Vision and Reading Abilities in Icelandic Children ages 8-12 years

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Abstract

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Background: Reading tasks are challenging for the visual system and under normal conditions reading is more or less effortless. The aim for this study was firstly to examine if there is a correlation between reading speed, DEM saccade test and several accommodation functions such as binocular accommodation amplitude, binocular accommodation facility, positive- and negative relative accommodation, MEM retinoscopy and cross card. Secondly, to establish which test procedures are most important to prioritize in the optometric practice when having a person with poor reading performance.
Methods: A cross-sectional study with the study population of 29 children from Reykjanesbær, Iceland. The participants were between the ages of 8-12 years old with mean age 10,1 ± 1,35(STD) years with and without reading problems were recruited from the ophthalmology practice during the period 1st October 2015 to 31st March 2016. Patients at the ophthalmology practice that meet the study criteria were given an opportunity to participate in the study. Reading speed was composed from Logos screening test results.
Results: No correlation was found between reading speed and binocular accommodation amplitude, binocular accommodation facility, positive- and negative relative accommodation, MEM retinoscopy and cross card.
Conclusions: Firstly, this research indicates no association between reading speed and accommodative functions and secondly, reading speed and DEM saccade test. For the purpose to establish what test to prioritize in the optometric practice when examining individual who has poor reading performance, it suggests to take suitable binocular vision examination, included DEM saccade test. Findings in this study are statistically inconsistent with the clinical expectations and reveal that further research with larger group of participants is necessary.

Key words: Reading disabilities, accommodation function, DEM saccade test, reading speed

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1.0 Introduction

Dyslexia is characterized as difficulties in decoding and recognizing words, often resulting in poor reading comprehension (Handler et al., 2011). Dyslexia can explain the phonological difficulties in every language, which develop in the brain cells. These difficulties will affect reading ability and can result in reduced knowledge and poor reading results (Shaywitz and Shaywitz, 2001). Having reading disability will often require more concentration, attention and energy to achieve reading tasks.

From personal experience, Icelandic parents often talk about their child´s reading problem as dyslexia even if the child has not been diagnosed with such a problem. If the child´s reading comprehension is poor or the child simply reads too slowly, parents and teachers will often try to find the actual explanation. Teachers are trained to identify signs of a child struggling and with screening programs for reading disability hopefully no child will graduate from elementary school without the knowledge of having a reading problem and without having received suitable help (http://lesvefurinn.hi.is/node/182).

Reading tasks are challenging for the visual system. Under normal conditions reading is more or less effortless, therefore when reading becomes problematic the child should undergo a full eye examination with a special focus on the binocular tests (Scheiman and Wick, 2014). They noted that if a visual problem exists, uncorrected visual errors of significant degree, visual training or reading glasses are amongst possibilities that can make the child´s school day easier regardless of a reading problem or not. Abnormalities in the visual system can be the cause of reading disabilities and therefore must be eliminated (Hoyt and Taylor, 2013, Evans, B.J.W, Patel, R., Wilkins, A. J., Lightstone, A., Eperjesi, F., Speedwell, L., & Duffy, J., 1999).

By investing the impact of reading speed in relation to several visual functions this essay seeks to understand the role of the optometrist when examining children with reading problems. The essay will first provide an overview of the main topics, which are dyslexia and/or reading disabilities, accommodation function and eye movement. Secondly, it will summarize other studies in this specific field and demonstrate how screening for

visual function and reading disabilities are performed in Iceland. This is a cross-sectional study with participating children at the age of 8-12 years old. The participants had to answer a questionnaire, history form and clinical examination was performed. In addition, the participants gave consent to collect the Logos screening test results from Fræðsluskrifstofa Reykjanesbæjar. Finally this essay will focus on reading speed and how it is influenced by the accommodation functions and DEM tests results, and create two hypothesis questions.

1.1 Dyslexia and reading difficulties

Scheiman and Wick (2014) defined reading disability as:

> *" a failure to learn to read despite average or above average intelligence, adequate or even abundant educational opportunities, normal sensory development (auditory and visual), such as mental retardation, emotional disturbance, educational deprivation, hearing impairment, and visual handicaps are eliminated from being primary determinants."* (p. 595)

As previously mentioned dyslexia is characterized as abnormality of the phonologic skills that results in difficulties when decoding written words (Handler, S. M. and Fierson, W. M. and the Section on Opthalmology and Council on Children with Disabilities, American Academy of Ophtalmology, American Assiciation og Certified Orthoptists, 2011, Shaywitz and Shaywitz, 2001). Dyslexia is a severe type of reading disability that originates in the brain cells (Evans et al., 1999). There is no clearly defined line between dyslexia and reading difficulties and these terms are often used interchangeably in the literature (Handler et al. 2011, Scheiman and Wick, 2014). The neural networks in the brain that are responsible for word reading are the bilateral basal temporal regions for feature recognition, the angular gyrus, middle and superior temporal gyri for cross-modal integration and phonological processing mainly in the left hemisphere (Shaywitz and Shaywitz, 2001). Functional imaging studies have found under-activation of the posterior regions in individuals with dyslexia and sometimes hyperactivity in the frontal regions (Fletcher, 2009, Shaywitz and Shaywitz, 2001). Furthermore, when intervention is successful these posterior differences predominantly normalize (Fletcher, 2009).
The prevalence of reading disability is somewhat between 5-20% of school children in

the United States with the most severe cases having the prevalence of 2-5%. (Handler et al., 2011, Fletcher, 2009, Evans et al., 1999). There are no differences in the prevalence between genders of dyslectic children although there are some controversies in the literature regarding this (Shaywitz and Shaywitz, 2001). The origins of dyslexia are neurobiological as earlier stated and the cause of it can be both environmental and hereditary. The heritable element is assumed to account for about 50–80% of the difference in reading results. There are no dyslexia-specific genes although some studies link loci on chromosome 2,6 and 15 to dyslexia (Fletcher, 2009, Shaywitz and Shaywitz, 2001). A major environmental factor is if the parents have poor literacy and don´t read much for the child at risk. It is essential that the child at risks receives high quality instructions from their schools. Better reading ability for the dyslectic child are associated with early intervention (Handler et al., 2011, Fletcher, 2009).

1.2 The accommodation and vergence system

To be able to read one must use both the accommodation- and vergence systems. These two systems work closely together, although their problems can be independent off one another (Scheiman and Wick, 2014). When reading, the near point of accommodation and the convergence are mainly used, it is therefore important that the eyes converge and accommodate to the visual target especially to be able to sustain these tasks over longer periods. The push-up method is a measurement of the near point of accommodation and reveals if this is insignificant (normal value of accommodation amplitude in table 2.3.2). The authors note that this can be a problem for near task such as reading. The accommodation facility is a measure of how the eyes can relax and stimulate accommodation, using ±2,00DS flipper where one cycle equals accommodation stimulation and relaxation. If the accommodation facility shows low values (table 2.3.3), then this could also, similar to near point of accommodation be challenging for reading task. Further, the relative accommodation gives information about the accommodation while convergence is constant and is measured both with positive and negative values (table 2.3.3). Most accommodation abnormalities result in blurred vision, headaches, asthenopia and difficulty changing focus, although each diagnosis has their own special characteristics (Rowe, 2012, Scheiman and Wick, 2014).

