Simulating Homonymous Hemianopsia for the Care Team

by

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Abstract

Homonymous hemianopsia is a visual impairment that involves the bilateral loss of a complete visual field. While research has been done to ascertain the details of cause and prognosis of homonymous hemianopsia, an obvious disparity arose in the research on how to educate the supporting care team of a person with homonymous hemianopsia to maximize the creation of educational and rehabilitation plans. This research presents two studies focused on closing that gap by providing an alternative method of understanding. In the initial study 16 participants with a confirmed caregiver relationship to one or more persons with homonymous hemianopsia were surveyed on their personal knowledge of the visual impairment. These participants were asked to express any visual obstacles they have encountered, and to ascertain the availability of a device or program that could provide an interactive interpretation of how their homonymous hemianopsia patient views their surroundings. Survey results confirmed the need for a program that could easily simulate homonymous hemianopsia for the care provider. An additional usability study was completed by eight of the 16 previous participants on a mobile homonymous hemianopsia simulation application prototype. User tests showed that participants gained a significant increase in understanding of how those with a homonymous hemianopsia visual impairment view the environment. Results confirmed that the mobile simulation application was regarded as easy to use and expected to be utilized often. Additionally, it was discovered that future development could include the simulation of additional visual impairments to assist a greater number of care teams who are striving to safely engage and encourage their patients to thrive in the world around them.

Acknowledgments

I would like to express my gratitude to Dr. Greg Walsh, who has served as my thesis advisor for the IDIA program. Without his guidance throughout all my graduate studies, I'm positive I would not have completed this research in a timely fashion.

Additionally, I would like to thank my family for being completely supportive and motivating, especially my wife who vigorously pushed me to complete this project.

Finally, I would like to acknowledge my youngest son Cole, who served as the inspiration for this entire project, without him I would be part of the society who doesn't know about homonymous hemianopsia, I am relieved to finally experience and share his world view.

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Introduction

Homonymous Hemianopsia is a visual impairment that involves the bilateral loss of a visual field. While this impairment is easy to explain, it is difficult for an unimpaired person to truly understand. Homonymous hemianopsia is not a medical condition involving the actual eyes, it is a condition involving the occipital lobe, a part of the brain located in the posterior region, not being able to process the "picture" being viewed by the eyes. Among other causes, this condition is frequently known to be associated with patients in both the adult and pediatric populations, whose history includes stroke, traumatic brain injury, or neurosurgical procedures such as hemispherectomy. Stroke is reported to be the most common cause of homonymous hemianopsia (Goodwin, 2014) (*Hemianopsia.Net*, n.d.).

Extensive research has been done on what exactly homonymous hemianopsia is, what the causes of homonymous hemianopsia are, and the long-term prognosis of homonymous hemianopsia. However, little can be found on educating caregivers, teachers, rehabilitation specialists, general medical practitioners, etc. on how to encourage and allow these persons to thrive in the world *THEY* see. Additionally, there are minimal tools/devices easily available to these care/educational/medical teams that allow them to properly develop, intervene, and motivate, in their prospective areas, persons with homonymous hemianopsia. Currently available to the population are highly unreliable "DIY" plastic glasses with ½ of each lens blacked out using tape or marker, or unreasonably expensive and bulky medical-grade glasses intended to replicate visual impairments.

The intent of this paper is to investigate what exactly homonymous hemianopsia is, how it affects those diagnosed with the impairment and the challenges these individuals face. This research will then identify types of therapies, general rehabilitation, and relevant tools/equipment available for those with visual impairments. Furthermore, a discussion on how homonymous hemianopsia affects the educational planning of affected children, the Individualized Education Program (IEP) process, as well as correlating assessments required for planning appropriate accommodations. In addition, an overview and examination of recent research being reported on visual impairments.

Finally, an introduction to Simulating Homonymous Hemianopsia for the Care Team including a study analysis and exploration into the development of a homonymous hemianopsia simulation tool that will allow those that provide care for individuals with homonymous hemianopsia to see the world as they do. This new research could potentially help medical specialists, education professionals, and family members develop and implement higher quality individualized care, education, and general rehabilitation for persons living with this condition.

Literature Review

Medical Explanation / What is homonymous Hemianopsia?

When a typical person visually explores their environment, their eyes scan the surroundings three times per second, on average (Sahraie, 2014). According to Hemianopsia.net (n.d.), when a person is interpreting their surrounding environment through vision, they are seeing an image using both eyes (Figure 1a). The left side of the image they are "looking at" travels from the left visual field of each individual eye to the right side of the brain for processing and interpretation, vice versa for the right side of an image (Figure 1b).

