermore, motoric skill such as swimming or cycling is often also more difficult to learn**.** Learning how to read means that the child have to learn the ability to automatically translate single letters into the sound of the spoken language’s smallest unit; the phoneme; and to combine different phonemes to words. A dyslexic has difficulties perceiving that a word is built by different phonemes. It has been described that the main indicator of dyslexia is insufficiency of phonological awareness, which is the ability to recognize and identify syllables and phonemes in the spoken language (Vellutino et al., 2004). Other deficiencies are insufficient phonological working memory (Menghini et al., 2011) and insufficiency of phonological word mobilization, meaning that it takes long time for the reader to find the word in his/her vocabulary memory. The combination of disabilities involved in dyslexia, not only makes it difficult for dyslexics to read, but also to benefit from other school subjects than reading.

The inheritance of dyslexia has been described since the 1950’s. About 50% of dyslexic’s persons have a genetic inheritance (Vellutino et al., 2004). Families and twins have been studied, e.g. by Lyytinen et al. (2004) who made long term study in Finland. They found that 40% of children with dyslexia in the family have problems with phonological word mobilization. A stimulating home environment plays a major role for dyslexic children’s reading development.

During the last decades a lot of research has been conducted of the underlying biological and cognitive causes of dyslexia. According to Ramus et al. (2003) there are three leading theories regarding dyslexia. The dominating theory is the phonological theory that postulates that dyslexics have a specific impairment in the storage, representation and/or retrieval of speech sounds (Ramus et al., 2003). Supporters of the second theory, the cerebellum theory claim evidence to show that dyslexic's cerebellum is mildly dysfunctional and as the cerebellum plays a role in motor control and in automation of over-learned tasks, a number of cognitive difficulties ensue. Leonard and colleagues (2001) found, when studying brain imaging, anatomical, metabolic and activation differences in the cerebellum of dyslexics. Finally, the third theory, the magnocellular theory unifies the findings in the above mentioned theories. According to this theory, the magno pathway of the visual system is affected in dyslexia. The magnocellular system is involved in the saccadic eye movements that could cause instable fixation. Autopsies have shown that the magnocellular area at the lateral geniculate nucleus in dyslexics was smaller than that in non-dyslexics (Stein, 2001). Stein (2001) also suggests that dyslexics have smaller magnocellular receptive fields and that the functions of the magnocellular neurons are reduced. This theory has been frequently discussed, for example, Bucci et al. (2012) could not find evidence supporting that theory.

While reading, a variety of eye movements are required. Saccades, small jumping eye movements, move the eyes to the next fixation forward or backwards (regression). The angle of vergence of the two optic axels must be adjusted to fixate at the right distance and the right place (e.g., a book or a computer) and it must be maintained for a period of time. This is a prerequisite for the images to fall on corresponding retinal areas and for the creation of a single image. In other words, when reading you need to continuously monitor the vergence angle and adjust it for proper fusion to have binocular vision of a text. Without fine-tuned vergence adjustment the fusion process might fail and reading might be disturbed.

Dyslexics have more frequent and longer fixations, shorter saccades amplitude and a higher percentage of regression when reading (Bucci et al., 2007; De Luca et al., 2002) than non-dyslexics. The coordination of saccades is also poor in dyslexics. Dyslexics often make unequal saccades between the two eyes, and therefore have a bigger disconjugacy in the end of a saccade (Bucci et al., 2007). Other studies have found that dyslexics have the same saccade and vergence movement as non-dyslexics when looking at single LED-lights at different locations (Bucci et al., 2009). Kapoula et al. (2008) investigated eye movements while looking at single targets in different positions and compared them with the eye movements during free exploration of artwork. When looking at artwork the dyslexics had larger disconjugacy of saccades and increased disconjugate post-saccadic drift compared to non-dyslexics.

Studies testing vergence ability in dyslexics have shown various results. Kapoula et al. (2007) found that dyslexics have more limited divergence capacity at near distance as well as at far distance. They also found that dyslexics have a more remote near point of convergence. Wahlberg-Ramsay and colleagues (2012) evaluated binocular function, including vergence and near point of convergence, in dyslexic children, and compared their results with a group of age-matched non-dyslexic children. They did not find any differences in binocular functions between dyslexics and non-dyslexics. These results are in line with the results of Lennerstrand et al. (2004) who also did not find any difference in vergence capacity between dyslexics and non-dyslexics.

