Reduced Visual Acuity and Asthenopic Symptoms among Secondary School Students in the Niger Delta

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Abstract: _**Background:** The concept of visual acuity has metamorphosed from the nineteenth century. Overtime, it has been shown that Visual acuity assessment can reveal refractive errors, optical disorders and ocular diseases. The adverse health impact of reduced vision on the health of children is asthenopia (eye strain). **Materials and Methods:** A descriptive cross sectional study was used that involved the use of Data form, for each of the 2 secondary schools and the administration of 360 self administered structured questionnaires to pupils in these secondary schools. A simple random sampling was employed in choosing the students that were studied. **Results:** Out of 350 students studied, 77.29% (194) of students with normal visual acuity had asthenopic symptoms, and 80.81% (80) of the 99 students with reduced visual acuity had asthenopic symptoms. In our study there was no significant association between visual acuity and asthenopic symptoms. (X^2 calculated = 0.52, X^2 tabulated = 3.84, degree of freedom = 1, ض-value = 0.05. therefore X^2 tabulated > X^2 calculated). **Conclusion:** The adverse health impact of reduced vision on the health of children is asthenopia (eye strain). Not many work exist on this. However, it is on records that reduced vision often results in a low motivation to explore the environment, initiate social interaction, and manipulate objects. Unlike what is believed that asthenopia results from reduced vision, in this study series there was no relationship between reduced visual acuity and asthenopic symptoms._

Keywords: Reduced 'visual acuity', asthenopia, refractive error" school children, visual screening.

1. Introduction

The concept of visual acuity has metamorphosed from the nineteenth century. It first started in 1843; Germany enacted a treatise advocating the need for standardized vision tests and developed a set of three charts. Edwards von Jaeger published a set of reading samples to document functional vision in 1854. In 1861, Franciscus Donders coined the term visual acuity to describe the sharpness of vision and defined it as the ratio between subject's visual acuity and standard visual acuity. A year later (1862), Hermann Snellen published his famous letter chart. He designed special targets, which he called "Optotypes" and which he based on a 5 x 5 grid. This was crucial because it was a physical standard measure to reproduce the chart. Snellen defined standard vision as the ability to recognize if the person viewing it can discriminate a spatial pattern separated by a visual angle of 1 minutes of arc (one element of the grid).[1]

In 1868, John Green of St. Louis proposed a chart with a geometric progression of letter sizes and proportional spacing between letters. Then in 1875, Snellen changed from using feet to meters (from 20/20 6/6 respectively. Today the 20- foot distance prevails in the United States; 6 meters prevails in Britain, 5, or 6 meters are used in continental Europe. In the same year also, Felix Monoyer proposed replacing the fractional Snellen notional with its decimal equivalent (e.g 20/40 -0.5, 6/12 = 0.5, 5/10 = 0.5). Decimal notion makes it simple to compare visual acuity values, regardless of the original measurement distance. 1888 saw Edmund Landolt propose the Landolt c, a symbol that has only one element of detail and varies only in its orientation. The broken ring symbol is made with a "C" like figure in a 5x5 grid that, in the 20/20 optotypes, subtends 5 minutes of arc and has opening (oriented in the top, bottom, right, or left) measuring 1 minute of arc. This proposal was based on the fact that not all of snellens optotyoes were equally recognizable. This chart is actually the preferred visual acuity measurement symbol for laboratory experiments but gained only limited acceptance in clinical use.[1]

Visual acuity assessment can reveal refractive error (as in this study), optical disorders and ocular diseases. [2] Refractive errors affect a large proportion of the population worldwide, irrespective of age, sex and ethnic group. If they are not corrected or the correction is inadequate, refractive errors become a major cause of visual impairment and even blindness. Its estimated globally that 154 million people over five years of age are visually impaired as a result of uncorrected refractive error while 8 million are blind. 12.8 million People in the age group 5-15 years are visually impaired from uncorrected or inadequately corrected refractive errors. In addition, the number of people aged 16-39 years who are visually impaired from uncorrected refractive errors is 27 million. [3]

The adverse health impact of reduced vision on the health of children is asthenopia (eye strain). Not many work exist on this. However, it is on records that reduced vision often results in a low motivation to explore the environment, initiate social interaction, and manipulate objects. These students cannot share common visual experiences with their sighted peers, and therefore vision loss may negatively impact the development of appropriate social skills [4],[5],[6],[7],[8]. Our study seeks to find out if there is relationship between reduced visual acuity and asthenopic symptoms.

