



Elucidating Dyslexia Spectacles

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ABSTRACT

Dyslexia is an incurable neurologically-based learning disability causing varying degrees of difficulties decoding language, affecting 15% of the population¹. Recent technological advances have introduced innovative devices to help people overcome literacy difficulties, but these can be expensive and inconvenient. Dyslexics need a more simplistic, convenient, cost-effective device to help them read faster with more accuracy. To solve this problem, a pair of assistive glasses were created to allow for more clarity and focus with a stimulative reminder of directional orientation, to assist dyslexics to read. Once constructed, the glasses were tested on 6 participants independently diagnosed with dyslexia. With the glasses, 83% of participants averaged a 16% faster reading speed and 32% more accuracy (Figures 1 and 2). Participants appeared relaxed and indicated that the glasses were more convenient than other devices that they have used, helping them focus and relax their eyes when reading. The prototype could benefit from design modifications such as adapting them to be wireless and incorporating a disable switch for the vibration motor for those that do not like or need the orientation reminder. With modifications, if further studies show similar results, the glasses could become integral in improving a dyslexic's quality of life.

INTRODUCTION

It is estimated by Dyslexia International that more than 700 million people worldwide have dyslexia.² Studies have shown that people who have dyslexia have a hard time reading and white paper distracts and confuses their ability to process what they see causing them to lose orientation and text can “jump” or become scrambled so instead of seeing “now” they would see the word as “won” or they would read “left” instead of “felt”.^{3,4} The extra concentration required causes their reading to be slow and they become quite fatigued trying to struggle through reading passages, and often end up experiencing headaches. Dyslexia can be considered a spectrum disorder as it has a wide range of symptoms and not everyone suffers the same difficulties in spite of some common ailments. There are four different classified types of dyslexia: Phonological Dyslexia (difficulty with phonemic awareness), Surface Dyslexia (difficulty reading words that are spelled differently from how they're pronounced e.g.: “subtle” or “thorough”), Rapid Automatic Naming Dyslexia (difficulty automatically recognizing and processing numbers and letters) and Double Deficit Dyslexia (difficulty with two types of dyslexia such as phonological and rapid naming deficit dyslexia which are the two forms most commonly suffered together).⁵ All of these reading difficulties also affect abilities in writing, spelling and math. These issues can greatly affect a dyslexic's emotional wellbeing as they become very stressed and frustrated because they can't seem to keep up with their peers.⁶

Individuals with dyslexia can learn, but they often need specialized instruction and tools to help them succeed. Old tricks such

as holding one's left hand out to form an “L” or wearing a bracelet on one's left arm to provide a point of orientation, using a ruler to focus on fragments of text when reading, and using cream or pastel coloured paper to prevent the glare of white paper from clouding the text, have all been tricks psychologists have used for decades to teach dyslexics how to cope.⁷ Using fonts that have less crowding effects and more shape cues, such as Helvetica, Courier, Arial or Verdana are recommended to help with short character fixation⁸. In more recent years, assistive technology has become a crucial aid for dyslexics to help ensure independence and productivity in their daily life by helping them overcome their intellectual difficulties.⁹ Currently there are a wide variety of products available such as speech recognition software, text-to-speech software and mind-mapping software designed to allow the user to verbally communicate what they want and have it converted to written text for them, as well as special spell-checking programs that are designed to recognize and correct common mistakes that are made by dyslexics. There are also smart pens that can scan and read a text back to the user, but these are currently only available for limited platforms. All of these assistive technologies can be very expensive and also inconvenient for a person to always have on hand and be able to use quickly.¹⁰

HYPOTHESIS

If by creating a pair of non-prescription glasses with green lights to allow for more clarity, blinders to aid with focus, and a vibrational motor to create a stimulative reminder of directional orientation, then a person with dyslexia should be able to read at a faster rate with higher accuracy.