The vergence system maintains fusion and helps to keep the eyes aligned on the visual target. There are four types of convergence, tonic, accommodative, fusional and proximal and all of them contribute to reading. Positive relative convergence (PRK) and negative relative convergence (NRK) are measurements that provide information about how much converging takes place when accommodating on a constant target (Scheiman and Wick, 2014). Convergence insufficiency and convergence excess are the largest groups of the non-strabismic binocular vision problems, affecting approximately 3-5% of the population (Handler et al., 2011, Scheiman and Wick, 2014) and 5-8%, respectively (Scheiman and Wick, 2014). The characteristics of disorders of the vergence system that are complicating for reading are mainly blurred vision, diplopia, and difficulty changing focus. For both the accommodation and vergence systems it is undeniable that these symptoms can contribute to reading difficulties although it is debatable whether these are the cause of decoding difficulties (Scheiman and Wick, 2014, Handler et al., 2011) Normal values for vergence measurements are listed in table 2.3.8.

1.3 Ocular motor dysfunction

Scheiman and Wick (2014) have classified ocular motor dysfunction (OMD) for the diagnosis of fixational, saccadic and smooth pursuit eye movement disorders. It is unusual to find these disorders, as a single diagnosis therefore this term is preferred. This is a functional disorder with no underlying pathology. One cannot stress enough the importance to rule out differential diagnosis of OMD, which can be pathological cause in the upper midbrain (Scheiman and Wick, 2014, Rowe, 2012).

When reading, eye movements used are fixations, saccades and regression. For normal readers, there are great variations between and within fixations and saccades. The regressions are eye movements from right to left and occur when a reader overshoots a word, misinterprets the text, or has bad reading comprehension. The result is slower and inefficient reading (Scheiman and Wick, 2014). Much is unclear regarding how close the relationship is between reading and OMD. Nonetheless, the authors note that there are theories about eye movements causing reading disability, the reading disability leading to inconsistent eye movements, or the combination of both alternative theories. Eye movements can be tested by DEM saccades test, which is a visual-verbal format.

The DEM test can test children as young as six years old. The child has to call out numbers first vertically and then horizontally, while any incorrect numbers are noted. Total time on the vertical part of this test helps to establish the child's automaticity when naming. The ratio between vertical and horizontal performance is essential in this test, and accounts for four clinical behavioral types as shows in table 1.1 (Scheiman and Wick, 2014, Richman, J.E., 2009).

Table 1: DEM test behavioral types

	Details of DEM test behavioral types
Normal	Normal age performance for vertical horizontal and ratio
Oculomotor deficiency (OMD)	Vertical test normal, horizontal test abnormal, high ratio
Automaticity deficiency (RAND)	Abnormal age performance in both vertical and horizontal test, normal ratio
Mixed (RAND/OMD)	Abnormal age performance in both vertical and horizontal test, abnormal ratio

1.4 Literature review

There is controversy in the literature regarding which optometric measurements have the most affect when testing poor readers. The evidence that dyslexia is mainly a phonological defect is not to be ignored and it is debateable whether the visual function is a direct cause of dyslexia (Handler et al., 2011). Children with dyslexia and other learning disabilities statistically have the same ocular health as any other children without these learning problems (Handler et al., 2011). On the other hand there are several studies that show that vision problems can worsen the reading- and writing skills of the dyslexic child. It is therefore sensible to treat any binocular and accommodative problems to reduce the negative influences from the visual function (Evans et al., 1999). A study conducted on 8-13 year old Spanish children found reduced fusion reserves in the distance vision among poor readers versus controls (Palomo-Alvarez & Puell, 2010).

Same colleagues found that monocular accommodation amplitude and binocular accommodative facility where significantly lower in groups of poor readers versus controls. They concluded that accommodation amplitude and accommodative facility should be included in every visual examination for children scoring below average on reading tests (Palomo-Álvarez and Puell, 2008). In addition, to clarify, these two previous studies tested children which were poor readers, but non-dyslectics.
Another research tested groups of subjects with reading disabilities versus controls from Austria (Dusek, Pierscionek & McClelland, 2010). They found reduced convergence, accommodation of amplitude, accommodation facility (monocular and binocular), vergence facility and distance visual acuity in the reading disability group.
Additionally, Buzzelli (1991) measured stereovision, accommodation and vergence facility on thirteen year olds with and without dyslexia and found that vergence facility was worth examining in dyslectics (Buzzelli, 1991).
Similarly a Swedish study investigated children in 4^{th} to 9^{th} grades and found monocular and binocular accommodative amplitude was reduced for dyslectic groups (Wahlberg-Ramsay, M., Nordström, M., Salkic, J., Brautaset, R., 2012).
A large Canadian study did compare reading speed, cycloplegic refraction and oculomotor function in poor readers versus controls (Quaid and Simpson, 2013). This study found significant correlation between uncorrected hyperopia, reduced vergence facility and reduced reading speed. Furthermore the study emphasized the importance of including these tests in every visual examination for poor readers.
Marran, L.F., De Land, P.N., & Nguyen, A.L. (2006) examined eye movements by testing 299 elementary school children. They found that 170 children had binocular vision abnormalities. They concluded that accommodation insufficiency have high near task symptoms score on the CITT Study Group Symptom Survey (CISS questionnaire). When analyzing convergence insufficiency as a single group they found that it has no more symptoms than the control group. They also investigated eye tracking with DEM test and discovered that the groups of convergence- and accommodation insufficiency had significantly more difficulties with eye movements than the control group.
In a similar manner, a new study from 2016 investigated dyslectic children versus controls for abnormal eye tracking such as saccades, regression and fixations (Tiadi, A., Gérard, C.-L., Peyre, H., Bui-Quoc, E., & Bucci, M. P., 2016). They used video-oculography

system (EyeBrain® T2) for eye movement recording. Firstly, they found that the total number of saccades is higher in the dyslectic group than the non-dyslectic group. Secondly, they found that the total number of saccades decreases significantly with age, only in the non-dyslectic group, thus eye movements in the dyslectic group didn't progress. The authors assumed that this outcome could be due to an immaturity of the cortical parts controlling the fixation system as well as reduced attention abilities in the dyslectic group. Both the dyslectic group and controls where excluded from any binocular vision abnormalities, although the authors found poorer vergence capability in the dyslectic group (Tiadi et al., 2016).

Another eye movement study also found that dyslectic readers have additional saccades, more regressions and slower reading speed (Tiadi, A., Gérard, C. L., Peyre, H., Bui-Quoc, E., & Bucci, M. P., 2015). Since all binocular vision tests were normal the authors concluded that eye movement pattern in these children seems due to their difficulty in processing visual text into verbal information. They discussed the importance of eye tracking to detect dyslexia in young children for early invention. Handler et al. (2011) from the American Academy of Pediatrics argue that dyslexia is not the result of oculomotor dysfunction but rather that dyslexia is the cause of increased regression and losing place in the text.