2. Materials and Methods

2.1 Study Area

The study was conducted among students of Foundation Comprehensive College in Aluu with a population of 486 students and Community Secondary School Rumuekini in Rumosi with a population of 1200 students, (private and public schools respectively) both in Ikwere Local Government Area of Rivers State , which has a total number of thirty five (35) public secondary schools. Both are mixed school comprising Junior Secondary (JSS) and Senior Secondary School (SSS). Therefore, there are six levels in school.

2.2 Study Population

This consisted of students of foundation Comprehensive College and Community Secondary School. The eligibility criteria were as follow:

Inclusion Criteria
- Student of foundation Comprehensive College and Community Secondary school.
- Students within the age of 11-17 years.

Exclusion Criteria
- Students less than 11 years
- Students greater than 17 years of age.

2.3 Study Design

It was a descriptive cross sectional study of students of Foundation Comprehensive College and Community Secondary School.

2.4 Sampling size Determination

A total number of 360 students were selected from the study population. The sample size was derived thus:

The population of children with reduced visual acuity as shown from other studies is 30.8%, as referred from a work carried out Kasmann-Keller B and Rupercht K.W. in Germany [9]. This was taken as our working population. The precision tolerated was set at 5% at 95% confidence interval using the formula:

$$n = \frac{pq}{\left(\frac{e}{1.96}\right)^2}$$

Where,
n= sample size
p = working proportion = 30.8%
q = 100-p = 100-30.8 = 69.2%
e = margin of sampling error tolerated (5%), at 95% of degree of confidence.

$$n = \frac{30.8 \times 69.2}{\left(\frac{5}{1.96}\right)^2}$$

$$n = \frac{2131.36}{6.51}$$

n = 327
Attrition rate was taken as 10%. Therefore, adjusting for 10% attrition

$$= \frac{10 \times 327}{100}$$

= 32.1
= 33

Hence, adjusted sample size = 327 +33 = 360
Working sample size = 360 students.
School A = Foundation Comprehensive College, Aluu
School B = Community Secondary School Rumuekini Rumosi
The ratio of school A: School B = 1:3
Working sample size of school A = 90 students
Working sample size of school = 270 students

2.5 Sampling Method

A proportionate stratified Random sampling method was used. Each level represented a stratum i.e. JSS1, JSS2, JSS3, SSS1, SSS2 and SSS3.

Steps
1. Sampling frames were obtained from the study areas.
   Sampling frames:
   486 = for foundation Comprehensive College, Aluu.
   1200 = for Community Secondary School Rumuekini, Rumosi.
2. The contribution of each stratum (level) to the study population was noted.

School A: Foundation Comprehensive College, Aluu.

2a. Contribution of each stratum to the study population:

JSSI = 37, 37/486x100/1 = 7.61%
JSS2 = 52, 52/486x100/1 = 10.70%
JSS3 = 75, 75/486x100/1 = 15.43%
SSS1 = 89, 89/486x100/1 = 18.31%
SSS2 = 143, 143/486x100/1 = 29.42%
SSS3 = 90, 90/486x100/1 = 18.52%

3a.The percentage contribution of each level in school A to the sample size was determined.

JSS1 = 7, JSS2 = 10, JSS = 14
SSS1 = 16, SSS2 = 26, SSS3 = 17
Total: 7+10+14+16+26+17=90

4a. The subjects were randomly selected using a table of random numbers.

School B: Community Secondary School Rumuekini, Rumosi

2b. Contribution of each stratum to the study population was noted.

JSSI = 250, 250/1200 x100/1 = 20.83%
JSS2 = 230, 230/1200x100/1 = 19.17%
JSS3 = 203, 203/1200x100/1 = 16.92%
SSS1 = 182, 182/1200x100/1 = 15.17%
SSS2 = 176, 176/1200x100/1 = 14.66%
SSS3 = 159, 159/1200x100/1 = 13.25%

3b. the percentage contribution of each level in school B to the sample size was determined.

JSS1 = 56, JSS2 = 52, JSS3 = 46,
SSS1 = 41, SSS2 = 40, SSS3 = 35

Total: 56+52+46+41+40+35=270
(Sample size for school B)

4b. the subjects were randomly selected using a table of random numbers.