MATERIALS AND METHOD

To construct the Elucidating Dyslexia Spectacles, a pair of plas-



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tic non-prescription eye glasses were wired to an Arduino board to allow the incorporation of green LED lights programmed to constantly shine onto a white paper when one reads causing the white paper to reflect the green wavelength of colour and in turn eliminating glare to aid in minimizing black font text from blending into the page. For use in this prototype, the colour green was chosen as it is considered in science to be the easiest colour on the eyes. This design is fully adaptable to have prescription lenses used in cases where the user needs visual correction. A vibration motor was wired to the left arm of the glasses and an Arduino board was programmed to vibrate it for one second every minute to stimulate the person to stay aware of directional orientation. This can be adapted to be placed on the right arm of the glasses for those who want to read in languages such as Arabic or Hebrew which read from right to left. The lenses were modified using black adhesive paper to narrow down the sight line so that the user can focus their attention to only reading one line of text at a time. Photograph 1 depicts the completed E.D.S. prototype.

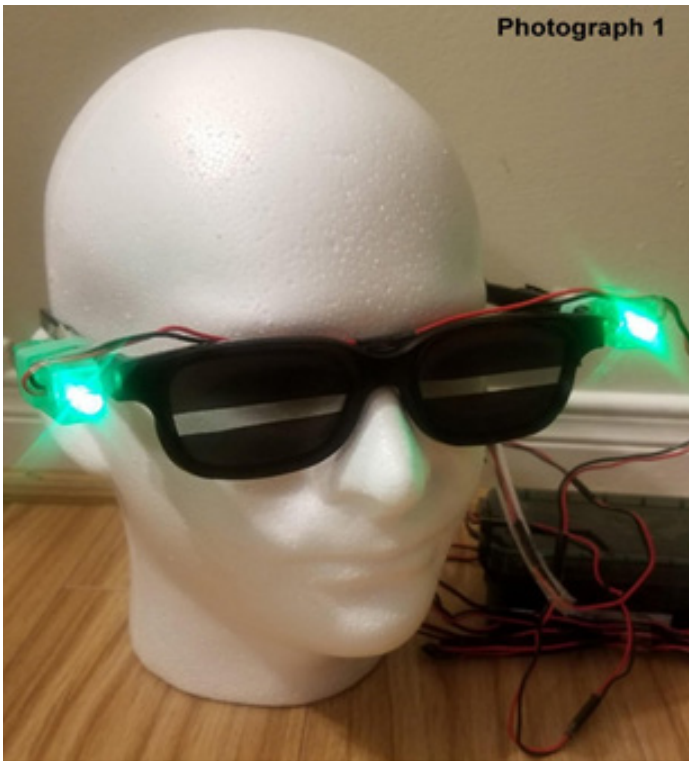
The completed prototype was then given to a group of 6 participants from Southern Ontario to study the effectiveness of the Elucidating Dyslexia Spectacles. Testing was conducted in the same room so that the glasses could be tested under the same lighting conditions. Participants also used the same reading passage for comparing their reading both with and without the glass-

es as it was important that the testing be identical in each scenario and it was improbable that participants would memorize the passage after reading through it once, and thus was unlikely to affect results. The mean age of the participants was 46 years old and apart from the control subjects who did not suffer from dyslexia, all participants had been independently diagnosed with dyslexia. After testing was complete, the participants were given a subjective survey to convey their personal assessment of the prototype.

RESULTS

Initial results revealed a few design flaws with the prototype. First, the initial types of lighting that were chosen proved to be ineffective and through trial and error with many different strengths and sizes of lights that were mounted in different positions on the glasses it was discovered that a casing to help bend the light to where it needed to shine was the best. Another flaw that was noted was the positioning of the vibration motor. Initially, it was installed on the inner side of the glasses arm, however, this rested too close to one's ear and the audible frequencies caused the user's skull to vibrate. Thus, the motor was moved to the outer side of the arm, behind the ear and worked well. Once all the hardware was securely attached and the circuitry proved to work correctly, the glasses were then tested.