1.5 Logos test

The Logos test is a diagnostic tool for assessing reading disabilities (Høien, T.2008). The Logos screening test is divided into four subtests. The first and second subtests measure reading speed and comprehension. The third subtest measures sounding (phonologic) and the student has to sound out non-words. The fourth subtest is reading words that have writing different than pronouncing. The results for each subtest are given in percentile and the best possible results are 100, which indicates that 100% of children have equal or worse performance than the tested child. Percentile between 15-30 means that the child has mild problems and that additional reading support is needed. Percentile between 0-15 indicates that the child is at risk of reading problems and that further evaluation is needed (Høien, T.2008). Children in risk groups in all subtests will undergo the entire Logos test. These screening parts of the Logos test can indicate how

children will perform on The National Test that 4th, 7th and 10th graders undergo each year (Einarsson, 2014).

1.6 Screening in schools in Iceland; visual- and reading abnormalities

In Iceland visual screening begins at 4 years of age. The health care nurse performs the screenings that include only monocular visual acuity at 3 meters and stereovision (Landlæknir, 2013). The visual screening continues in 1st, 4th, 7th and 9th grades and includes only monocular visual acuity testing, except from color vision testing in 7th grade (Landlæknir, 2014). Since reading is a near task it is essential to test the visual functions at near. Children that are under investigation for reading disabilities should have a thorough visual examination. This is important to ensure that any abnormalities in the visual system that can relate to reduced reading ability are revealed (Handler, 2011). Visual acuity testing is therefore not satisfying to judge children´s visual function in fact, it would have been more appropriate to include more binocular vision tests (Quaid and Simpson, 2013).

Prevalence of dyslectic Icelandic children in 10th grade has been reported 15%, with statistical difference between the genders where boys have more problems than girls (Aðalsteinsdóttir, 2013). In the local community were the children in the study are recruited from, are good routines regarding screening for reading disabilities. As early as kindergarten, at the age of 5-6 years old, children are introduced to literacy. At this point all children in the local community are screened for language development and phonological awareness (http://namsmat.is/vefur/prof_malitaki/prof_malitaki.html). LtL (Leið til læsis) is an Icelandic screenings test, which all 1st graders undergo, in the local community. This test addresses phonological awareness, language development and decoding. LtL is submitted early in the school year, so the teacher will get an indication of the weaknesses of each student. This will give the teacher useful information regarding the continuing reading tutoring and the teacher can pay special attention to weak students (http://lesvefurinn.hi.is/node/182). The screening continuous in 3rd grade, 6th grade and 9th grade, but with Logos screenings test (http://www.logos-test.is/aboutLogos.htm). As previously discussed, Logos is a diagnose

test for dyslexia and reading disabilities. The Logos test is quite recognized in The Northern countries and was founded by professor Torleiv Høien, a Norwegian professor of education (Logometrica, 2016). The aim of repeated testing on different class levels is to ensure that all dyslexic students will be identified and characterized, so that they can get suitable help. The reading aids available include, prolonged time with examination, audiobooks and extra tutoring help (http://lesvefurinn.hi.is/adstod_i_bodi).

1.7 Aims

The aim of this study is to map the visual function in Icelandic children, ages 8-12 years old with a special weight on the accommodation function and eye movements. The visual functions of interest are then compared to reading speed of the children participating in this study.

H_0: There is no correlation between the accommodation function and reading speed in Icelandic children, ages 8-12 years old.
H_1: There is a correlation between the accommodation function and reading speed in Icelandic children, ages 8-12 years old.

H_0: There is no correlation between DEM test results and reading abilities in Icelandic children, ages 8-12 years old.
H_1: There is a correlation between DEM test results and reading abilities in Icelandic children, ages 8-12 years old.

Furthermore it is important to determine which test procedures are most important to prioritize in the optometric practice when testing a person with reading disabilities or who are undergoing investigation for this. In addition to eye care professionals the results of this study can be of great interest to special education teachers. It is important that more agencies are informed and united to take care of these children and to have the opportunity to investigate the binocular vision and the visual function to rule out reading problems caused by the vision.

2.0 Methods

2.1 Study design

This is a clinical cross-sectional study to establish an overview over the visual condition in children that come to visit the optometric practice and to examine if there is a correlation between visual functions and reading speed.

2.2 Patients selection

The optometry in Iceland today only allows optometrist to examine children under the age of 12 years old that have to undergone a routine check-up by ophthalmologist in advance. Because the population in this study is children under 12 years old it is necessary to recruit the patients from Sigríður Másdóttir´s database, which is an ophthalmologic at the local practice in Reykjanesbær. Otherwise, all of these tests are standard clinical optometric tests which are used daily in the optometric practices. These tests are non-invasive and are of no inconvenience to the participants. The study population is Icelandic children between the ages of 8-12 years old with and without reading problems who have an appointment at the ophthalmology practice during the period 1st October 2015 to 31st March 2016. Current patients at the ophthalmology practice that meet the study criteria will be given an opportunity to participate in the study. The children need to be able to read and undergo the optometric procedures to participate. In the recruitment period the patient's selection is continuous, therefore it will be randomized how the age, gender and reading skills will be distributed. The reading skills are defined from the reading speed results of the Logos screening test. The Logos screening test is performed in late third grade and early sixth grade, thus the patient selection is dependent on that, consequently having only 3rd, 4th, 6th and 7th grade participating in the study.

The exclusion criteria for the patients selection is all other age groups other than earlier explained, cognitive disability, for example caused by head trauma or developmental disabilities and children that don't have Icelandic as their first language.

2.3 The examination

The examination was scheduled to take approximately one hour. The test procedures are a part of a routine examination at the optometric practice, which may include the following procedures as listed in tables 2-9.

Table 2: Participants´ history of diagnosis. (Appendix D).

Diagnose	Question	Parents reply
Premature	Is the child born before week 37?	0= not premature 1= premature
Dyslexia/Reading disability	Have the child confirmed dyslexia diagnose?	0= not been diagnosed 1= diagnose confirmed 2= Under investigation 3= Self-reported reading problem*
ADHD	Have the child confirmed ADHD diagnose?	0= not been diagnosed 1= diagnose confirmed
Motoric difficulties	Has the child a motoric problem with the extremities?	0= not been diagnosed 1= diagnose confirmed
Concentration difficulties	Have the child concentration difficulties other than ADHD?	0= not been diagnosed 1= diagnose confirmed

*Self- reported reading problem is defined such as poor comprehension or reading slowly without dyslexia diagnosis.

Table 3: Overview of accommodation amplitude measurements in this study, with detailed explanations and expected values (Appendix D) (Scheiman and Wick, 2014).

Test	Details	Normal value w/ STD	Definition of abnormal
Accommodation amplitude: sustained blur on RAF rule, target towards the participant.	Participant report when number target gets unreadable. Monocular and binocular with habitual correction	18-⅓ of age ± 2DS	Values < 12-13 > DS
Accommodation amplitude: Push-down on RAF rule, target from the participant.	Participant report when number target gets clear. Monocular and binocular with habitual correction	18-⅓ of age ± 2DS	Values < 12-13 > DS

Table 4: Other accommodation measurements performed in this study. Detailed explanations and expected values for monocular- and binocular accommodation facility, negative- and positive relative accommodation, cross card and MEM retinoscopy (Appendix D) (Scheiman and Wick, 2014).