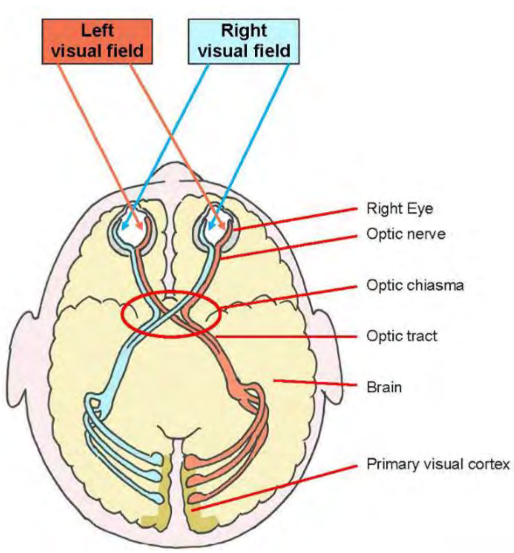


***Figure 1a*. Visual pathways to the brain**
(The visual pathway from the eye to The brain, n.d.)

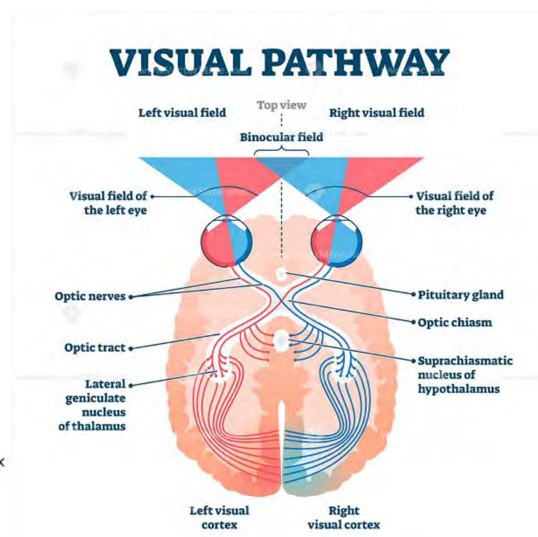


***Figure 1b*. Visual pathways to the brain**
(The visual pathway from the eye to the brain, n.d.)

Homonymous hemianopsia is defined as the loss of half of the field of view on the same side in both eyes. In a practical setting, this definition means that a person diagnosed with left-sided homonymous hemianopsia does not receive visual information from the left visual field of either eye. Meaning, when this person is "looking" out, their brain is only processing the right side of what they are "looking at", and vice versa for those diagnosed with right-sided homonymous hemianopsia.

Hemianopsia.net (n.d.), reports that the individual with homonymous hemianopsia does not see black on the affected side, rather it is a void in the vision. The brain of the homonymous hemianopsia patient fills in the field loss perceptually in a way that matches the color and brightness of the environment of what they do see.

***Figure 2*. Simulation of what a homonymous hemianopsia patient sees (Hemianopsia.net, n.d.)**

Homonymous hemianopsia is rarely attributed to eye injuries or optic tract damage. According to Perez and Chokron (2014), optic tract damage is responsible for approximately 5% of all homonymous hemianopsia cases, while damage to the brain's occipital cortex or parietal lobe accounts for approximately 70% of diagnosed cases. Most noted causes of brain damage leading to a homonymous hemianopsia diagnosis are stroke 52% - 70% of cases, traumatic brain injury 14%, or tumors 11% (Goodwin, 2014).

Of all stroke patients diagnosed with homonymous hemianopsia, approximately 80% are left with a permanent visual impairment, while an estimated 17-19% of patients are able to make a complete recovery, most notably within the first month. The odds of a complete recovery dwindle the longer it has been since the onset of the homonymous hemianopsia impairment (Goodwin, 2014).

For these permanently visually impaired patients, studies show that they are able to naturally develop some form of compensatory mechanisms the longer it has been since the beginning of the homonymous hemianopsia (Goodwin, 2014). Known compensatory mechanisms reported are anomalous head posture (AHP), and/or Exotropia (Koenraads et al, 2014). Anomalous head posture is the physical tilting of the head to the left or right (depending on where the affected side is) by a visually impaired person to obtain a more comfortable position to utilize the most of their vision (Teodorescu, 2015).
Exotropia is a state when one or both eyes of the visually impaired person turn outwards (Exotropia, 2019). According to Koenraads et al. (2014), exotropia can create a “more panoramic view” to expand the remaining visual field. It was also noted that these compensatory mechanisms are extremely common in children who have had a hemispherectomy.

In a single patient case study, Trexler (1998) reported that a woman who had complete homonymous hemianopsia after a confirmed stroke was able to detect visual stimuli in her impaired visual field by her own natural skills when at rest and not intellectually stimulated (Figure 3a). It was marked that she performed well until simple intellectual tasks were introduced. The simple tasks that were given to the subject caused her focus to shift and her visual perception returned to approximately 50%, her documented baseline (Figure 3b).

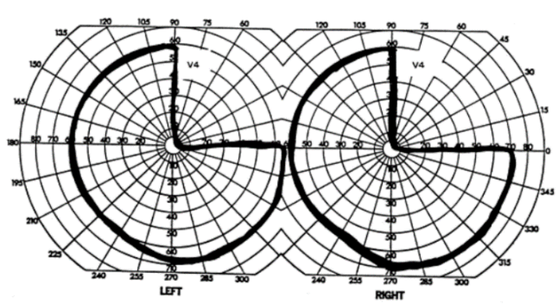


***Figure 3a*. Patient’s visual field w/ effort (Trexler, 1998)**

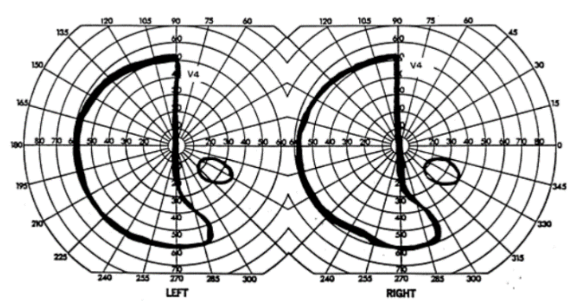


***Figure 3b*. Patient’s baseline visual field (Trexler, 1998)**

Challenges

A visual impairment can affect multiple aspects of a person's life including social, emotional, and physical well-being. Adapting to severe visual impairments such as homonymous hemianopsia is even more constraining and often requires special considerations. Patients with homonymous hemianopsia report that their visual impairment affects their ability to drive, read, and navigate. Orientation and mobility pose daily difficulties; running into walls, knocking things over, and being easily startled as obstacles seem to suddenly pop into view are common occurrences (Hemianopsia.net, n.d.) (Perez, 2014).