Several studies have found that dyslexics have more fixation disparity than non-dyslexics, especially when reading (Jainta et al., 2011; Kirby et al., 2011; De Luca et al., 2002). Kirby et al. (2011) compared the amount of fixation disparity between dyslexics and non-dyslexics during reading and dot-scanning. They could not find any differences between the two groups when dot-scanning, but when reading, dyslexics had significantly more fixation disparity. Kirby et al. (2011) suggested that it is not the poor binocular coordination, but the reading task itself, that induce impairment in the binocular saccade and fixation instability in dyslexics.

Bucci and colleagues (2012) had a hypothesis that saccade and vergence interaction in dyslexic children is immature in relation to the children's chronological age. They found that an eleven year old dyslexic child with reading ability of a nine year old, have similar eye movement patterns, regarding the length of saccades and the number of regressions as a nine year old with normal reading abilities (Bucci et al., 2012).

Bucci et al. (2012) suggest that "orthoptic vergence training, together with specific visual attentional training and reading tasks, could be useful tools in dyslexic children to improve visual attentional span, vergence capabilities as well as saccade yoking."

It is commonly accepted that orthoptic training plays an important role in the treatment of vergence deficits. There are some computerized orthoptic training programs designed for vergence training, i.e. convergence insufficiency (e.g. RetCorr, retcorr.se; CVS, computer Orthoptic Home Based Vergence Exercise Program; computerorthoptics.com). Orthoptic treatment has rarely been used for dyslexics previously. Green Jonsson & Ullmark (2012) studied a group of dyslexic children training with RetCorr computerized vergence treatment program. The present study is an enlarged version of the Green Jonsson & Ullmark study comprising more subjects and a control group.

The aim of present study was to investigate whether computerized vergence training could improve reading ability in dyslexic children, regardless of the reason for poor binocular coordination.

2. Material and methods

The study was performed at Ängkärrskolan in Solna, Stockholm. Ängkärrskolan is an elementary school dedicated exclusively for dyslexic children in grade 4 to 9. The study population consisted of 13 students and the control group included 12 students in grade 7, i.e., 13-14 years old. In the study group, one subject was excluded because of unwillingness to fulfill the training and in the control group three subjects were excluded because of unwillingness to do the follow-up reading test. Furthermore, one subject in the control group was excluded because of unreliable result (Table 1).

	Subjects	Controls	Total
Girls	5	3	8
Boys	7 (8)	5 (9)	12 (17)
Total	12 (13)	8 (12)	20 (25)

Table 1: Demographic data (original numbers in parentheses)

All subjects and controls in the study have a diagnosis of dyslexics based on individual examinations by speech therapists.

Before the study, all subjects had undergone a vision screening (Appendix A and B). No vision screening was done in the control group. The vision screening consisted of visual acuity, near point of convergence, phorias, amplitude of accommodation, fusional reserves, stereopsis and amplitude of prism-flipper (4Δ BI/12Δ BO). The subjects used habitual glasses if needed.

Visual acuity

Visual acuity (VA) for distance was measured with a vision chart at 4m. The VA with a +1.0 diopter was also tested. The near VA was measured at 35 cm with new EDTRS chart. Both monocular and binocular VA was recorded.

Convergence and accommodation

Near point of convergence (NPC) and amplitude of accommodation was measured with the RAF rule (Royal Air Force rule).

Ocular alignment and fusional reserves

Phoria was examined with cover test. The subject was told to look at a small object at 4m (distance) and 35 cm (near). Any eye movement was recorded as phoria or tropia and measured with a prism bar. Fusional reserves were measured with prism bars. The subject was instructed to look at a small object at the distance of 4m and at 35cm. Negative and positive vergence were measured and recorded.

Stereopsis

Stereopsis was tested with Lang stereo test 1 (Oculus Germany).

Prism flip

Amplitude of prism flip was measured at 35 cm with prism flip 4Δ BI/12Δ BO. The number of cycles in one minute was recorded.

Exclusion criteria

Exclusion criteria was lack of stereopsis and near VA <0.8.

