Comparison of the Effect of Enlarged Print VS a Hand Held Visolett Magnifier on Reading Performance in Fully Sighted Children.

Naomi Roediger, BAppSci(Orth)[1]
Sue Silveira, DipAppSc(Orth) MHealthScEd[2]

[1] Hunter Street Eye Specialists, Sydney, Australia
[2] Discipline of Orthoptics, University of Sydney, Sydney, Australia

ABSTRACT

Introduction: The aim of this project was to determine if reading performance in terms of reading speed, accuracy and comprehension was affected by use of two low vision aids (LVA) a Hand-Held Visolett Magnifier (HHVM) and enlarged print.

Method: Data was collected from 21 students in year 4, all fully sighted. Their reading performance was assessed whilst reading with a HHVM, with enlarged print and without a LVA. Reading performance was assessed using the Ekwall and Shanker Reading Inventory, which included a measurement of reading speed, accuracy and comprehension.

Results: Students gained maximum reading speed and accuracy with the enlarged print and without a LVA. Reading with the HHVM caused a reduction in reading speed and accuracy, however there was no difference in the comprehension scores between the three conditions.

Discussion: The enlarged print allowed the students to demonstrate a higher level of reading speed and accuracy when compared to reading with the HHVM, primarily due to the influence of the device and the student's inexperience as opposed to a reduction in the reading performance. This influence may be minimised with a period of training and adaptation to the HHVM. Reading comprehension was not affected when either the HHVM or enlarged print was used.

Keywords: Low vision aids, reading performance

INTRODUCTION

Being able to read is seen as one of the most important activities in today's society, and much of the way we learn, work and socialise is literacy bound. The development of reading ability is important in the learning processes of all children. Reading is a complex system of knowledge and activities which may be divided into four interrelated processes[1], including the phonological, meaning, mapping, and orthographic processes. The phonological process refers to the pronunciation of the written word[1]. The meaning and mapping processes contain the knowledge of word meaning and an ongoing understanding of the text[2]. The orthographic process is responsible for perceiving the sequence of letters in the text and is the first to be initiated as reading depends foremost on visual letter recognition[2]. A visual system that is able to resolve written words clearly and correctly is essential for children who are developing their reading skills[2] and the presence of vision impairment may seriously impede the child's progress[3].

The primary aim of reading is to develop understanding of the written text. Reading performance should therefore be assessed in terms of this understanding, that is, how the reader gains meaning, significance, enjoyment and value from the printed text[4]. When assessing oral reading, that is reading a passage aloud, the student's speed, accuracy and comprehension can all be used as specific measures of reading performance[1]. Reading speed is measured by the number of words read per minute and reading accuracy is measured by the number of individual errors recorded[5]. The assessment of reading accuracy is often termed miscue analysis and can be defined as the actual observed response, which does not match the expected response[6]. The miscue analysis allows insight into the reader's understanding of the text and aids in the evaluation of their reading performance. The aim of testing reading comprehension is to allow the

Correspondence: **Sue Silveira**
Discipline of Orthoptics, University of Sydney, NSW, Australia
Email: s.silveira@usyd.edu.au

student to express what they have learnt from the passage. This is assessed by testing the immediate recall of the main idea of the narrative through oral questioning.

The World Health Organization defines low vision as a permanent vision loss resulting in a visual acuity of less than 6/18 which cannot be medically or optically corrected[7]. The majority of low vision patients will seek support with reading8 and low vision aids (LVA) have been found to provide visual rehabilitation to a very high percentage of low vision adult readers[10]. Low vision children can also be assisted in their reading development by the use of LVAs. The selection of a LVA is usually dependant upon the child's residual vision and personal preference. Two common methods used to assist children with low vision are enlarged print and optical magnifiers.

Previous research has been conducted to compare how LVAs impact on reading performance, but frequently reading speed, in isolation from accuracy and comprehension, has been the only measure used to indicate reading performance. For example, in fully sighted adults who read with a magnifier, it has been shown that initially their reading speed is affected, i.e. speed reduces as the amount of magnification increases, possibly due to a mismatch with saccadic eye movements and the amount of magnification[11]. A decrease in the forward length of the saccade with an increase in the retrace movement has been shown to occur when reading with a magnifier[12]. However, this influence on reading speed has been found to be within 20% of normal reading speed, regardless of the type of LVA used[13]. Studies have shown stand magnifiers to cause maximum reduction in reading speed, with the least reduction caused by microscopes[14].

Similar studies have been conducted on low vision adults, finding that the reading speed may not differ significantly depending on whether large print or a magnifier is used, once the reader becomes experienced in using the LVA[8]. For low vision children the situation is much the same, once adequate training in the use of the LVA has been provided[8].