Test	Details	Normal value w/ STD	Definition of abnormal
Monocular accommodation facility (MAF)	Habitual correction. ± 2,00 DS flipper monocular in 1 minute. Total number of cycles is noted. One cycle equals one plus and one minus flip's. Target used: Accommodation Rock Cards, 20/30 at 40 cm	7 cpm, ± 2,5 cpm	Values < 4,5 cpm
Binocular accommodation facility (BAF)	Habitual correction. ± 2,00 DS flipper binocularly in 1 minute. Total number of cycles is noted. One cycle equals one plus and one minus flip's. Target used: Accommodation Rock Cards, 20/30 at 40 cm	5 cpm, ± 2,5 cpm	Values < 2,5 cpm
NRA	New distance prescription in the phoropter. Add plus glass till target gets unreadable. Target used is 0,2 LogMAR units on 40 cm	+2,00 DS ±0,5DS	Values < +1,50 DS
PRA	New distance prescription in the phoropter. Add minus glass till target gets unreadable or with cut-off value at -3,00 DS. Target used is 0,2 LogMAR units on 40 cm	−2,37 DS ±1,00 DS	Values > -1,50 DS
Fused cross-cylinder	New distance prescription, participant reports when horizontal and vertical lines are alike, or when vertical line is clear	+0,5DS ±0,5DS	Values > +1,00 DS and all minus values
MEM retinoscopy	New distance prescription, participant reads MEM card on retinoscopy. Noted max plus or lowest minus.	+0,5DS ±0,25DS	Values > +0,75, <+0,25 and all minus values

Table 5: Explanations of subjective refraction, habitual acuity and habitual refractive status used in this study (Appendix D).

	Details
Habitual status	Refractive status of the participants on the examination day. One of following noted: no correction used, distance glasses, reading glasses or contact lenses.
Subjective refraction	Dry retinoscopy followed by subjective refraction w/spherical and cylindrical BCVA. Converted to, and analyzed as spherical equivalent.
Visual acuity (VA) distance	Monocular and binocular habitual VA and monocular and binocular BCVA. EDTR, LogMAR table at 6m.
Visual acuity (VA) near	Monocular and binocular habitual VA and monocular and binocular BCVA. LEA, LogMAR table at 40 cm.

Table 6: DEM saccade test. The table clarifies the four behavioral types; the results come from the DEM software (Richman, J.E., 2009).

Test	**Details**	**Results**
DEM saccade test	Habitual correction. DEM software was used to analyze into four behavioral types (table 1.1)	Type 1= normal Type 2= oculomotor deficiency Type 3= automaticity deficiency Type 4= mixed

Table 7: Motility test. This table shows detailed information of the motility test and what observation was noted on the motility test (appendix D) (Scheiman and Wick, 2014).

Test	**Details**	**Observation**
Motility (head movement)	With penlight, in 8 positions of gaze	0= no head movement 1= head movement
Motility (smoothness)	With penlight, in 8 positions of gaze	0= smooth 1= stuttering/hesitate
Motility (in-comitance)	With penlight, in 8 positions of gaze	0= con-comitance 1= in-comitance

Table 8: Overview of different vergence tests performed in this study, with detailed explanations and expected values (Scheiman and Wick, 2014)

Test	Details	Normal value w/ STD	Definition of abnormal
Covertest, distance	Participant looks at a target at 6m with habitual correction, 2 VA snellen lines better than BCVA. Target has to be clear and single at all times. The size and direction of phoria noted.	1 exophoria ± 2 PD	Values > 1 esophoria and > 3 exophoria
Covertest, near	Participant looks at a target 20/30 VA on a fixation stick at 40 cm with habitual correction. Target has to be clear and single at all times. The size and direction of phoria noted.	3 exophoria ± 3 PD	Values: All esophoria and > 6 exophoria
Von Graefe's, distance	Participant looks at a target at 6m with new prescription in phoropter, 2 VA Snellen lines better than BCVA. Target has to be clear and single at all times. The size and direction of phoria noted.	1 exophoria ± 2 PD	Values > 1 esophoria and > 3 exophoria
Von Graefe's, near	Participant looks at a target 20/30 VA with new prescription at 40 cm in the phoropter. Target has to be clear and single at all times. The size and direction of phoria noted.	3 exophoria ± 3 PD	Values: All esophoria and > 6 exophoria
Howel's phoria card near	With habitual correction at 33cm. Place 6 bases down in front of right eye to split the lines. Participant reports where on the bottom scale the arrow points.	1 exophoria ± 1 PD	Values: All esophoria and > 2 exophoria
Near point of convergence	With habitual correction, taken with RAF-ruler towards nose. Participant report when vertical line gets double, mean value noted of three measurements.	2,5 cm ± 2,5	Values over 5 cm

2.3.1 Symptom questionnaire

In addition to normal vision testing the participant answer a symptom questionnaire form (appendix E). This is to understand how the participants experience symptoms regarding reading and near work. These questions were directed to the child in the

presence of the parent. The questionnaire used was from the Convergence Insufficiency Treatment Trial Study (CITT Study Group, 2009). It consists of 15 questions which each have four possibilites; never, infrequently, sometimes, fairly often and always. Each answer has a score which ranges from 0 (never) till 4 (always) and the cut-off scores are ≥ 16 to define the subjects that have near task problems. Subjects scoring under 16 point are considered not having symptoms connected to near task. The CITT Study symptom questionnaire is convenient to monitor those having convergence insufficiency symptoms in ongoing CI treatment and thereby will give an indication of near task symptoms (CITT Study Group, 2009).

2.3.2 Reading speed

To identify whether the participant has a phonological defect such as dyslexia, or reading disability the parents have to give consent to collect the Logos test results from Fræðsluskrifstofa Reykjanesbæjar. The result from the Logos test is central in this study in order to identify and analyse correlation between reading speed and vision variables.

2.4 Ethics

The children and parents or guardians that participate in this study will have an exclusive opportunity to have their visual function tested thoroughly. As previously mentioned all the tests are non-invasive and are all routine tests in every optometric practice. There are no known risks of participating in the study. An informed consent (attachment A and B) has been prepared for the participants and their parents or guardian to sign. The participants can discontinue involvement in the study at any time, without any given reason. It will not have any negative consequences for the actual participant and its future follow up at the optometric practice. This will be clarified in the informed consent. This study is performed according to The Declaration of Helsinki. The parents or guardians will be asked to give consent to implement the testing and collect the results from Logos, screening test for dyslexia. This information will be collected from Fræðsluskrifstofa Reykjanesbæjar with the parents or guardians consent. Data such as cycloplegic refraction will be collected from Sigríður Másdóttir´s patient database. To assure privacy, each participant will receive an ID number. The ID number will be used for all the data collected and the questionnaire. A codebook witch links to

the ID numbers to the actual participant will be prepared. The codebook will be stored in a locked safe in the optometric practice and will not be stored with other data from the study. This is to ensure that sensitive personal information will not get lost. This codebook will be shredded as soon as the study is completed.