Reading speed test

There are different ways of assessing reading speed. Commonly used tests are the H4 and the H5 tests developed in the 1950´s by professor Lindahl at the University of Gothenburg. The tests consist of columns of words that the student reads for one minute and the number of words that are correctly read is counted. These tests are considered equivalent and they are often used interchangeably to reduce the risk of learning effect. H4 and H5 are the tests used by Ängkärrskolan for monitor progress in reading. The subjects as well as the controls underwent the H5-test (Appendix C) by the same special educator before and after the treatment period.

The RetCorr Computer

RetCorr AB has designed a computer set-up that enables orthoptic treatment of ocular vergence eye movements. That computer set-up has been the object of earlier studies at Karolinska Institutet. Zetterström and collegues (2010) studied a group, suffering from convergence insufficiency training with RetCorr. As mentioned above a study like this was conducted in 2012 (Green Jonsson & Ullmark).

The computer consists of two parts: software that uses the principles of stereogram and hardware that consists of two screens and a semi-transparent mirror (Figure 1). Polarized light from each screen meet at the mirror and enable a computerized stereogram to appear. The screens are covered with polarized film, perpendicular to each other, and by using polarized glasses, fusion is possible and a three-dimensional image appears. By increasing the distance between the two images, the divergence is stimulated and by crossing the images, the convergence is trained. According to the ability of the student, the starting value for the oscillation was set and the degree of difficulty was increased twice during the training period.

Figure 1: Polarized light meet at the semi-transparent mirror in the middle, and by using polarized glasses, fusion is possible and a stereogram appears. (Picture from Zetterström et al., 2010)

The subjects were instructed to practice for 15 minutes, 3 times a week. The pedagogues at the school scheduled the practice which was done during regular school hours. The vergence training was to play games or watch a DVD-film. Doing pleasurable activities probably increases the compliance. As the computer logged all the training undertaken by the subjects, it was possible to follow their compliance.

All parents gave their consent to their child´s participation in the study. The study was performed according to the Declaration of Helsinki.

Statistics

Graphpad Instat was used for statistical analysis, two-tailed paired t-test and two-tailed unpaired t-test. Correlation was tested with linear regression. A p-value of 0.05 or less was regarded as significant.

3. Results

Reading speed test

The dyslexic subjects conducted orthoptic training between five and fourteen times (mean 11.75 ±2.53 SD) during a period of five weeks. The number of words read on the H5 test was compared before and after training. On average, the number of words per minute read before training were 87.83 (± 16.80 SD) and after training 95.58 (±18.08 SD). The difference was statistically significant, [p=0.0066: two-tailed paired t-test].

The control group underwent the H5 test during the same period of time as the dyslexic subjects, i.e., twice with dyslexic subjects treatment period in between. At the first occasion the number of words read per minute were on average 85.00 (±19.68 SD) and at the second occasion 89.37 (±19.71 SD). The difference was not significant, [p= 0.1235: two-tailed paired t-test].

The individual change in number of words read per minute can be seen in Figure 2 (dyslexic subjects) and in Figure 3 (control group).

