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Reading rate of low vision children using optical devices: A pilot study

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Background: Visual impairment in children negatively impacts their learning ability compared with their normally sighted peers and the use of optical devices may in turn assist the learner in their educational pursuit.

Aim: To determine the reading rate of children with low vision, with and without the use of optical devices.

Setting: The study was conducted at an eye clinic in KwaZulu-Natal.

Method: A pilot study was conducted on 15 children with low vision, aged between 6 years and 19 years (mean = 13.86 ± 3.34 years). Reading rate was assessed at near, using the English Paediatric Rate of Reading Test, and evaluated with and without the use of optical devices.

Results: The mean reading rates were 59.32 word per minute (wpm) ± 24.08 wpm and 67.04 wpm ± 25.63 wpm without and with the optical device, respectively ($p = 0.087$).

Conclusion: While this was a pilot study having implications on statistical significance, the results indicated an improvement in reading rate with optical devices compared with without.

Contribution: Vision is integral for the efficient performance of daily tasks. Improved reading performance relates to a happier child despite their visual limitations, hence managing low vision effectively impacts scholarly progression as well as quality of life including physical, mental and social well-being of the child.

Keywords: vision; impairment; reading; rate; low vision; optical; devices.

Introduction

Reading is an essential component that drives the learning process and can be assessed through the measurement of reading rate.[1,2,3] Reading rate is defined as the number of correct words read in 1 min and reflects the basic reading processes when the reader interacts with the text.[4,5] Irrespective of a child having normal vision or visual impairment such as low vision, the access to educational curriculum should be equivalent. Children with low vision should have ample resources such as low vision devices to facilitate the learning process.

The World Health Organization clinically defines low vision through measurements of visual acuity and visual fields,[6,7] while other authors expanded this definition to functional implications related to daily activities, communication, work and even learning.[8,9] Children presenting with low vision should not be functionally disadvantaged and have a right to uninhibited access to their environment and education. While extensive research on the impact of low vision on the adult population, without the use of optical devices, has been conducted,[10,11,12] Virgili et al. found a variation in the reading performance of adults across a range of optical devices.[13] The results, however, were inconclusive because of the restricted sample size in the study. Lovie-Kitchen et al. assessed the reading performance of children with low vision and revealed that children with visual impairment, despite low acuity reserve, are able to utilise their limited vision better than adults, thereby achieving a better reading rate.[14] They further suggested that with the use of appropriate magnification, reading performance would be comparable to normally sighted peers. From a pedagogical perspective, however, there is a lack of research and evidence to support effective strategies to assist children with visual impairment. Coping with the challenges of low vision and yet being expected to excel and progress comfortably through their schooling years, should therefore become a public concern requiring holistic interventions and management.

The use of low vision devices and rehabilitation in the management of children with low vision enables functional use of their residual vision.[11] This study therefore aims to provide evidence to support future research regarding the provision of optical devices to children with low vision to facilitate efficient reading and progressive learning.

Research methods and design

A quantitative quasi-experimental study design was used in this research.

Instrument

Anecdotal evidence reveals that the reading rate assessment of low vision children is not routinely performed because of poor access of test charts with a range of visual acuities.[15,16,17,18,19] For this reason, the English Paediatric Rate of Reading (PRR) test was designed for primary school children presenting with normal vision or low vision.[20] The Paediatric Rate of Reading test was used in this study to collect quantitative data reflecting reading speed, errors and rate. The PRR test, available in Arial and Times New Roman, consists of six chart versions: A to F with visual acuities ranging from 1.0M (0.4 logMAR) to 4M (1.0 logMAR) corresponding to 6/15 to 6/60, respectively. Each version is different and contains random placement of words per line printed in black on a white background for maximum contrast. To ensure that the child is able to read the words on the PRR test, a pre-test chart is also included in the design, which contains the same words as that of the test. Each version of the PRR test has a separate scoresheet allowing the examiner to follow the reader as well as simultaneously record errors and rate.[20]

Study sampling

Two primary schools were selected randomly from a list of schools for the visually impaired within the province. While all the parents of the children from Grades 1 to 12 were provided with the study information and consent documents, only the first 20 children of whose parents signed the consent forms were included in the study. This included children from Grades 1, 2, 3, 4, 6, 8, 10 and 11 only. Both males and females, irrespective of ethnicity, were included in the study provided they passed the PRR pre-test. The aetiology of the low vision for the participants was obtained from the school clinical records that were completed by ophthalmologists. Considering that five learners were unsuccessful on the pre-test evaluation, only 15 learners continued to the PRR reading rate assessment.

The procedure for data collection

The overhead fluorescent lighting provided constant illumination as in a clinical setting during the visual assessment. Case history, near and distance unaided and aided visual acuities, retinoscopy, subjective refraction, colour vision, contrast sensitivity, internal ocular health evaluation and optical device selection were conducted on each participant as routinely performed during a low vision assessment. Distance and near visual acuity using the distance Bailey-Lovie and near logMAR charts of the right, left and both eyes, respectively, were measured and recorded in M notation and logMAR.