2.5 Economics

This project was self-fundable; no incoming financial support was accepted.

2.6 Data analysis

The results where analysed using SPSS V.23. The tables and graphs were made in SPSS V.23 and Excel 2011. The variables used in the analysis where not significant when tested for normality distribution by Shapiro-Wilk, therefore non-parametrical tests were used for analyzing the results. The data were also tested and excluded for outliers.
The tests that had both binocular- and monocular measurements were evaluated for correlation to see if just one of the measurements was fit to use in the final analysis or in other cases an index was more suitable.

3.0 Results

29 Icelandic children participated and completed the study, 16 girls and 13 boys from ages 8-12 years old with mean age 10,1 ± 1,35(STD) years. Only 29 participants completed the study and will assume that the data was not sufficient to have clear statistical significance.

Regarding the habitual status of the 29 participating children, 5 had glasses prescribed with distance correction and the remaining 24 children where not corrected with distance, reading or contact lens prescription. Table 9 lists the descriptive statistics of the habitual- visual acuity and -correction and new subjective refraction in the entire study population. The parents or guardians answered questions regarding history of diagnosis and this information is outlined in table 10. This table shows, which participants have, the listed clinical diagnosis confirmed. For clarification of the dyslexia category, 2 children were under investigation for dyslexia at the time of the examination and the 9 children that were self- reported did not have dyslexia diagnosis, although the parents reported that the children struggle with reading performance.

One participant had intermittent exotropia, which was decompensated through most of the vergence tests. It is uncertain whether this participant was suppressing the exotropic eye under the accommodation tests and DEM saccade test, however this did not exclude the participant from the analysis.

Table 9: Descriptive statistics for reading speed, habitual visual acuity (logMar), habitual refractive error (spherical equivalent) and new subjective refractive error (spherical equivalent) for all the participants

Clinical test performed	Mean (st.dev)	Min	Max
Reading speed (percentile)	31,1 (±30,2) %	0 %	89,4 %
Habitual visual acuity distance OU	0,07 (±0,17) VA	-0,16 VA	0,5 VA
Habitual visual acuity near OU	0,08 (±0,11) VA	-0,06 VA	0,5 VA
Habitual spherical equivalent OD	0,06 (±1,12) D	-3,00 D	3,13 D
Habitual spherical equivalent OS	0,08 (±1,22) D	-3,25 D	3,13 D
Subjective spherical equivalent OD	0,01 (±1,39) VA	-2,88 D	3,75 D
Subjective spherical equivalent OS	-0,01 (±1,46) VA	-3,5 D	3,50 D

Table 10: Overview of the participants' history of diagnosis. The self – report category includes the ones that have no dyslectic diagnosis confirmed but do struggle with reading performance

	Not diagnosed	Have a diagnose	Under investigation	Self-report
Premature	27	3	0	0
Dyslexia/RD	13	6	2	9
ADHD	27	3	0	0
Motoric abnormality	30	0	0	0
Concentration difficulties	28	2	0	0

One of the hypothesis questions in this study was to find out if there were any correlations between different accommodation measurements and reading speed. Pearson correlation was performed to analyze the relationship of each of the accommodation measurements with reading speed. The results of the accommodation tests fail to reject the null hypothesis, as there was no correlation found between each accommodation measurements and reading speed. The details of this analysis are presented in table 11. The binocular measurements for accommodation- amplitude and facility (BAF) were used since these tests did correlate well with the monocular measurements ($r= 0,835$, $p<0,01$ for right eye and $r= 0,842$, $p<0,01$, for left eye).

Table 11: Pearson correlation analysis results for accommodation amplitude, negative relative accommodation (NRA), positive relative accommodation (PRA), binocular accommodation facility (BAF), cross card and MEM retinoscopy with reading speed as dependent variable.

Clinical test performed	Mean (st.dev)	Min	Max	r (27)	p
Accommodation amplitude binocular, sustained blur	15,6 (±4,75) D	3,50 D	2,00 D	-0,197	0,31
NRA	+2,63 (±0,88) D	+1,25 D	+5,00 D	-0,101	0,61
PRA	-2,40 (±0,76) D	-3,00 D	-0,75 D	0,096	0,62
BAF (± 2,00 DS)	6,33 (±4,81) cpm	0 cpm	15 cpm	-0,227	0,24
Cross card	0,38 (±0,33) D	0,00 D	+1,25 D	0,067	0,73
MEM retinoscopy OU	0,81 (±0,40) D	0,00 D	+1,75 D	-0,019	0,92

The other hypothesis question in this study was to find out if there were any correlations between Dem test results and reading speed. Non-parametric Kruskal-Wallis was conducted to compare the effect on DEM test categories on the reading speed. The results for the eye movement tests also failed to reject the null hypothesis,

as there was not a significant correlation between reading speed and DEM test results (H(2)=3,806, p=0,283) with a mean rank of 5 for the normal category, 5 for oculomotor deficiency, 7 for automaticity deficiency and 12 for the mixed category.

The motility testing had interesting findings regarding dyslexia diagnosis. For the 29 participants there were 2 that had stuttering movements, one of those participants did have dyslexia diagnosis and the other was under investigation for dyslexia. Correspondingly, one had head movement on the motility testing and this child did belong to the self – report category, which means the parents sensed the child struggling but the child has not been diagnosed with dyslexia.

The symptoms questionnaire, outcome was the only variable that correlated fairly well to reading speed, r (27)= -0,410, Pearson p= 0,027. The questionnaire had a mean value of 19,77 (± 10,8 STD), with minimum value of 3 and maximum value of 42. When analyzing the symptom questionnaire it is natural to look at the near point of convergence since the questionnaire is indeed used to evaluate the follow up in convergence insufficiency therapy (CITT Study group, 2009). This analysis concluded that neither reading speed or the symptom questionnaire correlate with near point of convergence. Further, when looking at the correlation between vergence tests at 40 cm as covertest, Howells phoria card and Von Graefe´s, they did not correlate with reading speed. As expected these vergence tests correlated mutually.

When looking at the variable habitual status, 24 of the 29 participants did not use any prescription at the examination time. The examination revealed that of those 24 participants, 9 needed reading glasses and 6 participants needed distance glasses for myopia. For those 9 participants that needed reading glasses, 6 of them did score below the 30th percentile for reading speed at the Logos screening test.
Further, when viewing the participants' history of diagnosis, particularly children in the self- reported category, there were 7 of 9 that did score below the 30th percentile for reading speed on the Logos screening test.
Of those participants that needed reading glasses, 5 were diagnosed with accommodation insufficiency (AI) and 3 of those did score below the 30th percentile for

reading speed at the Logos screening test. Consistency was with the participants that had accommodation insufficiency and positive relative accommodation (PRA) outcome, the same AI participants did also manifest as abnormal (see table 3) for the PRA measurements.

For the binocular accommodation facility (BAF) measurement there were 8 participants that manifested as abnormal (see table 4). These 8 children had trouble clearing +2,00 lenses on the flipper and none had substantial problems with clearing -2,00 on the flipper. This was not consistent with the negative relative accommodation measurements with only 2 participants manifesting as abnormal (see table 4). For those 8 participants defined as abnormal on the BAF test, 6 of them did score below the 30th percentile for reading speed on the Logos screening test.