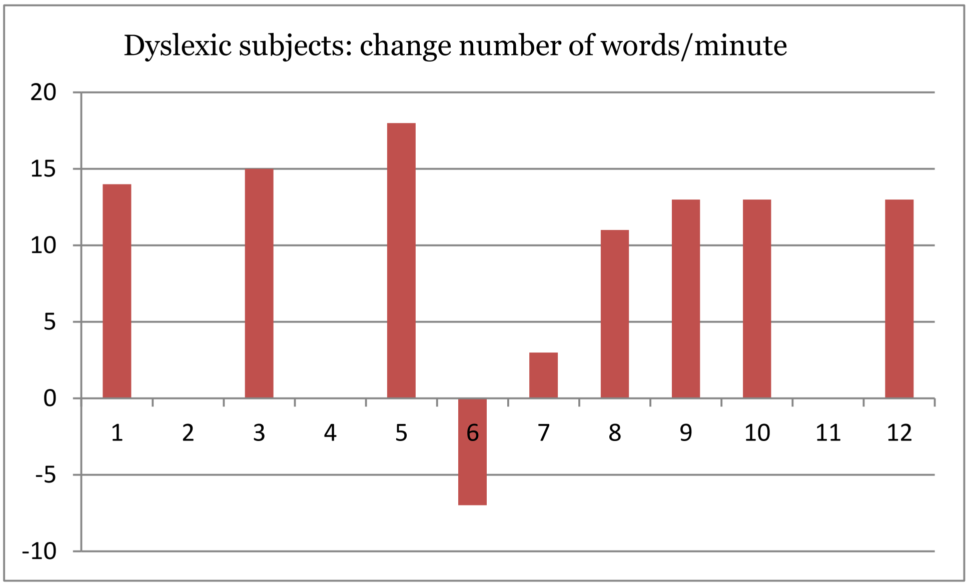

Figure 2: Dyslexic subjects: Change in number of words read per minute on the H5 test (y-axis) for each subject (x- axis) before and after vergence treatment.

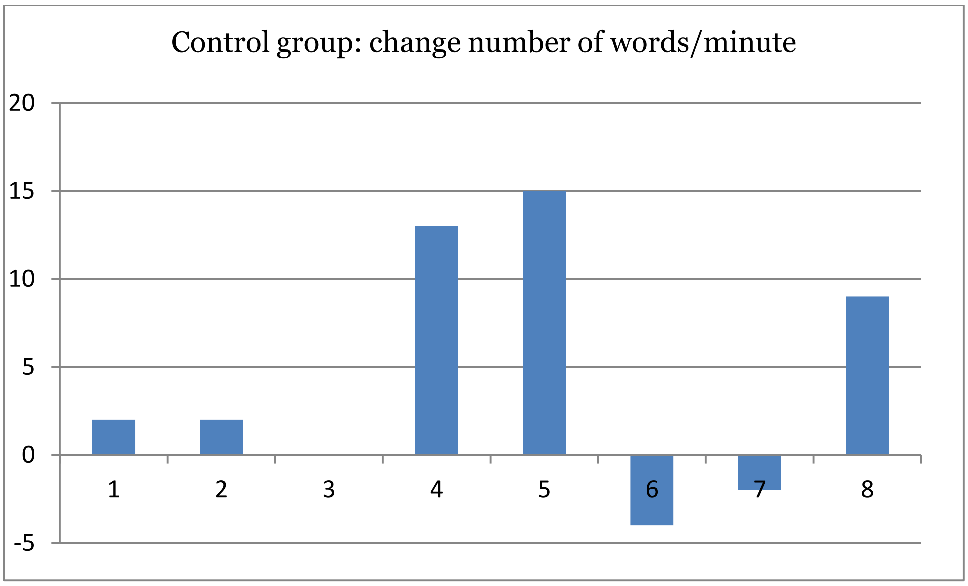

Figure 3: Control group: Change in number of words read per minute on the H5 test (y-axis) for each student (x-axis).

On average the dyslexic subjects increased their reading speed by 7.75 (± 8.04 SD) words per minute and the control group increased their reading speed by 4.38 (± 7.70 SD) words per minute. This difference was not significant, [p=0.3481: two-tailed unpaired t-test].

Among the dyslexic subjects 7 out of 12 students increased the number of words read per minute by more than 10, while in the control group only 2 out of 8 students increased by 10 words per minute or more.

No correlation could be found between the number of training sessions and the increase in number of read words per minute [r= -0.035, r2=0.0012, p= 0.915].

Prism flip

The change in prism flips was not quite significant, [p=0.0509, two-tailed paired t-test]. The mean value before training was 15.5 cycles per minute (± 3.37 SD) and after training 17.5 cycles per minute (± 3.73 SD).

Fusional reserves

The change in fusional reserves was not significant [two-tailed paired t-test]. The mean value for negative and positive vergence can be seen in Table 2.

	Mean value before training	Mean value after training	p-value
Negative vergence	11.67 Δ(± 4.07 SD)	13.0Δ (± 3.67 SD)	0.3541
Positive vergence	22.33Δ (± 8.26 SD)	29.92Δ (± 8.29 SD)	0.2060

Table 2: Mean fusional reserves before and after orthoptic training.