3. Study Instruments

3.1 Snellen chart

This is an eye chart used to measure distant visual acuity. The symbols on chart are known as optotypes. The optotypes have the appearance of block letters and are intended to be seen and read as letters. Each line of letters is noted from the top to the bottom respectively;

$$\frac{6}{60}, \frac{3}{36}, \frac{6}{24}, \frac{6}{18}, \frac{6}{12}, \frac{6}{9}, \frac{6}{6}, \frac{6}{5} \text{ and } \frac{6}{4}$$

For this study, a three metre snellen chart was used (reverse snellen chart)

3.2 Pinhole occlude

The pinhole occlude is an opaque disc with one or more small holes, which is used to test VA. It is a sampling way of focus light, temporarily removing the effects refractive error. Hence, it is used to distinguish visual effects by refractive error, which improves when the pinhole occlude is used from other problems which do not.

3.3 Data form

This is a form which consists of the biodata and the result of the screening in each eye. A copy of the data form, questionnaire and the photograph of the instrument is shown in the appendix.

3.4 Questionnaire

The questionnaire consists of parts.

a. The biodata
b. Asthenopic symptoms

The biodata was comprised of age, sex, class and parent's occupation. The asthenopic symptoms were particularly of the ocular symptoms. Thus, questions used to elicit these symptoms included; itching, redness, ocular pain, tearing, headache and none (that is, is the respondent did not have any of the symptoms listed above).

3.5 Study Procedure

The principals for the two schools were contacted and an informed consent was obtained after a detailed explanation of the purpose, content and benefit of the study. The students were also made to understand the essence of the screening and specific conducted in a hall with normal day light lighting.

A six meter distance was mapped out and the snellen chart was placed at one end. A seat was placed at the other end of the distance with the back of the seat directly on the sis meter line. The right (R) eye was the let (L) eye with an occlude without pressing tightly. The child was not allowed to squint, tilt-head or close occlude eye.

The child was told to read the letters on the chart from top to the bottom moving across the line from right to left using a pointer. If any student failed to read a line, it was repeated in the reverse order. If the line was failed twice, the visual acuity (VA) is taken as the next higher line read correcting. The procedure was repeated with the right eye occlude. The pinhole was used for children with visual Acuity (VA) less than or equal to 6/9.

For subjects using spectacles, Visual Acuity (VA) with spectacles was tested and recorded. The visual Acuity (VA) was recorded as a fraction where the numerator (top number) represents the distance from the chart while the denominator (bottom number) represents the lowest line read correctly on the chart.

3.6 Data Analysis

Information obtained from the data form and questionnaire used for the screening exercise were analyzed manually by sorting and tallying. Summary statistics, simple frequency, cross tabulations and chi square test computed. The cut off for normal distant visual acuity was taken to be vision of greater than or equal to (6/6, 6/5 or 6/4) using the Snellen chart.

Visual acuity of less than or equal to 6/9 ($\leq$6/9) was taken as criteria for reduced visual acuity because WHO criterion for 1000 vision (VA$\leq$6/18 in the better eye) is already grossly subnormal for school children. The students with refractive error were defined by those whose reduced vision improved with pinhole.

3.7 Study Limitation

i. Some children who were selected declined the test for reason not known.
ii. Some children may have pretended not to see some of the letters on the chart.
iii. Some children may have memorized the chart which would affect the outcome

4. Result Analysis

4.1 Introduction

The visual acuity of three hundred and fifty students of two schools; community secondary school Rumuckini 260 (74.28%) and Foundation secondary school Aluu (90) (27.7%), were tested. Out of the three hundred and fifty students selected (350). Ten students did not participate in the screening exercise (3 were absent 7 declined). Hence, the response rate was 97.22% and the attrition rate 2.78%. 100% response from Foundation Comprehensive College and 96.15% from Community Secondary School, Rumuekini. The students tested were between the ages of eleven and seventeen years (11-17) Seventy students (20.00%) were within the ages of 11-12 years, one hundred and fifty three students (43.71%) were within the ages of 13-15 years and one hundred and twenty seven (36.29%) were within ages of 16-18 years.