Testing results show that 83% of the 6 participants tested improved their reading with use of the glasses with a 16% faster reading speed and 32% higher accuracy. Figure 1 shows that all but two subjects showed an average 21 second improvement in reading speed. The outliers to this trend include participant 1 with only a slight 3 second improvement in reading speed and participant 2 who was the sole participant to see a 2 second decline in reading speed with use of the glasses. Figure 2 illustrates the trends in reading accuracy, and as the red line that plots the number of errors attests, test participants on average saw 2.25 fewer errors with use of the glasses as compared to their measured accuracy without use of the prototype, as is represented by the blue line. Test subjects 1 and 2, did not show any improvement in reading accuracy with the glasses. Participants appeared to be relaxed and seemed excited to be using the Elucidating Dyslexia Spectacles during testing- smiling and verbalizing their enthusiasm to the study administrator. Using a subjective survey to provide feedback, participants reported that they felt the glasses were a great idea, helping focus and relax vision and the design was "not too gaudy" so they wouldn't stand out when using them. The glasses were identified as being "more convenient to use than other devices" currently used, however, the wires were cumbersome and some stated they didn't need or want the vibration reminder. Participants also suggested adapting the lenses to allow for prescription lenses where needed and also instead of using a temporary adhesive paper to act as a blinder, once the person's line of vision is determined, coating the lenses with a permanent black-out coating to ensure the blinders would last with repeated use.

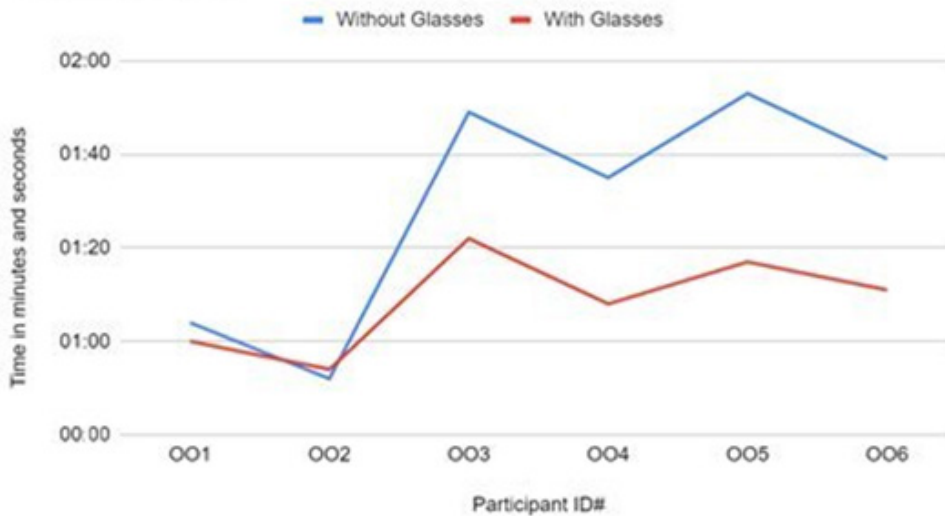


Photograph 1 depicts the E.D.S. prototype



Reading Speed

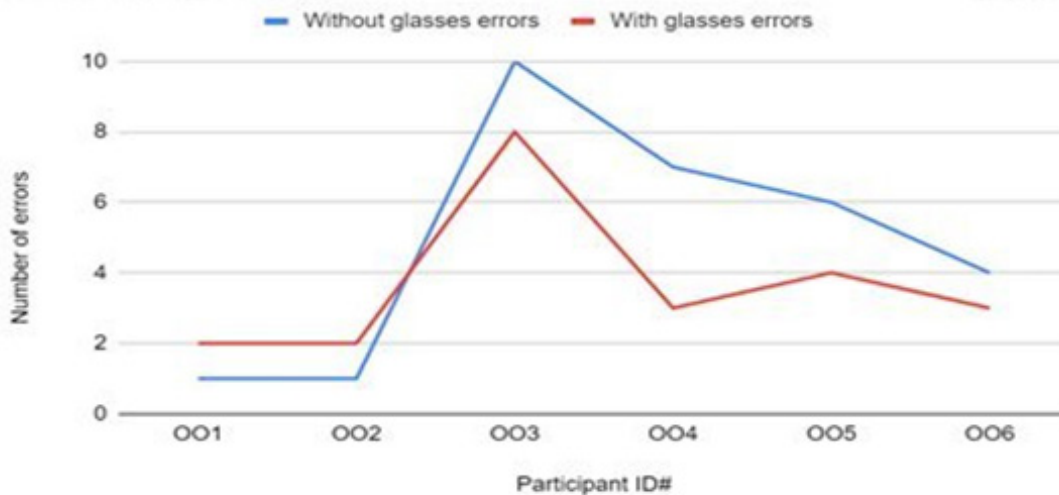
Figure 1



83 percent of the participants saw a 20 second improvement (16% increase) in reading speed while wearing the glasses. Test participant 002 saw a decline in reading but this is most likely due to the difficulties they encountered trying to use the E.D.S. over top of their own prescription glasses.