4. Discussion

The aim of this study was to determine whether orthoptic training could be beneficial for dyslexics. The results show a significant increase in the reading speed of the treatment group which strengthens the suggestion of Bucci et al. (2012) that orthoptic training could help dyslexics. There are, however, different opinions regarding whether dyslexics could benefit from orthoptic treatment or not. Handler et al. (2011) does not support vision therapy for dyslexics. Nevertheless, we could see an increase in the reading speed test result and seven out of twelve subjects increased their reading speed by more than ten words per minute. Normal value for the reading speed test used in this study was an increase by four words per semester. Maybe orthoptic treatment could complement the ordinary special reading education?

There is an important social aspect to reach a certain level of reading speed. For instance, a reading speed of at least 100 words per minute is required in order to follow the subtitles on Swedish television. It is satisfying to see that many in the treatment group have reached that level or are close to doing so.

Previous studies have shown that dyslexics do not have different binocular eye status compared to non-dyslexics (Wahlberg-Ramsay et al., 2012; Bucci et al., 2009), except in reading situations (Kirby et al., 2011; de Luca et al., 2002). In the current study all subjects had normal orthoptic status according to the vision screening. When designing the study, we discussed whether the control group should be vision screened, but no screening was undertaken, since an abnormal status was not expected.

A trend in increasing vergence could be seen. Eight out of twelve subjects increased their fusional reserves but these increases were not statistically significant. It is possible that the fusional reserves would have been higher if the treatment period had been longer. When treating convergences insufficiency with RetCorr, the recommended treatment period is about three months and in consideration of that fact, this treatment period of five weeks probably was too short.

We could not find any statistical significance between the number of training sessions and the improvement since most of the subjects trained for approximately the same number of occasions.

The measurements were performed with a prism bar, which is a method we were not quite familiar with. Furthermore, the prism bar has rather big steps in the higher prism values which might reduce the accuracy of the measured vergence value.

The subjects answered a questionnaire after the treatment period, and four out of twelve students responded that the reading ability had improved. Moreover, four out of twelve found that it felt better in the eyes while reading. Some comments were “it´s easier to concentrate on texts” and “I have a minor problem with jumping lines”. Even though one student decreased in the reading speed test, he experienced the reading to be easier after the treatment period according to the questionnaire.

As mentioned before, our institution conducted a similar study in 2012, by Green Jonsson & Ullmark. Only four subjects participated and the compliance was low. In their study two subjects increased their reading speed, one decreased and one remained at the same level. In the current study there were a larger number of subjects, a good compliance and an age-matched control group. As progress in reading was expected for all students, the control group studied at the same school with the same pedagogic education as the vergence training group. The control group did not demonstrate any significant change in the reading speed test.

According to the instructions of RetCorr, an individual calibration should be performed before each training session. The calibration did not work at the previous study (Green Jonsson & Ullmark, 2012), so we decided to make individual settings instead. It is recommended that in any future studies, calibration should be used.

Further studies could include larger number of subjects and a longer period of treatment. It would also be interesting to equip the subjects with a RetCorr computer in their home to facilitate the training. As all activity is logged, by the RetCorr computer program, it would still be possible to monitor the training. It could be interesting to add measurements of saccades, fixations and post-saccadic drift to investigate whether the binocular coordination also improves and correlates with the reading speed.

Despite an ongoing extensive research there is still a lot of investigation to be done. Most scientists agree that dyslexia is mainly a phonological impairment. Early recognition and individualized pedagogic support is important. Interaction between different professionals is essential for helping dyslexics in their daily life. If orthoptic training could be a benefit for dyslexics, optometrists could contribute to help.

Sammanfattning

Bakgrund: Man beräknar att 5-8 % av befolkningen har dyslexi. Vid läsning krävs en kombination av olika ögonrörelser. Specifikt vid läsning har dyslektiker längre fixationer, kortare saccader, fler regressioner och mer fixationsdisparitet. Vid icke lässituationer har dyslektiker inte mer binokulärproblem än icke dyslektiker. Studiens syfte var att undersöka om ortoptisk databaserad vergensträning kan underlätta dyslektikers läsförmåga.

Metod: Studien genomfördes på Ängkärrskolan i Solna, en grundskola för dyslektiska barn. 12 försökspersoner, 13-14 år tränade med RetCorr, ett datoriserat vergensträningsprogram. Läshastigheten mättes före och efter träningsperioden. En åldersmatchad kontrollgrupp utförde samma läshastighetstest vid samma tidpunkter.