However, reading is a complex activity that cannot be conclusively assessed using a single measure. Reading speed only measures one aspect of oral reading and does not provide an indication of accuracy and comprehension as reading speed does not always correspond with reading performance[4]. The measurement of reading speed, accuracy and comprehension could provide a better picture of how a LVA affects a child's reading performance. An assessment of reading performance of fully sighted children whilst using a LVA could provide a more accurate indication of the influence of LVAs on these specific aspects of reading performance. This information may then assist clinicians in the prescription of the LVAs which are likely to maximise reading performance.

The present study assessed the reading performance of fully sighted children under three conditions. These conditions were reading with an optical magnifier, enlarged print, and without any aids, (termed standard reading). These two LVAs were selected because previous research[15,16] has shown that the performance of an optical magnifier and enlarged print with respect to reading speed and comprehension were comparable. However a comparison with respect to reading accuracy has not been carried out.

The aim of this study was to assess the effect the three reading conditions had on reading performance. By selecting fully sighted children the impact of reduced vision was controlled for.

METHOD

Participants

A sample of 21 year four students (19 females and 2 males) was taken from an independent primary school in Sydney. Year four students were selected because they have reached a stage at which they can read an extensive range of texts independently, respond to a variety of themes and issues and when reading aloud use appropriate stress, pause and intonation[18].

Before students were selected for the sample, a subject information statement and informed consent form were distributed outlining the aims for the research and what their participation involved. Students were then included in the sample once signed informed consent was gained from either their parents or guardian.

All students selected for the sample underwent vision screening to ensure an equal standard of vision, straight eyes and a normal range of eye movements. This vision screening assessed six aspects of visual function. Visual acuity was measured at 1/3 metre using the Maclure Bar Reading Book and at 6 metres using the Snellens Chart. Students with vision of 6/6 and N5 or better in both eyes were included in the sample as this was considered normal vision.

A cover test was performed at 1/3 metre and 6 metres, assessing the student's ocular posture. Students with an exophoria greater than 8, esophoria greater than 4, or with any vertical or manifest deviation were excluded from the study. These criteria ensured that children with a poorly controlled heterophoria which could potentially disrupt reading were not included in the sample.

Each student's convergence near point was measured using the 'pen to nose' technique. Students who were unable to converge to within 5cm of their nose were excluded from the sample. This criterion ensured that only students with good binocular control of their eyes were included.

Ocular movements were completed for all nine positions of gaze and students with a significant A or V pattern were excluded from the sample; significant A or V pattern was considered as a difference of greater than fifteen dioptres for an exo deviation and ten dioptres for an eso deviation[18]. This criterion ensured that students whose heterophoria increased in depression were not included in the sample.

Lang Stereotest was used to measure the amount of stereoacuity in seconds of arc. Students who did not demonstrate stereoacuity of 200 seconds of arc or better were excluded due to a lack of high quality binocular single vision.

Materials

The Hand Held Visolett Magnifier (HHVM) of 1.8 times was selected for use in this study due to its ease of use, availability and the fact that it is a commonly prescribed LVA by Vision Australia for low vision children[19]. The HHVM consists of a high powered convex lens surrounded by a plastic carrier, causing an increase in print size and a reduction in the field of view available for reading.

Enlarged print refers to any size print that is larger than normal and generally refers to 18 or 24 point type[20]. To obtain the enlarged print, each piece of text was enlarged by 1.8 times so the size of the text was the same size as the text seen through the magnifier. This created approximately 24 point type, which also equated to type seen through the HHVM.

Procedure

The subject's reading performance was assessed under three conditions, reading with the use of the HHVM, enlarged print and reading without a LVA (standard reading). The three test conditions were administered in random order to eliminate a learning effect.

Reading was assessed using the Ekwall and Shanker Reading Inventory[21]. The inventory contains four equivalent reading passages written by Ekwall using the Harris-Jackson Readability Formula[21]. The passages were divided into two sections. Passages A and C were designed for assessing oral reading and B and D were designed for the assessment of silent reading. However in this study, the two silent reading passages were used for the assessment of oral reading, which allowed for four passages, one for practice and the remaining three for testing. The reading passage for each of the reading conditions was randomised. Each passage contained ten sentences, each of which related to a comprehension question, creating a total of ten questions.

Three aspects of reading were analysed during the reading assessment. Each student's reading rate was calculated as the time taken to read the complete passage divided by the number of words in the passage, to provide a word per minute ratio.

The reading accuracy errors were divided into six different categories. Omissions occurred when the student failed to read a word in the passage. Insertions occurred when another word was added into the text. Substitution occurred when a similar word to that printed on the page was spoken and repetition occurred when a word or phrase was repeated by the student. Mispronunciation and words which were pronounced for the student when they were unable to decode the word in less than five seconds were also included as errors[21].