Regarding how the results for reading speed under the 30th percentiles were distributed in the DEM test behavioral categories, the categories of interest were the automaticity deficiency with 7 out of 9 participants and the mixed category (automaticity- and oculomotoric deficiency) with 8 out of 12 having reading speed below the 30th percentile score on the Logos screening test (see figure 1).

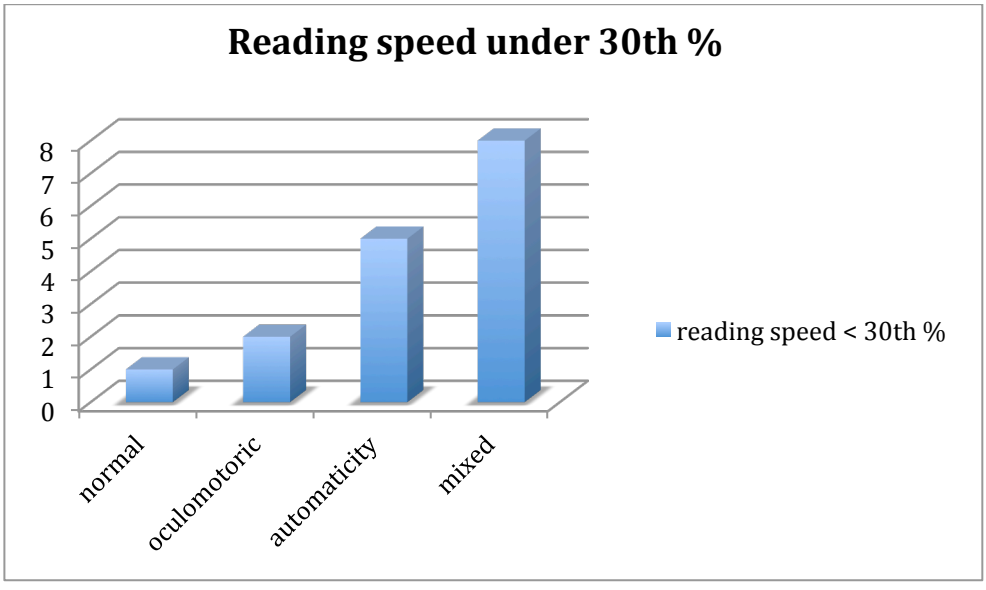

Figure 1: Demonstrates how reading speed under the 30th percentiles is distributed in the DEM test behavioral categories.

4.0 Discussion

The purpose of this study was firstly, to investigate whether accommodation measurements that are a part of standard procedures in the optometric practice for binocular evaluation are correlated with reading speed. Secondly, to investigate whether DEM tests results have an effect on reading speed and thirdly, to evaluate what tests are suitable when testing a person with reading disabilities or who are undergoing investigation for this.

Analysis of the data shows that the accommodation tests that were included in this study did not indicate a significant relationship to reading speed. These findings are consistent with Handler et al. (2011) who stated that children with dyslexia and other learning disabilities statistically have the same ocular health as any other children without learning problems. However, other studies have generally found reduced accommodation- amplitudes and facility amongst poor readers (Palomo-Álvarez and Puell, 2008, Dusek, Pierscionek and McClelland, 2010) and dyslectic children (Wahlberg-Ramsay et al., 2012).

For clinical purposes it is valuable to look into the optometric findings of the participants. The majority of the participants did not have any prescription prior to the examination. That is not unusual since the participants were recruited from the ophthalmologic practice. The examination revealed that five of the participants have got accommodation insufficiency (AI) diagnosis and positive relative accommodation (PRA) did correspond for those participants, which was expected (Scheiman and Wick, 2014). Three of the participants with AI diagnosis did score below the 30th percentile for reading speed at the Logos screening test. The 30th percentile is the cut-off value for those that need further follow-up to achieve better reading performance.

In addition, for the binocular accommodation facility measurement, for those eight participants that did manifest as abnormal (see table 4) and each failing + 2,00 DS on the flipper, six of them were below the 30th percentile cut-off value. The conclusion for these six children was indeed prescription glasses for the first time (Scheiman and Wick, 2014). In this study, time limitations made it difficult to follow-up on these participants but it would be interesting to see if reading speed has improved since reading prescription was given. From the above findings, suggest that accommodation

measurements, such as amplitude and facility testing are important to prioritize in the optometric practice when testing an individual with poor reading performance.

The DEM test results and its effect on reading speed did not indicate a significant relationship. The result from this study is consistent with Vagge et al. (2016) and Ayton et al. (2009), who both concluded that alterations of eye movements do not depend on oculo-motor dysfunction but are secondary to a defect in the visual processing of linguistic material. Ayton et al. (2009) found that the DEM test was not a suitable test for measuring eye movements because it did not correlate well with eye movement parameters, but as it did correlate with reading performance, the authors concluded that DEM test was suitable for a diagnostic role in a clinical practice. Tiadi et al (2016) performed an eye tracking research and found significant difference in higher number of saccades in the dyslectic group versus controls. The discrepancy is which is the cause of what, is poor performance on eye tracking test the cause of poorer reading skills, or does reading disability cause poor performance on the eye tracking tests. To set the limit in this study, this will not be included. It is however, important to rule out any binocular abnormalities before testing eye movements (Vagge et al., 2016).
For the DEM test it is important to consider how the participants performed in each DEM test category in relation to reading speed for clinical value. The participants that scored below 30th percentile on the Logos screening test were mostly distributed in the automaticity deficiency category and the mixed category and only one participant in the normal category measured below the cut-off value. To further understand the practical implications of DEM test results considering reading performance it is not to be ignored that DEM test is worth testing for those with poor reading performance, although it would have been interesting to test the participants with new prescription to rule out any inconsistencies.

Another interesting result was that the symptom questionnaire was significant in relation to reading speed. The symptom questionnaire correlated negatively to reading speed, the more symptoms the participants had, the lower the reading speed. This finding was not expected, since reading speed itself has not been related to symptoms, it was more expected to find correlation between accommodation measurements and

symptoms (Marran et al., 2006). However, when looking at the participants that had accommodation insufficiency in this study, three did score high on the symptom questionnaire, this is consistent with the three participants that had reading speed below the cut-off value. Although the CISS questionnaire has been used for monitoring symptoms development in convergence insufficiency treatment (CITT Study Group, 2009) it is also suitable for screening for symptoms of accommodative insufficiency (Marran et al., 2006).

Seven of those of the nine participants had parents that categorized them as having self-report reading problem. The self-report reading problem refers to children that struggle with reading but that are not assumed dyslectic from the Logos screening test. The seven children whom this applied to had poor reading speed outcome, in fact all of them scored below 15th percentile. When the practical implication is considered, it is not to be ignored that there are cases of children that have reading problems despite not fitting into the dyslectic category.

A possible explanation for the low correlation findings in this study could be the small size of the study population. An important aspect to consider is how the participants were recruited, they all had an appointment at the ophthalmology practice to have an eye examination for different reasons. This would be considered a qualification to this study, especially if the recruitment period had been longer and more children participating.