Resultat: De dyslektiska försökspersonerna genomförde ortoptisk träning tre gånger i veckan under fem veckor (medelvärde 11.75, ±2.53 SD). Före träningsperioden var antal lästa ord per minut 87.83 ord (±16.80 SD) och efter träning 95.58 ord/minut (±18.08 SD). Den skillnaden var statistiskt signifikant. Kontrollgruppen ökade under samma period från 85.0 ord (±19.68 SD) till 89.37 ord/minut (±19.71 SD). Den skillnaden var inte signifikant.

Diskussion: De flesta forskare är överens om att dyslexi framförallt är en fonologisk svaghet. Dessa resultat visar att vergensträning förefaller kunna hjälpa dyslektiker. Större studier behövs för att ge vägledning i detta ämne.

Acknowledgements

Thanks to:

All students in 7B for patiently participated in our study.

Birgitta Wollert, our contact at Ängkärrskolan, for all the help, to answer all our questions and for conducting the H5-tests.

The staaf at Ängkärrskolan that made it possible to conduct the study.

RetCorr, Michael Malmqvist, for information about the RetCorr computer.

Rune Brautaset, for guidance and support.

Referenses

Bucci M.P, Brémond-Gignac D, Kapoula Z. (2007). Poor binocular coordination of saccades in dyslexic children. Graefes Arch Clin Exp Ophthalmol (2008) 246:417–428

Bucci M.P, Nassibi N, Gerard C-L, Bui-Quoc E. and Sassau M. (2012) Immaturity of the Oculomotor Saccade and Vergence Interaction in dyslexic Children: Evidence from a Reading and Visual Search Study. PLoS One: e33458 (volume 7 issue 3)

Bucci M.P, Vernet M, Gerard C-L, Kapoula Z. (2009) Normal speed and accuracy of saccade and vergence eye movements in dyslexic reader children. Journal of Ophtalmology, volume 2009, article ID 325214

Christiana M, Leonard, Mark A, Eckert Linda J, Lombardino, Thomas Oakland, John Kranzler, Cecile M. Mohr, Wayne M. King, and Alan Freeman (2001) Anatomical Risk Factors for Phonological Dyslexia, (2001) Cereb cortex 2001; 11: 148-157

De Luca M, Borelli M, Judica A, Spinelli D,& Zocolotti P. (2002) Reading words and pseudowords: An eye movement study of developmental dyslexia. Brain and Language 80, 617-626 (2002).

Green Jonsson K & Ullmark E (2012). Vergence eye movements and dyslexia. Magisterprogrammet i klinisk optometri 2012

Handler S.M, Fierson W.M, Learning disabilities, Dyslexia, and Vision. Pediatrics Vol. 127 No. 3 March 1, 2011 pp. e818 -e856

Jainta S, Kapoula Z, 2011, Dyslexic Children are confronted with unstable binocular fixation while reading. PLoS One: e18694 (vol 6, issue 4)

Kapoula Z, Bucci M.P, Jurion F, Ayoun J, Afkhami F, Bremond-Gignac D (2007) Evidence for frequent divergence impairment in French dyslexic children: deficit of convergence relaxation or of divergence per se? Graefe's Arch Clin Exp Ophthalmol (2007) 245:931–936

Kapoula Z, Ganem R, Poncet S, Gintautas D, Eggert T, Bremond-Gignac D, Bucci M (2008) Free exploration of painting uncovers particularly loose yoking of saccades in dyslexics. Dyslexia 15: 243 – 259 (2009)

Kirby J.A, Blythe H. I, Drieghe D, Liversedge S.P. (2011) Reading text increases binocular disparity in dyslexic children. PLoS one: e27105 (volume 6, issue 11)

Lennerstrand G, Ygge J, Jacobsson C, (1994), Control of Binocular Eye Movements in normal and Dyslexics. Annals of the New York Accademy of Sciences Vol. 682, issue 1, 2006

Lyytinen H, Aro M, Eklund K, Erskinel J,Guttorm T, Laakso M-L, Paavo H, Leppfinen T, Lyytinen P, Poikkeus A-M, Richardson U,Torppa M. (2004) The Development of Children at Familial Risk for Dyslexia: Birth to Early School Age. Annals of Dyslexia, Vol. 54, No. 2, 2004