Orientation & Mobility

Homonymous hemianopsia patients often struggle with assessing and maneuvering the environment around them. General disorientation and an inability to detect hazards lead to colliding into objects increasing the risk of injury from falling (Goodwin, 2014).

In a 2011 study on hospital wayfinding, Rousek and Hallbeck (2011) tested the effect of visual impairments on patients navigating a hospital. Participants with no documented visual challenges were supplied special goggles that have the ability to simulate different visual impairments. When simulating homonymous hemianopsia, participants were given directions to specific locations around the hospital. At the conclusion of the simulation, participants noted that when doing their tasks, they often tripped and consistently became lost.

Reading

The impact of homonymous hemianopsia on a person's reading ability is directly related to which visual field has been affected in combination with the directionality of the text. Individuals with a left visual field loss (left homonymous hemianopsia) whose text is intended to be read from left to right, typically find it difficult to continue from the end of one line of text to the next (Figure 4a). Additionally, identifying the start of a new line is particularly challenging when it originates in the left visual field (Visual Field Impairment, n.d.).

Individuals with a right visual field loss (right homonymous hemianopsia) whose text is intended to be read from left to right, may be at a greater disadvantage than those diagnosed with left homonymous hemianopsia (Figure 4b). Low Vision Centers of Indiana (n.d.) acknowledge the increase in difficulty due to the lack of ability to easily identify when a sentence or a particularly long word ends. Missing these crucial elements of a text can change the intended meaning of the content, leading to increased frustrations with reading (Visual Field Impairment, n.d.).

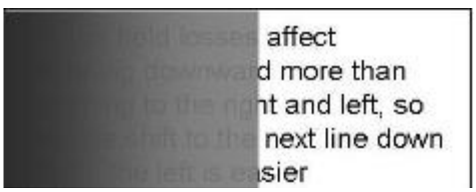


***Figure 4a*. Example of reading w/ left HH (Visual field impairment, n.d.)**

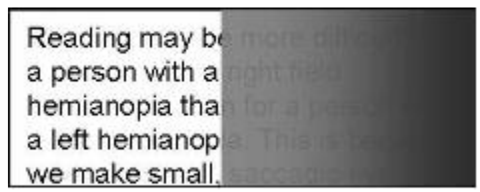


***Figure 4b*. Example of reading w/ right HH (Visual field impairment, n.d.)**

Writing/Drawing

Similar to noted reading challenges, individuals with homonymous hemianopsia are known to neglect their affected side when it comes to writing and drawing. Oftentimes, children and newly diagnosed persons with homonymous hemianopsia will naturally only write or draw on half of a sheet of paper and will typically ignore the other half of the paper completely (Figure 5) (Visual Field Loss in Children, n.d.).

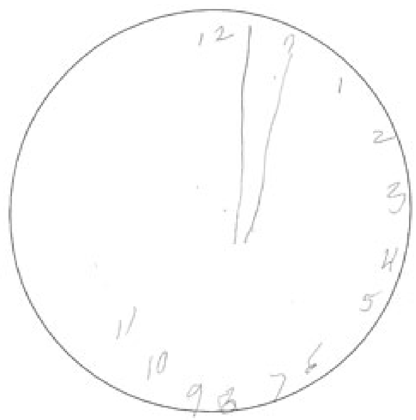


***Figure 5*. Example of an HH patients drawing of a clock. (Hemianopsia.net, n.d.)**

Unilateral Spatial Neglect

Persons diagnosed with homonymous hemianopsia all have documented visual challenges; additionally, some of these individuals also develop physical impairments.

The neglected impaired side of a person with homonymous hemianopsia may not be exclusively limited to vision. General awareness of the affected side may be impaired including the person’s extremities. A decrease in response to stimulus on the affected side may require an evaluation for unilateral spatial neglect (Adriana, 2019).

Social / Emotional

The challenges associated with severe visual impairments such as homonymous hemianopsia can have profound emotional and social implications.

Simple everyday routines like moving around the house, performing daily self-care, or enjoying typical home recreation activities i.e., TV watching, internet surfing, can become tedious especially to someone who is newly diagnosed. Getting out of the house to escape escalating frustrations poses new additional irritations - walking across the street in traffic can be hazardous, driving can be near impossible and in more than half of the United States illegal, thus limiting the employment opportunities available.

It is reported that 27 States require individuals to have a horizontal visual field of at least 110 degrees in order to be eligible for a driver's license (Goodwin, 2014). Person's with no documented visual impairments have a horizontal visual field of 180 degrees (Figure 6a). Someone who has sight in only one eye (either left or right) is recorded to have a horizontal visual field of 150 degrees (Figure 6b). Those diagnosed with homonymous hemianopsia have a visual field of about 90 degrees horizontal (Figure 6c).

***Figure 6a*. Healthy field of vision**

***Figure 6b*. Monocular field of vision**

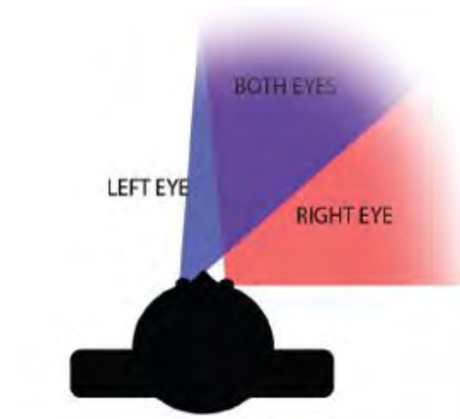


***Figure 6c*. Left homonymous hemianopsia.**
(Why you don't want homonymous hemianopsia and what you can do for it, n.d.)