Table 1: A table showing the standard deviation of age distribution

Class Interval	Class mark[x]	Absolute freq [f]	Relative freq[%]	fx	x-x-3.5	$(x-x)^2$	$F(x-x)^2$
10-12	11	70	20	770	-3.5	12.25	857.5
13-15	14	153	43.71	2142	-0.5	0.25	38.25
16-18	17	127	36.29	2159	2.5	6.25	106.25
total		350		5074			1002

$$\overline{X} = \frac{\sum fx}{\sum f}$$

$$\overline{X} = \frac{5074}{350}$$

$$\overline{X} = 14.50$$

$$S = \sqrt{\frac{\sum f(x-x)^2}{n-1}} = \sqrt{\frac{1002}{350}} = 1.69$$

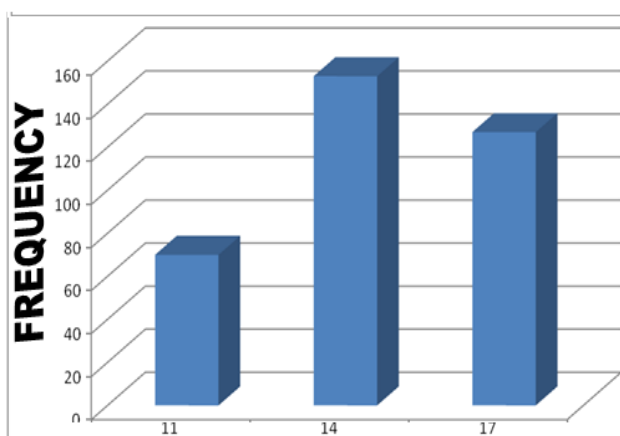$$\text{Mean} \pm \text{SD} = 14.50 \pm 1.69$$

Figure 1: showing age distribution

Among the students tested, there were more females than males. The females were 200 (57.14%), with 40 from foundation and 160 from CSS Rumuekini. One hundred and

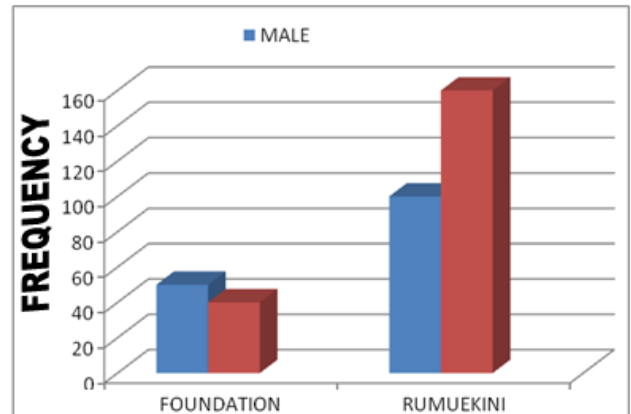fifty (42.85% were males, 50 from foundation and Hundred from Rumuekini.

Figure 2: Bar chart showing sex distribution of each school.

Of all the students tested, 59 (16.86%) were in JSS1 (foundation 7, Rumuekini 52), 57 (16.29) were in JSS2 (f10, R40), 60 (17.14) were in JSS3 (F14, R46), 56 (16.28%) were in SSS1 (F16, R40), 60 (17.14%) were in SSS2 (F26, F34), AND 58 (16.57%) were in SSS3 (F17, R41).

Table 2: A table showing frequency distribution of class and sex

School	Male	Female
JS1	17	42
JS2	25	32
JS3	26	34
SS1	20	36
SS2	30	30
SS3	32	26

4.2 Proportion with Normal Visual Acuity

Out of the three hundred and fifty students tested, two hundred and fifty one (71.71%) had a visual acuity of 6/6 or 6/5 or 6/4 in either eye of which 45 (17.92%) were between ages 10-12 (F10, R35), 118 (47.20%) were between ages 13-15years (F30, R88) and 88 (35.20%) were between ages 16-18 (F28, R60).

Table 3: A table between age distribution and normal vision

Age	Normal
10-12	45
13-15	118
16-18	88

4.3 Proportion with Reduced Visual Acuity

A total of Ninety nine (28.28%) students have reduced visual acuity that is visual acuity of 6/9 or worse. Of this number, 29 (29.22%) were within ages 10-12 years (F4, R25), 33 (33.33%) were between ages 13-15 (F6, R27) and (37.37%) students were within ages 16-18 years (F12, R25).