At this stage, for the initial reading rate evaluation without the assistance of a low vision device, the version of the PRR chart chosen was dependent on the visual acuity following refractive error correction. The PRR test with the Arial design was considered in this study as it replicated the font type used in most of the prescribed books of the learners. Dependent on the participants vision and preferred working distance, a test distance of either 40 cm or 25 cm was considered and maintained using a ruler while the PRR chart was placed on a reading stand. The illumination preferred by each child was considered and used during this reading rate evaluation process. The errors made and reading rate were measured without devices and recorded as total errors (errors per minute [epm]) and words correctly read (correct words per minute [cwpm]) per minute following the procedure depicted by Nirghin.[20]

Subsequently, visual acuity and reading rate were re-assessed for each participant with an appropriate and preferred optical device providing the best near visual acuity. One child could read 1M at 25 cm without the aid of an optical device. A selection of hand and stand magnifiers were used for the reading rate evaluation depending on the preference of the participant. Many of the children were familiar with the devices as they had used such devices before. A few who had not used them before were trained prior to the reading rate assessment.

Versions A, C, D, E and F of the Arial font PRR chart were used dependent on the participants visual acuity with the low vision optical device. The number of children who were examined with versions A, C, D, E, and F without low vision devices were 1, 4, 3, 5 and 2, respectively, followed by 12 children who used version A and two children used version D with the assistance of low vision devices. On one child, however, the low vision device did not make a clinical difference for near. The reading rate without and with the devices were analysed with the descriptive statistics and paired samples *t*-test using the Statistical Package for Social Sciences (SPSS) version 18 and presented as frequency distribution tables and figures.

Results

The demographic profile of the participants was black South Africans aged 6 years to 19 (mean = 13.86 ± 3.34) years. This included 80% females (n = 12) and 20% males (n = 3). The disparity in gender could be attributed to a greater population of females enrolled at the school, with females appearing more enthusiastic to participate in the study than males. Albinism (35.7%) and congenital cataract (21.4%) were the most common causes of low vision (Figure 1). Other causes

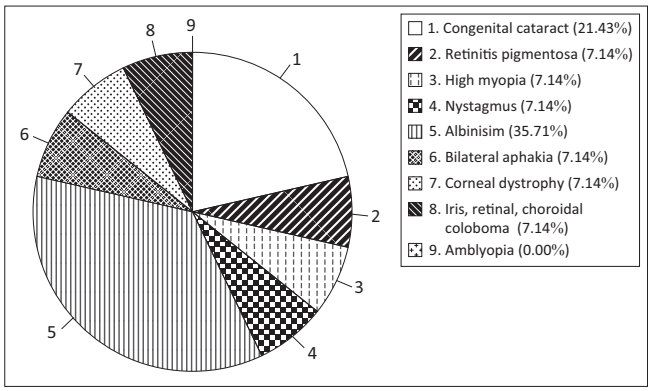
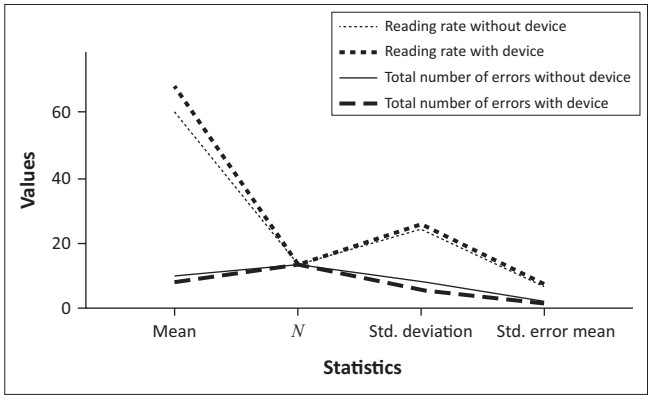


FIGURE 1: Percentage distribution of low vision aetiology of participants in the study.



N, number; Std., standard.

FIGURE 2: Reading rate and errors with and without optical devices.

were corneal dystrophy, coloboma of the iris, retina and choroid, retinitis pigmentosa, myopia and nystagmus as well as combination of the listed conditions.

The mean reading errors made by the participants and their reading rate without and with the low vision optical devices were 10 epm (± 8) and 8 epm (± 6) and 59.32 cwpm (± 24.08) and 67.1 cwpm (± 25.6), respectively (Figure 2). An increase in reading rate was observed from Grade 1 to 10 both without and with the low vision devices except for one participant in Grade 11 whose reading rate was 39 cwpm and 66 cwpm, respectively.

While Pearson's correlation coefficient ($r = 0.822$, $R^2 = 0.675$) showed a strong correlation, and the mean difference in reading rate without and with the devices (7.72 cwpm) suggests a clinical difference between the two sets of values, the lack of statistical significance ($p = 0.087$) may be because of small sample size.