With so many aspects of life affected, a decreased personal sense of self-worth seems inevitable, increasing the risk for depression.

The feeling of losing one's independence can have a major strain on the psychological well-being of the individual (Goodwin, 2014).

It is vital for those physically and mentally adjusting to a homonymous hemianopsia diagnosis to pursue support quickly, i.e., therapy and/or rehabilitation, after diagnosis. This will help to alleviate both the physical impairments as well as any psychological issues that may develop.

Rehabilitation

A variety of therapies, rehabilitation techniques, and devices are available for individuals adjusting to life with homonymous hemianopsia by making the most out of the remaining visual field. Basic suggestions and tips for self-adapting to a visual impairment can be provided by any healthcare professional with knowledge or experience with visual conditions. Neuro-Optometric Rehabilitation Association (n.d.) suggests that individuals with visual impairments including homonymous hemianopsia should strive to keep their physical eyes moist and remember to take frequent visual breaks to avoid visual overloads/eye-straining.

A comprehensive rehabilitation plan focused on vision can last anywhere from a few months to years and encompass therapy sessions, specialized techniques, and unique devices all depending on the patient's individual needs. Traditionally, visual rehabilitation methods typically fall under one of three categories; recovery (improving the remaining vision), substitution (aids that help expand the visual field), and compensation (helping to live and adjust to their visual impairment) (Perez, 2014).

Recovery

Recovery rehabilitation for visual impairments such as homonymous hemianopsia focuses on ways to improve the remaining vision itself. This emerging area of rehabilitation is developing new techniques to enlarge the working visual field.

One specialized recovery rehabilitation technique to improve eyesight is visual restoration therapy (VRT). VRT is an FDA-cleared visual therapy computerized program that is intended to recover a percentage of lost vision due to neurological brain damage using possible residual neuronal structures that may still be present (Vision restoration therapy, n.d.). The computerized program requires the participant to concentrate on a central location and acknowledge when the participant can see a light develop elsewhere on the screen. Additional visual stimuli are designed to engage the damaged visual field by appearing along the edge of the affected visual field and gradually moving further into the affected side (Figure 7). Progress is monitored monthly (*Vision restoration therapy, n.d.).*

***Figure 7*. Patient using VRT software**
(Vision restoration therapy (vrt) - novavision, n.d.)

Recovery rehabilitation is still being studied. Approved techniques are not widely available and require a commitment of time and consistency for a minimum of six months to over a year.

Substitution

When referencing the substitution aspect of rehabilitation for visual impairments such as homonymous hemianopsia, the focus is on helping patients expand their visual field by moving visual information to their non-affected side, typically with the use of specialized lenses (Perez, 2014). The most utilized tool used in substitution rehabilitation is prism lenses.

Prism lenses are specifically designed to use reflecting light either vertically or horizontally to relocate and reposition the patient's visual field. This shift in light is generally useful when there is a misalignment in the eye such as visual impairment diplopia (double vision); for homonymous hemianopsia, the goal is to augment the functional visual field by expanding the view. There are a variety of different brands of prism lenses (Alsabeh, 2019). The Gottlieb Visual Field Awareness system, EP Horizontal lens, and the Chadwick hemianopsia lens are three examples of visual field expander prism lenses designed for visual field maximization (Hemianopsia.net, n.d.). Understanding the restrictions of each of these popular prism lens types, aid in making the best use of the patient's remaining vision.

***Figure 8a*. Normal field of view**

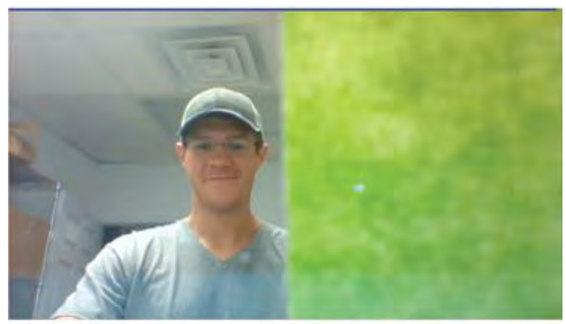


***Figure 8b*. Visual field w/ right HH**

***Figure 8c*. Visual field w/ right hh & horizontal peripheral prism**
(*Understanding prism designs for homonymous hemianopsia*. (n.d.)

Gottlieb Visual Field Awareness System

The Gottlieb Visual Field Awareness System (Gottlieb VFAS) is a prism lens that uses a small “wafer” shaped lens inside the patient's glasses on the affected sides lens, the unaffected side would use a standard lens (Figure 9). The lens is not meant to be used continually but rather utilized by quick visual scans to allow a different view of the environment. According to studies done by the Low Vision Centers of Indiana, patients report an enhanced awareness of the affected visual field, an increase in maneuverability, and a decrease in colliding with obstacles (Hemianopsia.net, n.d.).

***Figure 9*. Example of a Gottlieb VFAS (Hemianopsia.net, n.d.)**

EP Horizontal Lens

Unlike the sudden image shift of the Gottlieb VFAS, the EP Horizontal Lens (Figure 10) is intended to be utilized continuously by providing a concurrent view of the affected visual field. The concurrent view is achieved by adhering either one or two “segments” inside the patient’s glasses on the affected side's lens. The segments can be placed above and/or below the line of sight for a smooth transition when scanning the environment (Hemianopsia.net, n.d.).