Reading Accuracy

Figure 2



67 percent of study participants saw an improvement of reading errors while using the glasses. The average improvement saw 2.25 fewer errors (a 32% increase in accuracy) when reading with the Elucidating Dyslexia Spectacles.



DISCUSSION

The quantitative data obtained from the study of the use of the prototype that showed improvements in both reading speeds and accuracy coupled with the favourable reception of the prototype by the study participants, supports this innovation as being a viable alternative to conventional devices that is more convenient, cost-effective and would help level the playing field by making the cognitive process of language decoding much easier for dyslexics. With modifications to correct and improve upon the original design using data collected from test participants as well as accounting for improving flaws noted in the design observations, notably the implementation of a disable switch to bypass the vibration motor, incorporating prescription lenses and permanently coating the lenses with blackout tinting in lieu of the temporary adhesive used, test scores would likely improve. Obstacles similar to those encountered when one user struggled to maintain fit of the prototype over top of their prescription glasses as they read thus slightly decreasing their reading speed, should be eliminated and would also increase the percentage of improvement when using the glasses.

Data from participant feedback indicated that most participants felt that they could read with greater ease using the glasses as compared to other devices and supports, and that they had minimal eye fatigue which would justify the need for further testing into the use of these glasses. Even though researchers have performed studies that both support and disprove the effectiveness of using colour and colour overlays to assist dyslexics because they argue dyslexia is not a visual problem, the use of colour has been proven to reduce visual stress. This can be seen with the increased reading speed and accuracy gained by participants in this study and the feedback provided by the participants, combining the use of colour with a more convenient way of narrowing one's focus when reading.^{11, 12} In addition, the fact alone that a high number of participants indicated that they found the prototype to be more useful than traditional devices that they have used in the past would support the likeliness that this device would be well received and used by dyslexics if the prototype is able to be perfected with the suggested modifications.

Additional testing would be needed to determine whether or not the results would remain consistent with a larger group of test subjects over a longer period of time, and whether these results would change if the prototype was modified to incorporate all of the suggestions to its construction that were listed in the observations. It would be ideal to have several prototypes made up and given to subjects to take home and use over a course of a month at school or work to obtain a more concise idea of how the glasses would fit into the daily life of a dyslexic.

If studies continue to show that the use of these glasses is favourable, the Elucidating Dyslexia Spectacles could be made available for personal use as a convenient tool that dyslexics could carry anywhere with them to help them inconspicuously read faster and more accurately and given the fact that the proto-

type costs less than \$60 to construct, the glasses would be widely affordable as compared to other assistive devices currently on the market for dyslexics.

CONCLUSION

Although the Elucidating Dyslexia Spectacles prototype would benefit from some design modifications and more in-depth testing, results this far, suggest both improvements in reading speed and accuracy and thus support that the concept that these glasses could be a very useful assistive device for dyslexics when reading, giving them more independence and less fatigue. Notwithstanding the gains in reading accuracy and speed results, test participant's feedback indicating that the glasses were well received and almost all participants indicating that they felt that the glasses made a significant improvement to their reading comfort in spite of the calculated results, may be considered a further validation of the usefulness of the E.D.S. prototype. Should future results remain consistent with existing test results and feedback, as these glasses are inexpensive to produce, they could become a pivotal assistive device that could greatly improve the quality of life for dyslexics by providing a convenient, less conspicuous means for them to overcome literacy obstacles.

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Joshua Middleton is a 14-year-old French Immersion student at M.M. Robinson high school in Burlington, Ontario. He has a passion for reading and writing and is someone who dedicates himself to learning the most he possibly can on a daily basis. Helping people and solving problems serve to challenge his mind and inspire him to create things to assist others in attempts to improve their quality of life. In his spare time when he is not reading or writing, he can be found enjoying the outdoors, camping, and spending time with his family.