Furthermore, one possible reason for these results is that the participants did not perform Logos screening test at the same time as the examination for the study. Fræðsluskrifstofa Reykjanesbæjar performs the Logos screening tests at a specific time for different grades. The Logos screening tests were performed up to one year before this study's examination day. Following this, one could speculate whether the right variable was chosen regarding reading performance, or if perhaps reading comprehension would have been more suitable than reading speed. Further studies regarding visual functions and reading ability is recommended.

5.0 Conclusion

This essay has focused on several visual functions affecting reading speed. The main topics, dyslexia and/or reading disabilities, accommodation function and eye movements have been overviewed. Moreover, it have been summarized how screening for visual function and reading disabilities are performed in Iceland. In this study 29 children were examined to evaluate if both accommodation measurements and DEM test results correlated with reading speed. Findings in this study are statistically inconsistent with the clinical expectations and reveal that further research with larger group of participants is necessary.

The screening program for reading disabilities/dyslexia in the local community where this study takes place is adequate, but screening for the near visual problems is on the other hand debatable. Since there is a disagreement in the literature regarding whether binocular optometric measurements do impact on reading performance, for practical implications it would be irresponsible not to make a full binocular vision examination of the child that struggles with reading, as a part of a routine in the diagnostic process. Several authors (Sheiman and Wick, 2014, Handler et al., 2011) believe co-management is the key to successfully handling children with reading problems, so why shouldn't optometrists be a part of this cooperation? It is important for our children to master good reading skills and comprehension if they are to be active leaders in their own life and have the chance to reach their full potential. Vision problems can worsen the reading- and writing skills of the dyslexic child. It is therefore sensible to treat any binocular and accommodative problems to reduce the negative influences from the visual function (Evans et al., 1999, Hoyt and Taylor, 2013).

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7.0 Appendix A-G

A: Information concerning the study to the parent or guardian
B: Consent to implement the testing
C: History form
D: Examination form
E: Symptom questionnaire
F: Checklist
G: Open Research Archive, contract between author and faculty

Appendix: A Information concerning the study to the parent or guardian

Høgskolen i Sørøst-Norge

Upplýsingabréf til foreldra/forráðamanna barna sem taka þátt í neðangreindri rannsókn

Sjón og lestrarhæfni á börnum 8 -12 ára

Kæri viðtakandi

Vinsamlega íhugaðu neðangreindar upplýsingar vandlega áður en þú ákveður hvort þú viljir taka þátt í þessari rannsókn.

Tilgangur og markmið verkefnisins

Sjón og lestrareiginleikar er rannsóknarverkefni sem unnið og framkvæmt verður af Jónu Birnu Ragnarsdóttur, meistaranema við Høgskolen í Buskerud og Vestfold (HBV) í Noregi. Jóna Birna er sjóntækjafræðingur að mennt og er að bæta við sig sérnámi þar sem sérstök áhersla er lögð á samsjón eða hvernig augun vinna saman. Sjónin og það að geta séð án þess að nota óþarfa orku er mjög svo mikilvægt í lestrarsamhengi, heimavinnu og nærvinnu yfirhöfuð. Erlendar rannsóknir benda til þess að börn með lestrarörðugleika séu með aukna tíðni sjónskerðingar, sérstaklega á þetta við samsjónina (hvernig augun vinna saman). Til að ákvarða hvort tengsl séu milli lestrarörðugleika og sjónarinnar er mikilvægt að skoða hvaða áhrif sjónlag hefur á lestur.

Hverjir geta tekið þátt og hvað felst í því að vera þátttakandi í rannsókninni

Börnum á aldrinum 8-12 ára sem hafa fengið tíma hjá Sigríði Másdóttir augnlækni eða Jónu Birnu Ragnarsdóttur sjóntækjafræðingi verður boðin þátttaka í þessu verkefni, óháð því hvort þau hafa verið greind með lestrarörðugleika. Ef barnið og forráðamaður þess vilja taka þátt í þessu verkefni verða teknar ítarlegar

mælingar á sjónlagi og samsjón. Áætlað er að þetta taki um klukkustund og fer rannsóknin fram í húsnæði Optical Studio, Hafnargötu 45, Keflavík. Foreldrar veita sjóntækjafræðingi leyfi til að fá niðurstöður úr nýjasta Logos, lestrarskimunarprófi sem Fræðsluskrifstofa Reykjanesbæjar hefur lagt fyrir grunnskólabörn. Niðurstöður úr þessu prófi verða notaðar sem viðmið um hvar barnið stendur í lestri. Einnig þarf að svara sérstöku spurningablaði sem notað er til að kortleggja hvort ákveðin einkenni tengist nærvinnu og lestri. Hvort sem þú velur að vera með í verkefninu eða ekki þá mun það ekki hafa áhrif á áframhaldandi þjónustu frá augnlækni eða sjóntækjafræðingi.
Aðal kostur þess að taka þátt í verkefninu er að barnið fær enn ítarlegri sjónskoðun, en hefur ekki í för með sér auka kostnað að þinni hálfu.

Ábyrgðarmaður er Sigríður Másdóttir, augnlæknir á Augnlæknastofu Suðurnesja s: 421-4548, sigridur.masdottir@gmail.com.
Jóna Birna Ragnarsdóttir, sjóntækjafræðingur er ábyrg fyrir öllum mælingum og úrvinnslu verkefnisins, s: 849-4696/ vs:421-3811, jona@opticalstudio.is

Persónuvernd, úrvinnsla og eyðing rannsóknargagna
Rannsóknin tekur mið af alþjóðlegum samþykktum, svo sem Helsinki-sáttmálanum og tilmælum Alþjóða heilbrigðisstofnunarinnar um siðfræði og mannhelgi í vísindarannsóknum. Öll rannsóknargögn verða varðveitt leyndarmerkt á öruggum stað hjá ábyrgðarmanni á meðan á úrvinnslu þeirra stendur og verða unnin án persónuauðkenna. Öllum rannsóknargögnum verður eytt að lokinni úrvinnslu þeirra og eigi síðar en fimm árum eftir rannsóknarlok.

Leitað verður eftir skriflegu samþykki þeirra þátttakenda sem leggja til upplýsingar og efnivið í þágu rannsóknarinnar. Þátttakendum er frjálst að hafna þátttöku eða hætta í rannsókninni á hvaða stigi sem er, án útskýringa og án áhrifa á frekari þjónustu hjá viðkomandi sjóntækjafræðingi/augnlækni. Forráðamenn eiga fullan rétt á að skoða öll þau gögn sem safnast um barnið.
Eftir að rannsókn lýkur verða niðurstöður birtar sem lokaverkefni á meistarastigi við Buskerud og Vestfold Háskólann í Noregi.

Fjármögnun

Jóna Birna Ragnarsdóttir stendur fyrir öllum kostnaði á þessari rannsókn. Ekki verður um neinar greiðslur né umbun að ræða fyrir þátttöku í rannsókninni.

Rannsóknin er unnin með samþykki Vísindasiðanefndar og leyfi frá Fræðsluskrifstofu Reykjanesbæjar.