Figure 10. **Example of EP horizontal lens (Hemianopsia.net, n.d.)**

Chadwick Hemianopsia Lens

The Chadwick Hemianopsia Lens is similar to the Gottlieb VFAS, however, it is designed to provide an authentic increase of the patient's visual field. The lens is designed to be inconspicuously fused to the patient's initial prescription lens in notably smaller frames (Figure 11a). This lens is intended to minimize the disruption of continuous multiple views, relying on rapid glances that skim the Chadwick Hemianopsia lens while maintaining an appealing appearance (Figure 11b) (Hemianopsia.net, n.d.).

Figure 11a. **Patient using Chadwick hemianopsia lens (Hemianopsia.net, n.d.)**

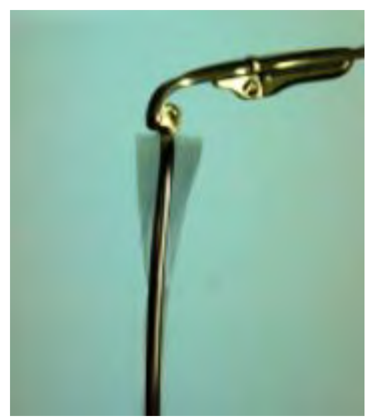


Figure 11b. **Example of how discreet Chadwick Hemianopsia Lenses can be. (Hemianopsia.net, n.d.)**

The doctors at the Low Vision Centers of Indiana reported that with the utilization of the Chadwick Hemianopsia lens in conjunction with an extensive visual therapy plan, the first hemianopsia patient was able to successfully receive a driver's license in Israel.

Compensation

The compensation portion is the largest portion of a visual impairment recovery plan for homonymous hemianopsia and involves therapy to teach techniques and introduce devices to acclimate to the visual field loss with an overall goal to improve the patient's quality of life. (Perez, 2014),

Therapy may refer to multiple services including physical therapy (PT), occupational therapy (OT), vision therapy, and/or psychotherapy. These services provide a path to recover confidence and are an essential part of an individual's healing. Most homonymous hemianopsia patients can benefit from the skills introduced at personalized sessions working with each of these services (Goodwin, 2014).

At minimum, PT sessions can work on spatial awareness and maneuverability with a visual field loss, OT can adapt the day-to-day functions for increased independence, visual therapy can provide scanning techniques to explore the affected visual field with or without utilizing prism lenses, and emotional coping strategies can be introduced in psychotherapy. All the services are able to work together to make up the bulk of a comprehensive rehabilitation plan. These services can be arranged through outpatient office visits for both adults and pediatrics or initiated through the school system for pediatrics diagnosed with homonymous hemianopsia.

Individualized Education Program (IEP)

Homonymous hemianopsia involves a complete visual field loss on the same side in both eyes - adults and children alike face similar challenges when acclimating to an approximately 50% vision loss. Just as homonymous hemianopsia limits an adult's job opportunities, the same challenges greatly impact a child's ability to access and thrive within the public education system.

Federal regulations state that any child with a disability has a right to Free Appropriate Public Education (FAPE) and guarantees the availability to meet all students' documented needs through the Rehabilitation Act of 1973 and the Individuals with Disabilities Education Act (IDEA) (*Special education rights, n.d.).*

According to federal regulations, all public school systems within the United States are required to follow the same step process to develop an individualized education program (IEP) that will allow those with different learning needs to have a fair and appropriate educational journey similar to their typical peers. IEPs are comprehensive and can include (but are not limited to) accommodation supports, assistive technology assistance, individualized educational instruction, and related service supports such as physical therapy / occupational therapy. All IEP's will document the student's present level of performance in school and develop strength-based yearly goals that provide a way to track the child's progress throughout the year.

The steps to develop and implement an IEP are recognition, referral, identification/assessments, eligibility/development of the IEP, implementation, and finally evaluation/reviews.

Recognition

Children diagnosed with homonymous hemianopsia already have a documented area of concern; however, to initiate the development of an IEP a referral needs to be officially submitted with the child's local public school system.

Referral

Referrals for special education services and/or accommodations are most often submitted by parents or school personnel (i.e., teacher, counselor) additionally, public health medical professionals, social workers, or childcare providers with a concern can also refer a child for evaluation. Referrals should be in writing and express all areas of concern pertaining to the student.

Broad concerns for children with homonymous hemianopsia include general mobility, safe maneuverability within the educational environment, current/expected reading/writing difficulties, and social acceptance by peers.

Identification / Assessments

After a referral has been submitted a coordinated multidisciplinary team (IEP team) is formed consisting of a general education teacher and/or special education teacher, a school district representative, providers of essential related services (psychologist, PT, OT, etc.), and the student's parents. The goal of this group is to perform special assessments to determine whether the child has a disability that requires special education services.

Commonly included assessments for students with visual impairments, Functional Vision Assessment (FVA) examines how the student uses their remaining functional vision, Learning Media Assessment (LMA) used to determine what is the appropriate literacy media (visual, tactual, and/or auditory learning) for the student, Orientation & Mobility (O&M) Assessment is requested to determine if/how the student moves around the environment safely both indoors and outdoors and an Assistive Technology Assessment to assess whether any assistive technology will be advantageous (*Assessments for students, n.d.*).