To obtain a reading accuracy score the total number of errors for each passage was counted and recorded. Words which were self-corrected, a disregard for punctuation and pauses of less than five seconds were not counted as errors. The counting of repetitions followed the suggested guidelines[21]. A high accuracy score indicated poor reading accuracy and a low score indicated an excellent reading accuracy. To enable a reliable measure of reading accuracy, the student's reading was tape-recorded and the miscue analysis was conducted once the testing was completed. The students were required to respond to questions verbally, assessing reading comprehension. This created a comprehension score out of ten. The students' answers were not required to be identical to the model answers on the scoring sheet to be judged as correct. A reasonable answer which meant the same as the written answer (such as Dad or Father) was judged as correct. When the student gave an answer which was unclear, the researcher prompted the student with a neutral question, such as 'Can you tell me more?', thus allowing the student to clarify their answer and ensure scoring accuracy; this method also followed the suggested guidelines[21].

The reading assessment occurred within the school grounds with only the student and researcher present in the testing room. The student was seated at a writing desk on an adjustable seat which could be moved to a height at which the student felt most comfortable.

The testing order of the three reading conditions was randomised. For each reading condition the student was instructed to read each passage as they would normally read aloud in class.

When reading with the HHVM, each student was given instruction on how to use the HHVM and allowed time to practice. The aim of the practice time was to familiarise the student and improve the student's manual dexterity while using the HHVM. However this practice time was only short, hence the student's lack of experience with the use of the HHVM could not be completely eliminated. When reading with the HHVM the student was instructed to maintain a constant distance between themselves and the HHVM to control for distance. This was monitored by the researcher. As with the HHVM, the student was allowed a period of time in which to familiarise themselves with the enlarged print and given a brief practice time.

Design and Analysis

A repeated measure design was used to analyse the results of the study. The independent variable was the type of LVA used and the dependant variable was reading performance, which was divided into reading speed, accuracy and comprehension. The data was analysed by a series of planned contrasts for each of the dependant variables; this is the most powerful form of analysis. A supplementary analysis using the Spearman rank order correlation was conducted to determine any relationship present between the dependant variables. Prior to the analysis the assumption that all three passages would be read at the same average speed was checked with an analysis of variance, followed by post hoc Scheffe tests to determine if all three test passages were read at the same speed.

RESULTS

Assumptions checks

A multiple comparison Scheffe test was used to test all four of the reading passages used for the testing procedure. This preliminary analysis was performed to determine if there was any difference between each reading passage in terms of speed, accuracy or comprehension. Passage B had significantly lower reading speeds when compared to passage C and D when the passage was used for standard reading (Table 1). There was no difference in reading speed between passage A and B. However, the average overall reading speed was the same whether passage B was included or not, hence to correct for passage B in the reading analysis was unnecessary. No other statistical differences were found when the other reading passages were compared.

Planned Contrast Results

Reading performance data was collected from twenty one year four students (2 males and 19 females) over a three month period from May 2002 to July 2002.

Descriptive statistics and within subjects' planned contrasts were performed to compare the results between standard reading, enlarged print and HHVM. Standard reading was used as the control condition.

Maximum reading speed was obtained by either reading with enlarged print or standard reading (Table 2). The standard reading speed was significantly higher than the enlarged print and HHVM combined ($F_{1,20} = 5.37$, $p = 0.031$). This difference appeared to be due to the lower score for the HHVM, which was significantly lower than the enlarged print reading speed ($F_{1,20} = 25.56$, $p<0.001$).

The HHVM had the highest mean of accuracy errors (Table 3). The HHVM accuracy score was significantly higher than the enlarged print and standard reading combined ($F_{1,20} = 9.184$, $p = 0.007$). However there was no difference in accuracy score between the enlarged print and standard reading ($F_{1,20} = 0.329$, $p = 0.573$).

Reading comprehension scores were compared across the three test scenarios. The mean comprehension score (out of ten) was equal for standard reading and enlarged print (Table 4). Although the comprehension scores for the HHVM appeared to be lower than the enlarged print and standard reading, this showed no statistical significance ($F_{1,20} = 1.191$, $p = 0.288$).

Supplementary Analysis

A Spearman rank order correlation was conducted to determine whether any relationship between speed, accuracy and comprehension was present. A Spearman correlation was selected to minimise the effect of significant outliers impacting the correlation.