Ef þú hefur spurningar um rétt þinn sem þátttakandi í vísindarannsókn eða vilt hætta þátttöku í rannsókninni getur þú snúið þér til Vísindasiðanefndar, Hafnarhúsinu v/Tryggvagötu, 101 Reykjavík, tölvupóstfang: visindasidanefnd@vsn.stjr.is.

Með von um góðar undirtektir,

Fyrir hönd rannsóknarhópsins,

_____

NAFN ábyrgðarmanns

Appendix: B Consent to implement the testing

Høgskolen i Sørøst-Norge

Samþykki fyrir þátttöku í rannsóknarverkefninu

Sjón og lestrarhæfni á börnum 8-12 ára

Við foreldrar/forráðamenn staðfestum að við höfum fengið þær upplýsingar sem við höfum óskað eftir varðandi ofangreinda rannsókn og samþykkjum að barn okkar

_____(nafn og kennitala barnsins), taki þátt í rannsóknarverkefninu Sjón og lestrarhæfni. Okkur hefur verið tjáð að þátttakan er sjálfviljug og að við getum hætt þátttöku hvenær sem er án útskýringa. Með samþykki þessu veitum við þar með leyfi til þess að Jóna Birna Ragnarsdóttir fái aðgang að Logos niðurstöðum frá Fræðsluskrifstofu Reykjanesbæjar. Sótt hefur verið um leyfi frá Vísindasiðanefnd og hefur rannsóknin verið tilkynnt til Persónuverndar.

Markmið rannsóknarinnar er:

Í fyrsta lagi er helsta markmið þessarar rannsóknar að skoða samhengið á milli lestrareiginleika og hvernig augun tvö vinna saman. Í öðru lagi er áhugavert að skoða hvaða mælingar á augum eru nauðsynlegar þegar verið er að sjónmæla einstaklinga með lestrarörðugleika.

Okkur er ljóst að eftirtaldir þættir eru hluti af því að taka þátt í rannsókninni:

1**.** Ítarleg sjónskoðun á samsjón hjá sjóntækjafræðingi sem tekur u.þ.b 1 klukkustund

2. Nálgun á niðurstöðu Logos lesskimunarprófi frá Fræðsluskrifstofu Reykjanesbæjar

3. Svörun spurningalista - um einkenni og nærvinnu, tekur u.þ.b. 10 mín.

_____

Dags. Nafn þátttakanda, barn undir 18 ára (prentstafir) Undirskrift

_____

Dags. Nafn foreldris/forráðamanns (prentstafir) Undirskrift

Ég lýsi því yfir að þátttakandi og foreldrar/forráðamenn hans hafa fengið munnlegar og skriflegar upplýsingar um ofangreinda rannsókn.

_____

Dags. Nafn þess sem leggur samþykkið fyrir (prentstafir)

Bréf þetta skal vera í tvíriti, eitt fyrir rannsakendur og eitt fyrir þátttakandann.

Appendix: C History form

Høgskolen i Sørøst-Norge

Sjón og lestrareiginleikar, börn á aldrinum 8-12 ára

Almenn heilsa barnsins, spurningar fyrir forráðamenn.

ID-nr	
Fyrirburi	**Já** **Nei**
Lyfjanotkun	

Staðfesting á greiningu	**Lesblinda**	**Lestrar-örðuleikar**	**ADHD**	**Skert hreyfigeta**	**Einbeitingar-örðuleikar**	**Annað**
Er í greiningarferli	**Lesblinda**	**Lestrar-örðuleikar**	**ADHD**	**Skert hreyfigeta**	**Einbeitingar-örðuleikar**	**Annað**

Fyrir rannsakanda að fylla út:

Er með lesblindu greiningu	**Er ekki með lesblindu greiningu en gengur illa í lestri**	**Engir lestrarörðuleikar**

Appendix: D Examination form

ID-nr			Dato of examination			Gender (F=1/M=2)						
Day of birth			Grade									
PD distance			Dominans (R=1/L=2)			Dist:			Near:			
Habitual status	Glasses	c-lens	not rx	Rx right eye					Rx left eye			
Habitual VA (Taken in this order)	**40 cm**					**6m**						
	BIN	OD		OS		OD			OS		OU	
Covertest	40cm	Direct.+ phor/tropi+ uni/altern				6m			Direct.+ phor/tropi+ uni/altern			
Howell card near	(exo=-, eso=+)			With +1,0 DS					With -1,0 DS			
NPA (RAF) (sustain blur, push-down)	OD	OS		OU		NPC (RAF) -mean of 3 measures -noted 1/2 cm, <5cm=4cm						
Motility (* w/incomitans wright findings)	0=smooth / 1=stuttering			0=no headmove / 1=headmo					0=concomit / 1=incomitant *			
Color vision (Isihara)				TNO Quality/ suppression								

Refraksjon										
Dry retinoscopy	OD (sph/cyl/axe)								VA 6m	Bin VA
	OS (sph/cyl/axe)								VA 6m	
Subj refraksjon	OD (sph/cyl/axe)								VA 6m	BinVA
	OS (sph/cyl/axe)								VA 6m	
Von Graefes -note size - exo=- eso=+	6m		NRK 6m (bas in) /				PRK 6m (bas in) /			
	40cm		NRK 40m (bas out) /				PRK 40cm (bas out) /			
MEM Lag = + Lead = -	OD	OS	Cross-card (bin)		NRA (-)			PRA (+)		
BAF (+/- 2,0D) note 1/2 cpm 0cpm fails +/- note diplopia			MAF OD				MAF OS			

Appendix: E Symptom questionnaire

Listi yfir streitueinkenni

ID nr:_____

Setjið kross í þann reit sem á best við þig

		Aldrei	Sjaldan	Stund-um	Oft	Alltaf
1.	Verður þú þreytt/ur í augunum þegar þú lest eða ert í nærvinnu?.....					
2.	Færð þú óþægindi í augun þegar þú lest eða ert í nærvinnu?.....					
3.	Færð þú höfuðverk þegar þú lest eða ert í nærvinnu?					
4.	Verður þú þreytt/ur við lestur eða ert í nærvinnu?					
5.	Missir þú einbeitingu við lestur eða vinnur nærvinnu?.....					
6.	Áttu í erfiðleikum með að muna það sem þú lest?					
7.	Upplifir þú að sjá tvöfalt þegar þú lest eða vinnur nærvinnu?.....					
8.	Upplifir þú að orð hoppa til eða synda/fljóta um á blaðsíðunni við lestur eða vinnur nærvinnu?.....					
9.	Finns þér þú lesa hægt?.....					
10.	Færð þú verk í augun þegar þú lest eða vinnur nærvinnu?.....					
11.	Upplifir þú að augun verða aum þegar þú lest eða vinnur nærvinnu?.....					
12.	Færðu tilfinningu eins og sé verið að draga í augun þegar þú lest eða vinnur nærvinnu?.....					
13.	Upplifir þú að textinn verður óskýr eða dettur úr fókus þegar þú lest eða vinnur nærvinnu?.....					
14.	Missir þú staðsetninguna í textanum þegar þú lest eða vinnur nærvinnu?.....					
15.	Þarftu að lesa sömu línu uppá nýttþegar þú lest?					