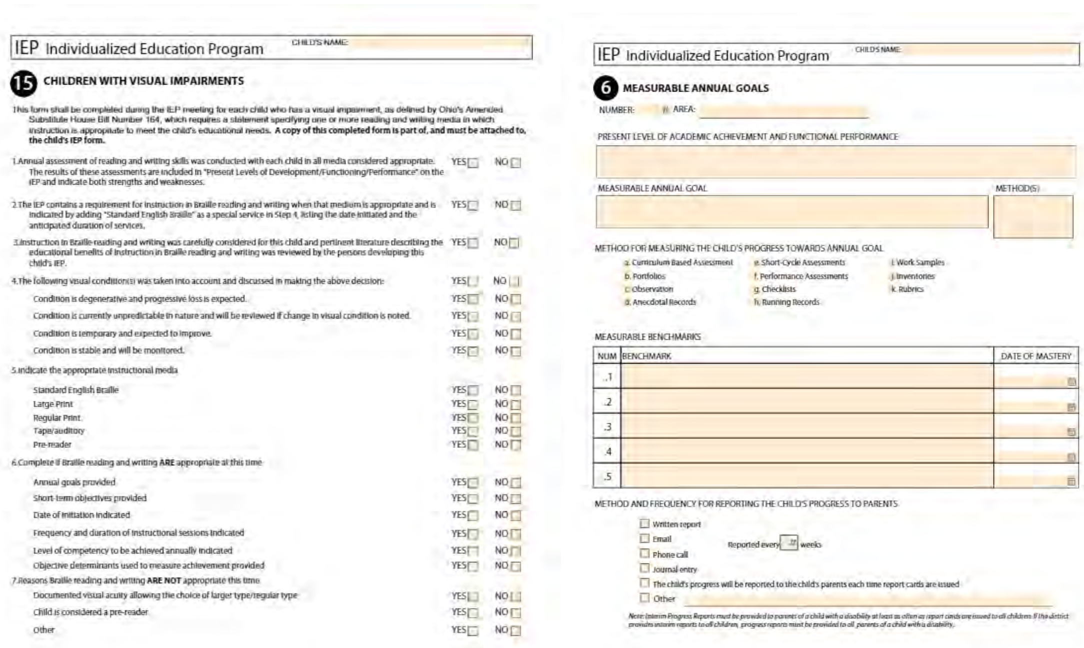
Eligibility

Once all requested assessments have been completed the IEP team reconvenes to review the collected data. This information is used to classify those who have a disability and are eligible for special education services. Students who have been evaluated and found to not meet the criteria for special education services would remain in the traditional classroom setting with no additional support.

Development of the IEP / Implementation

Once eligibility has been confirmed the next step is to create an IEP by reviewing assessment data, determining the student's individualized learning style, identifying resources/supports deemed necessary for the student’s progression, and the development of long-term goals with short-term objectives (Individualized education programs, n.d.) (brp-admin, n.d.).

Accommodations for a student with a severe visual impairment such as homonymous hemianopsia can range from simple supports i.e. preferential seating, slant board use to extensive support i.e. a dedicated 1:1 aid (Figure 12). At the conclusion of this meeting, a complete individualized education program for this specific student would be developed and agreed upon by the entire IEP team including the School district and implemented.


IEP Individualized Education Program CHILD'S NAME:

15 CHILDREN WITH VISUAL IMPAIRMENTS

This form shall be completed during the IEP meeting for each child who has a visual impairment, as defined by Ohio's Amended Substitute House Bill Number 164, which requires a statement specifying one or more reading and writing media in which instruction is appropriate to meet the child's educational needs. **A copy of this completed form is part of, and must be attached to, the child's IEP form.**

1.Annual assessment of reading and writing skills was conducted with each child in all media considered appropriate. The results of these assessments are included in "Present Levels of Development/Functioning/Performance" on the IEP and indicate both strengths and weaknesses. YES ☐ NO ☐

2.The IEP contains a requirement for instruction in Braille reading and writing when that medium is appropriate and is indicated by adding "Standard English Braille" as a special service in Step 4, listing the date initiated and the anticipated duration of services. YES ☐ NO ☐

3.Instruction in Braille reading and writing was carefully considered for this child and pertinent literature describing the educational benefits of instruction in Braille reading and writing was reviewed by the persons developing this child's IEP. YES ☐ NO ☐

4.The following visual condition(s) was taken into account and discussed in making the above decision: YES ☐ NO ☐

Condition is degenerative and progressive loss is expected. YES ☐ NO ☐
Condition is currently unpredictable in nature and will be reviewed if change in visual condition is noted. YES ☐ NO ☐
Condition is temporary and expected to improve. YES ☐ NO ☐
Condition is stable and will be monitored. YES ☐ NO ☐

5.Indicate the appropriate instructional media

Standard English Braille YES ☐ NO ☐
Large Print YES ☐ NO ☐
Regular Print YES ☐ NO ☐
Tape/auditory YES ☐ NO ☐
Pre-reader YES ☐ NO ☐

6.Complete if Braille reading and writing **ARE** appropriate at this time

Annual goals provided YES ☐ NO ☐
Short-term objectives provided YES ☐ NO ☐
Date of initiation indicated YES ☐ NO ☐
Frequency and duration of instructional sessions indicated YES ☐ NO ☐
Level of competency to be achieved annually indicated YES ☐ NO ☐
Objective determinants used to measure achievement provided YES ☐ NO ☐

7.Reasons Braille reading and writing **ARE NOT** appropriate this time

Documented visual acuity allowing the choice of larger type/regular type YES ☐ NO ☐
Child is considered a pre-reader YES ☐ NO ☐
Other YES ☐ NO ☐

IEP Individualized Education Program CHILD'S NAME:

6 MEASURABLE ANNUAL GOALS

NUMBER: AREA:

PRESENT LEVEL OF ACADEMIC ACHIEVEMENT AND FUNCTIONAL PERFORMANCE

MEASURABLE ANNUAL GOAL METHOD(S)