Discussion

Basic and functional literacy should be assessed on low vision individuals.[8] Basic literacy includes learning and developing reading skills that is primarily addressed in an educational setting, while functional literacy pertains to reading and writing using existing vision to complete tasks in daily living.[21] The latter can be efficiently managed by eye care practitioners with the use of optical devices, thereby providing most children with low vision access to reading material.

In this study, the reading performance of the participants revealed lower errors when reading with low vision optical devices compared with without, with an overall improvement in reading rate by 85%. As reading rate is affected by errors made, lower errors positively impact reading rate. It was evident during the assessment that the accuracy of recording errors was dependent on the skill and attentiveness of the examiner and that the testing environment should be free of distractions.

The increase in reading rate across grades shown in this study is in accordance with a study by Legge et al.[22] The authors stated that as a child grows, there is greater reading exposure followed by an increase in vocabulary and a corresponding progression in reading rate irrespective of the child having low vision or normal vision.[22] Faster reading rate implies efficient automaticity reflecting improved fluency.[23] Low vision children, however, compared with that of normal sighted children for each age group, display a lower reading rate.[24] It was established that children with low vision, up to Grade 3, have a reading rate of 60 wpm.[25] In contrast, children with normal vision should read, on average, 53 wpm in Grade 1 to 107 wpm in Grade 3.[26] Low vision children from Grade 4 to 6 should read at 70 wpm, while older children should read approximately 90 wpm.[27] Reading rate norms for normally sighted children, in comparison, range from 123 wpm (Grade 4) to 150 wpm (Grade 6).[26] Furthermore, the reading rate, of children with low vision is dependent on the degree of visual impairment. Kalloniatis and Johnston found that in low vision children of 9 years or older, a positive correlation exists between reading rate and near visual acuity.[28] This could explain the reduced reading rate of 11 participants of Grade 11 participant presenting with a congenital cataract. On a positive note, a considerable improvement in reading rate of 27 cwpm was achieved by this learner with the low vision device despite still being lower than expected.

Rumney and Leat revealed that the forward saccade, when reading, is 6.8 characters in persons with normal vision as opposed to a smaller saccadic movement of 3.5 characters in those with low vision with the latter being influenced by abnormal ocular motility or reduced visual span.[24] Legge et al.[22] stated that provided the print size is standard, the visual span of low vision persons is reduced to that of normal vision persons. Studies reflect similar findings whereby persons with vision loss display slower reading rate compared with normal sighted persons.[29,30] Consequently, with the use of appropriate magnification when reading, children irrespective of having low or normal vision can achieve similar reading rates.[14,31]

While reading, the eye movements displayed with an optical magnifier differ from that of without the device.[32] The image of a line of print appears to move in the opposite direction to the device and according to

Dickinson and Fotinakis,[32] these eye movements resemble optokinetic nystagmus of which further studies are recommended. An increase in the device magnification results in a decrease in the field of view. This in turn decreases the forward saccade, hence reducing the reading rate. To compensate for this reduction in forward saccadic eye movement, the authors suggest a simultaneous increase in head movement in the direction of the reading to improve reading speed. As part of the training on using the low vision devices, the participants, were applicable, were advised on concurrent head movement while reading. Apart from eye movements in reading, a person with low vision using an optical device will have to also display hand movement whereby synchronised hand and eye movements are necessary to ensure a stable retinal image, which proved a challenge to some participants. This, however, was facilitated in the training process.

There were some limitations identified in this study that may impede on definite conclusions derived from the study results. The sample size was relatively low affecting the generalisation of the study results. The majority of the participants were female, hence a need for a more representative sampling of both genders in upcoming studies. Although the study did include a range of ocular pathologies, the degree of visual impairment and its psychological impact on reading performance was not established, which may contribute to the outcome of low vision management and should be explored in future research.

Conclusion

While this being a pilot study, the evidence displays the clinical relevance of interventions to manage the reading performance of children with low vision. This ensures maximum use of their residual vision to access curriculum and educational resources. The compounding effect is on their personal social and emotional well-being of the child living with low vision exhilarating its effect on their educational pursuit with a positive outcome in their adult life. Furthermore, the results may help inform future research and encourage holistic management of children with low vision, encompassing various sectors within the healthcare system, educational and social services.

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Competing interests

The author declares that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Author's contributions

U.N. is the sole author of this research article.

Ethical considerations

This study complied with the tenets of the Declaration of Helsinki with the procedures and likely consequences of the study explained to the parents of the subjects, in detail, followed by obtaining their informed consent. The study was approved by the University of KwaZulu-Natal Biomedical Research and Ethics Committee (HSS/0525/2009) and all guidelines stipulated by the committee were adhered to before and throughout the research study.

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Data availability

Data supporting the findings of this study are available from the corresponding author, U.N., on request.

Disclaimer

The views and opinions expressed in this article are those of the author and do not necessarily reflect the official policy or position of any affiliated agency of the author.

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