Menghini D, Finzi A, Carlesimo GA, Vicari S (2011) Working memory impairment in children with developmental dyslexia: Is it just a phonological deficit? Developmental Neuropsychology 36:2, 199-213

Ramus F, Rosen S, Dakin S.C, Day B.L., Castellote J.M, White S. and Frith U (2003) Theories of developmental dyslexia: insights from a multiple case study of dyslexic adults. Brain (2003) 126, 841-865

Shaywitz SE, Shaywitz BA, fletcher JM, Escobar MD. Prevalence of reading disability in boys and girls: results of the Connecticut Longitudinal Study. JAMA. 1990; 264(8):998 – 1002

Stein J, (2001). The magnocellular theory of developmental dyslexia. Dyslexia 7:12-36 (2011)

The World Federation of Neurology (2002)

Vellutino F.R, Fletcher J.M, Snowling M.J & Scanlon D.M (2004) Specific reading disability (dyslexia): what have we learned in the past four decades? Journal of child psychology and psychiatry 45:1 (2004) pp 2-40

Vetenskapsrådet(2007). Dyslexi- en kunskapsöversikt

Wahlberg-Ramsay M, Nordström M, Salkic J, Brautaset R, Evaluation of Aspects of Binocular vision in children with dyslexia (2012). Strabismus Dec;20(4):139-44

Zetterström S, Wahlberg M, Abdi S, Brautaset R (2010) RetCorr, datoriserad synterapi. Optik 12:2010

Appendix A - PROTOKOLL NR 1

PROTOKOLL NR 1
ÄNGSKÄRRSKOLAN SOLNA

Namn Numrering
Födelsedata
Har glasögon

	Långt håll	+1.0 dptr	Nära håll
Visus (med ev korr)	H: V: Bin:		
CT			

PCT (Vid behov. Eso=mät bas ut Exo=mät bas in)		
Vergensmätning Negativ (bas in) (Dim)/bryt/ återgång		
Vergensmätning Positiv (bas ut) Dim/ bryt/ återgång		

LANG

KNP (bryt/återgång) cm

ACK-VIDD, dptr

PRISMAFLIPPER
(4 ^IN/12^UT)

Appendix B - PROTOKOLL NR 2

PROTOKOLL NR 2
ÄNGSKÄRRSKOLAN SOLNA

Namn Numrering
Födelsedata

	Långt håll	Nära håll
Visus (med ev korr)	H: V: Bin:	

KNP (bryt/återgång)
cm

	Långt hall	Nära håll
Vergensmätning Negativ (bas in) Dim /bryt/ återgång		
Vergensmätning Positiv (bas ut) Dim/bryt/återgång		

PRISMAFLIPPER
(4 ^IN/12^UT)

Frågor:
1: Hur har det varit att träna? Lätt/svårt/jobbigt/roligt
2: Har du märkt någon skillnad på läsningen? Lättare/svårare/ingen skillnad
3: Har du märkt någon skillnad hur det känns i ögonen vid läsning? Bättre/sämre/ingen skillnad
4: Övriga kommentarer:

Appendix C - H5 Test

BRAVKOD Avkodningstest 2 (motsvarande H5)
ELEVBLAD

av	om	är	vi	de	så	en	nu
åt	se	in	på	än	bo	ut	ja
ni	att	för	mor	hon	oss	vill	min
kan	med	bli	där	nog	och	ner	som
dag	god	hel	sol	vid	han	mer	dit
låg	mat	bil	gav	mål	fin	hög	lät
inte	från	hade	tala	över	stor	fick	bort
sina	såg	allt	mamma	liten	inne	bort	veta
uppe	ligga	fara	ögon	kväll	glad	väg	steg
nära	både	lika	säger	skall	sida	gata	före
snäll	röda	läsa	träd	land	resa	fram	sova
fast	hem	till	vänta	lika	ägg	åter	under
göra	hand	komma	gräs	mage	natt	ord	läsa
någon	sedan	vakna	stark	gröna	liksom	passa	väder
flytta	livlig	ensam	färdig	plats	skåp	kläder	hämta

BRAVKOD lösblad sid 6