Out of the ninety-nine students with reduced visual acuity fifty-five (55.56%) were females (F12, R43) and forty-four were (44.44%) males (F8, R36%). Out of the ninety-nine students with reduced visual acuity fifty-five (55.55%) were females (F12, R43) and forty-four were males (F8, R36). Out of the ninety-nine students with reduced visual

acuity (79.80%) had refractive error (F15, R64) and 20 (20.20%) had visual acuity problem with the macula (F7, R13).
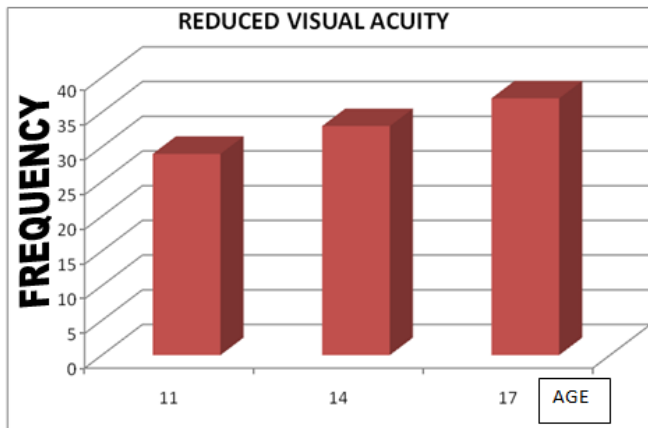

Figure 3: A bar chart showing age distribution and reduced visual acuity

4.4 Proportion with Asthenopic Symptoms

Out of the three hundred and fifty students tested, 194 (77.29%) students with normal visual acuity had asthenopic symptoms and 57(22.71%) with normal visual acuity do not have asthenopic symptoms. While 80 (80.81%) students with reduced visual acuity had asthenopic symptoms and 19 (19.19%) do not have asthenopic symptoms.

4.5 Association between Visual Acuity and Asthenopic Symptoms

Table 4: A two by two chi-square of visual acuity and asthenopic symptoms

Visual acuity	Present	Absent	Total
Normal	194	57	251
Reduced	80	19	99
Total	274	76	350

Assuming the null Hypothesis (H_0) = There is no significant association between visual acuity and asthenopic symptoms.

H^1 = There is significant association between visual acuity and asthenopic symptoms.

To calculate, Expected value (E) = $\frac{R_T \times C_T}{GRAND\ TOTAL}$

Where R^T = ROW TOTAL

C_T = COLUMN TOTAL

$X^2_{cal} = \sum \frac{(observed-Expected)^2}{Expected}$

$X^2_{cal} = 0.0318+0.1147+0.0806+0.2907$

$= 0.5178$

$= 0.52$

Degree of freedom (D_F) = (r-1)(C-1)

α = (0.05 (i.e 5%)

D_F (2-1)(2-1)=1

$X^2 = 3.84$

Since $X^2_{tab} > X^2_{cal}$ this accepts the null hypothesis which means that there is no significant association between visual acuity and Asthenopic symptom.

5. Discussion

In developed countries, screening for eye diseases in preschool and school children is done routinely even though there is an active debate about its value and cost effectiveness. Screening is mainly directed towards identifying children with amblyopia, strabismus and refractive error. In most Africa countries, no national preschool or school age screening service exists. Screening is only performed sporadically by some local eye personnel. The majority of the children never have an eye examination [10] Although the benefits of vision screening seem intuitive, the value of such programmes in Junior and senior schools has been questioned.

Recent studies have highlighted the importance refractive error as one of the leading causes of visual impairment. As a consequence, the World Health Organization has adopted the correction of refractive errors in developing countries as one of its main priorities of this "vision 2020: the right to sight" initiative.[11]

In our study, we used asthenopia (eye strain) as a measure of adverse effect of reduced visual acuity on the health of secondary school students. 251 students (71.71%) had normal Visual Acuity out of the 350 students. This was similar with findings obtained in other reports. Lopes et al in Brazil showed a high prevalence of 82.9% and 80.2% among children attending public and private schools repectively.[12] While Kasmann-Keller B and Ruprech KW reported a slight lower prevalence to 69.2% among children starting primary school in Saarland Germany.[13]

Out of 350 students studied, 77.29% (194) of students with normal visual acuity had asthenopic symptoms, and 80.81% (80) of the 99 students with reduced visual acuity had asthenopic symptoms. In our study there was no significant association between visual acuity and asthenopic symptoms. (X^2 calculate = 0.52, X^2 tabulated = 3.84, degree of freedom = 1, ض-value = 0.05. Therefore X^2 tabulated > X^2 calculated).