There was a significant correlation between reading speed and accuracy for both standard reading and enlarged print. There was a negative correlation between standard reading speed and accuracy ($r = -0.520$ $p = 0.016$) indicating that as reading speed increased the accuracy scores improved. This relationship was also present for the reading speed and accuracy scores achieved with the enlarged print ($r = -0.606$ $p = 0.005$). This relationship did not occur whilst reading with the HHVM indicating that some other factor was causing the reduction in reading accuracy. The comprehension scores showed no correlation with reading speed or accuracy.

Table 1. Results of multiple comparison Scheffe test for reading without a LVA.

Dependant Variable	Passage (I)	Passage (J)	Mean Difference (I-J)	Sig.
Reading speed	B B	C D	-61.6389 -51.2295	0.005 0.017

Table 2. Descriptive statistics for reading speeds obtained for standard reading, enlarged print and HHVM (N=21).

	Mean	Std. Deviation
Standard	132.4829	32.8912
Enlarged Print	133.8183	28.1705
HHVM	108.6769	23.5614

Table 3. Descriptive statistics for accuracy scores obtained for standard reading, enlarged print and HHVM (N=20).

	Mean	Std. Deviation
Standard	6.9000	5.2806
Enlarged Print	6.3500	4.5105
HHVM	11.1500	9.7185

Table 4. Descriptive statistics for comprehension scores obtained for standard reading, enlarged print and HHVM (N=21).

	Mean	Std. Deviation
Standard	7.8095	1.6006
Enlarged Print	7.8095	1.1670
HHVM	7.4762	1.9396

DISCUSSION

The aim of this study was to determine whether reading performance was influenced by using a HHVM or enlarged print. The use of fully sighted subjects eliminated the confounding variable of low vision, thus allowing the comparison of reading performance between each of the reading conditions to be made more clearly.

The results of this study indicated that standard reading and enlarged print allowed students to demonstrate a higher level of reading performance over a short period of time, when compared to the reading performance achieved with the HHVM. This was due to the HHVM causing a reduction in reading speed and accuracy. It has been shown that for adult readers and users of LVAs there is no significant difference in reading speed with enlarged print and optical magnifiers[8]. The reduction of reading speed in this study may have been due to the reader's inexperience with the HHVM and the reduced field of view caused by the device. When reading with the HHVM, students were required to concentrate on moving the HHVM smoothly and fluently across the page whilst maintaining comprehension. The task of using the HHVM, along with the students' lack of familiarity with the device may have been a contributing factor to the reduction in reading speed. The HHVM also caused a reduction in the field of view available for reading due to the optical magnification, although this was quite low in this study, at 1.8 times magnification. Other studies have reported a similar effect, although a much increased magnification was used[22]. The same phenomenon has been found in low vision readers who lacked experience in using magnifiers. Once experience was gained and the low vision readers adapted to the LVA, their reading speed was found to catch up[8].

When reading with standard or enlarged print the results showed that as reading speed increased, reading accuracy also improved. However, this relationship did not occur whilst reading with the HHVM, indicating that reading accuracy is not dependant upon how fast the passage is read but dependant upon some other factor. When reading with the HHVM, three students had reading accuracy scores in excess of 24, primarily due to a high number of word omissions. The high number of word omissions was caused by the students experiencing problems finding the beginning of a new line or loosing their place whilst reading across the line, resulting in a reduced accuracy score. The reduction in reading accuracy whilst reading with the HHVM may also be due to difficulties the students experienced adapting to the use of the HHVM as opposed to a reduction in their reading performance.

The reading comprehension scores were consistent across each of the three test conditions. A correlation analysis showed comprehension ability was not dependant upon reading speed or accuracy. This result supports other findings that reading speeds are not predictive of comprehension ability in low vision adults[23]. It has also been shown that when the presentation of reading material is intentionally slowed, reading comprehension is not affected[24]. Therefore, it should not be assumed that a reduction in reading speed and accuracy will cause a reduction in reading comprehension.

Enlarged print allowed the students in this study to demonstrate a high level of reading performance, however enlarged print is not readily available to all low vision students in activities of daily living. Therefore it is important that low vision students learn to use an optical magnifier, both within and outside the school environment. Proficient use of an optical magnifier will ensure the low vision student can read letters, labels whilst shopping and other reading tasks that are required for activities of daily living.

Thus, when assessing a low vision child's reading performance prior to prescription of LVA, it could be recommended that reading speed, accuracy and comprehension be considered. Conclusions can be drawn from this research for the cohort studied, i.e. a small group of fully sighted year 4 students. It was demonstrated that aspects of the child's reading performance will be influenced by the introduction of the LVA, however, this effect is temporary, and with training in the use of the LVA, will be minimised. Most importantly, during this training period, the child's comprehension of the text should not suffer, despite a reduction in reading speed and accuracy. Further research needs to be undertaken to determine whether a similar effect would be found on a cohort of children who are older and thus are involved with reading which has increased academic demands.

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