METHOD FOR MEASURING THE CHILD'S PROGRESS TOWARDS ANNUAL GOAL

a. Curriculum Based Assessment
b. Portfolios
c. Observation
d. Anecdotal Records
e. Short-Cycle Assessments
f. Performance Assessments
g. Checklists
h. Running Records
i. Work Samples
j. Inventories
k. Rubrics

MEASURABLE BENCHMARKS

NUM	BENCHMARK	DATE OF MASTERY
.1		
.2		
.3		
.4		
.5		

METHOD AND FREQUENCY FOR REPORTING THE CHILD'S PROGRESS TO PARENTS

☐ Written report
☐ Email
☐ Phone call
☐ Journal entry
☐ The child's progress will be reported to the child's parents each time report cards are issued
☐ Other

Reported every ☐ weeks

Note: Interim Progress Reports must be provided to parents of a child with a disability at least as often as report cards are issued to all children. If the district provides interim reports to all children, progress reports must be provided to all parents of a child with a disability.

***Figure 12*. Examples of IEP Forms (IEP form, n.d.)**

Evaluation / Reviews

A child's school is responsible for maintaining the agreed-upon supports outlined in the final IEP. An annual review is often required to discuss the student's progression to meet their educational goals. Revisions can be made in the event that the student is not meeting or exceeding agreed-upon goals/objectives.

Challenges

While the IEP process has a lot of room for challenges, students with homonymous hemianopsia or another severe visual impairment may find some additional situations that may be particularly frustrating. Not all IEP teams include a visual expert, even when addressing the needs of a visually impaired student. In these situations, the parents become the primary advocate for visual services. (*Special education rights, n.d.)*

Documenting a visual concern to be included in the IEP assessment is essential. Homonymous hemianopsia can be easily explained; however, it cannot be easily simulated to ensure the entire IEP team understands the practical limitations of this condition. If the student's impairment is not fully understood, then suggested accommodations may not be accurate to the needs of the student.

An additional challenge for parents with visually impaired children is the educational placement. All IEPs include an appropriate classroom placement for the student. Visually impaired students may have a choice between a state-run school for the visually impaired providing a full-time visual classroom educator or their local public school with visual educator support to the classroom teacher. Most school systems leave this decision to the parents as both placements could be considered appropriate. Making this decision without full knowledge of what each placement would provide can be overwhelming. The availability of a specialized tool that can simulate a visual impairment may assist a general educator with the needs of a visually impaired student allowing parents to consider the public school system as a viable alternative.

Recent Research Studies

Research on homonymous hemianopsia is still relevant and ongoing. As technology advances so do the needs of visually impaired children and adults. Studies using virtual or augmented reality devices are becoming a staple in the development of future tools/devices that will potentially further increase a person's quality of life.

Study: Driving with hemianopsia: Head scanning and detection at intersections in a simulator Bowers, et al. (2014)

In this study, participants diagnosed with homonymous hemianopsia were put into a driving simulator where simulated pedestrians would make movements such as crossing the street from both the left and right encouraging the participant to move their head and scan with their eyes. This study observed how the participant utilized head scanning techniques for detection while driving using a driving simulator.

The results report that the homonymous hemianopsia participants did not physically move their head further to compensate for their impairment more than the control group consisting of typical sighted individuals.

The study concluded that visually impaired persons with homonymous hemianopsia compensate for the loss of an entire visual field by relying on head movements and visually scanning the affected side (Bowers, et al. (2014).

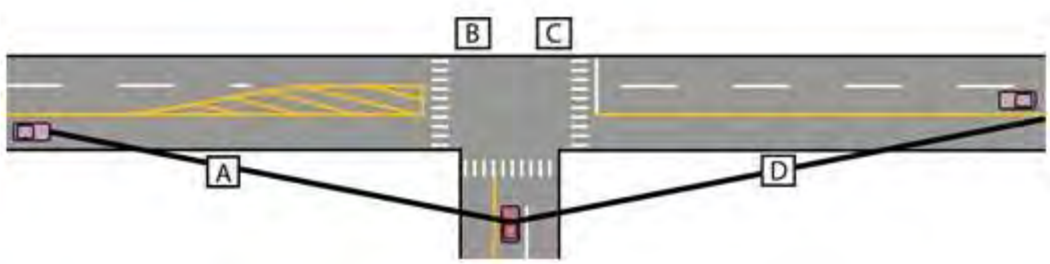


***Figure 13*. Example of the layout of the Driving with Hemianopsia study (Bowers et al. 2014)**

Study: Eye tracking and virtual reality in the rehabilitation of mobility of hemianopsia patients: a user experience study Gestefield et al. (2020)

This study focused on the usability of eye trackers and virtual reality headsets to evaluate the usefulness of these methods in the rehabilitation of homonymous hemianopsia patients.

Homonymous hemianopsia participants in the study were tasked with performing common visual therapy exercises while wearing an eye tracker and then again while wearing a virtual reality headset (Figure 14). Additionally, occupational therapists were given the opportunity to experience performing the same common visual therapy exercises to determine if these methods would benefit their patient sessions.