There has been little research on the relationship between reduced visual acuity and asthenopic symptoms. From our literature search, the only available published article was by Yuval Cohen, Orisigal et al on correlation between asthenopic symptoms and different measurements of convergence and reading comprehensions and saccadic fixation of eye movements. Asthenopic symptoms were scored by an asthenopic symptom questionnaire. The development of eye movement ratio score correlated with the asthenopic symptom scores (r=0.32, p=0.001), but the reading comprehension test score did not (r=0.12, p=0.4).[14] These findings show that asthenopic symptoms have a higher prevalence in students with reduced visual acuity than those without reduced visual acuity.

6. Conclusion

The adverse health impact of reduced vision on the health of children is asthenopia (eye strain). Not many works exist on this. However, it is on records that reduced vision often results in a low motivation to explore the environment, initiate social interaction, and manipulate objects. Unlike what is believed that asthenopia results from reduced vision, in this study series there was no relationship between reduced visual acuity and asthenopic symptoms.

7. Acknowledgements

References

[1] Wikipedia. Visual acuity. httt://en.wikipedia.org/ wiki/visual_acuity; Assessed on 23/02/2012. Retrieved on 23/02/201

[2] Krissa Lyse B. Drentlaw, COT. Visual Acuity, the critical measure. http://www.atpo.org /visual%20 Acuity%20the%20Critical%20Measure!.pdf; Assessed on 22/02/2012. Retrieved on 22/02/2012.

[3] Griffin JR, Princeton, Radley Opticians, Contact lens doctor. Definitions visual acuity http://www.google.com.ng/search?hl=en&defl=en&q=d efine:visual+acuity&ei=GEC6sdfdAZWyyQWomjmjB g&sa=X&oi=glossary_definition&CE=tittle; Assessed on 28/02/2012.retrieved on 23/02/2012.

[4] America Foundation for the Blind (n.d.). Statistics and sources for Professionals. Retieved 21/09/2011 from http://www.afb.org/section.asp?SectionID=15&Docume ntID=13

[5] Huebner, K.m., Merk-Adams, B., Stryker, D., & Wolfe, k. the national agenda for the education of children and youths with visual impairments, including those with multiple disabilities. New York: AFB Press; 2004.

[6] National Dissemination Center for Children with Disabilities. (2004), Fact sheet 13. Retieved October 01, 2011 from www.nichy.org/pubs/facthe/fstxt.htm

[7] Spungin, S. When you have a visually impaired student in your classroom: A guide for teachers, New York: AFB Press; 2002

[8] Turnbull, A., Turnbull, R. & Wehmeyer, M.L. Exceptional lives special education in today's schools, 2007. Upper Shaddle River, NJ: Pearson Merill Prentice Hall.

[9] Chia EM, Mitchell p, Rochtchina E, et al. Unilaternal visual impairment and health related quality of life: the Blue Mountains Eye Study. Br J Ophthanlmol. 2003; 87:392-395.

[10] Susanne H W eder, David A Ross, Rebecca Balia. Prevalence of eye disease in primary school children in a rural area of Tanzania. Br J Ophthalmol 2000; 84:1291-1297.

[11] C-SDH$_o$, C-BCHg, Ngeow, R Wigaya. Uncorrected Refractive errors in Singapore teenagers. British Journal of Ophthalmology 2006; 90:202-207.

[12] Sharma seema, BM Vanshisht, Kalhan Meenakshi, Goel Manish. Magnitude of Refreactive errors among school children in rural block of Haryana. The Internet Journal of Epidemiology 2009;6(2).

[13] Kasmann-Keller, Ruprechi KW, Vision screening survey of all children starting primary school in 1998 in the federal state of Saarland, Germany. Strabismus 2000;8(3):201-207

[14] Yuval Cohen, Ori Segal et al, Correlation between asthenopic symptoms and different measurements of convergence and reading comprehension and saccadic fixation eye movements, optometry St Luis mo(210) volume;issue 1 page 28-34

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