At the completion of all common visual therapy exercises, participants scored the devices on their practicality during a typical therapy session. The results concluded that while the eye tracker scored slightly higher than the virtual reality headset both devices would make for an advantageous addition to visual rehabilitation therapy. (Gestefield et al. (2020)

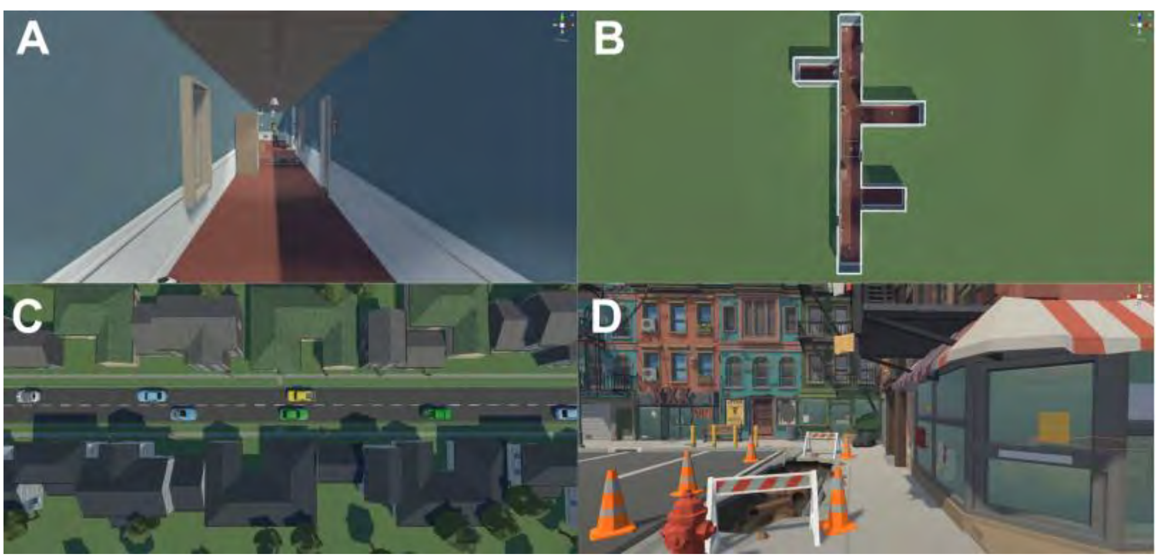


***Figure 14*. Example of what the participants saw in this study (Gestefeld et al. 2020)**

Study: Use of NeuroEyeCoach to improve eye movement efficacy in patients with homonymous visual field loss (Sahraie, 2016)

NeuroEyeCoach is designed to be a systemic eye movement training software program available in the residential setting to assess and mark any advancement of a visually impaired person's progress using compensatory techniques.

The software requires a standard computer where users are able to respond when a visual stimulus appears on the screen (Figure 15). Focused participants in this study were diagnosed with visual field loss post brain injury. A control group of unimpaired participants was additionally assembled. All participants were asked to use this training software in a rehabilitation clinic setting on a daily basis for a set amount of time.

The conclusion of the study remarks that the NeuroEyeCoach was effective in developing compensatory techniques for patients with visual field deficits after a brain injury.

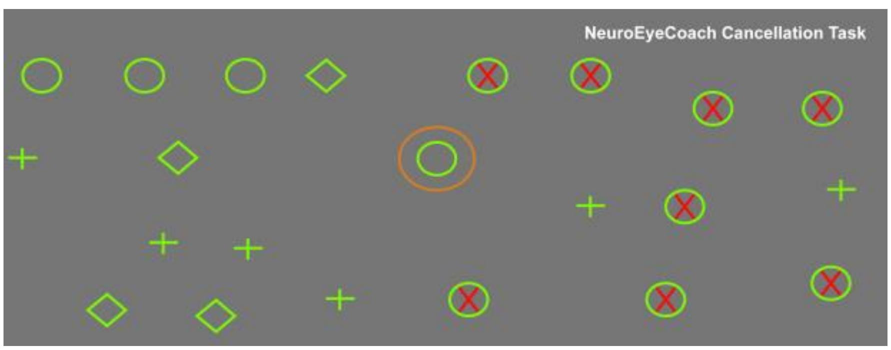


***Figure 15*. Example of Neuro Eye Coach software (Neuroeyecoach - novavision, n.d.)**

Conclusion

Current research relating to homonymous hemianopsia is focused on the visually impaired person and their rehabilitation progression. It would be an advantageous expansion for researchers to investigate tools and techniques that could potentially provide the rehabilitation care team of a visually impaired person a greater understanding by easily simulating a visual impairment and the effects specific devices have on the impairment.

Currently, most care teams do not appear to have access to real-time simulations and use theory to explain a desired effect of a rehabilitation tool. For example, prism lenses exist and are thought to help the patient expand their visual field, however, the rehabilitation care team can only introduce the theory of what the prism glasses should do for the patient and struggle to determine which exact type of prism lens (Gottlieb VFAS, EP Horizontal, etc.) would provide the greatest benefit.

The obvious movement toward using modern technology such as augmented and virtual reality devices, allows for continued advancement in understanding visual impairments and rehabilitation. Could these advanced methods provide a path toward correcting the disparity of the care team's literal understanding of their patients' visual impairment, the recent advancements in research suggest yes.

The framework for new and improved ways to enhance the quality of life for those visually impaired has been set. Bowers' (2014) research gives insight into the possibility of an increase in individuals with homonymous hemianopsia having the opportunity to drive, and therefore a chance for a higher level of independence. Improvements in rehabilitation techniques provide a chance to facilitate confidence by encouraging greater self-satisfaction. Building on the findings from previous research focused on everyday activities such as environmental orientation and directional maneuverability like in Rousek and Hallbeck (2011) where pathfinding was tested in hospitals on simulated visual impairments. These types of studies provide a strong foundation for improvements in visual therapy as reported in Sahraie's (2016) study on the NeuroEyeCoach eye movement training software.

With further exploration of these rehabilitation advancements, it seems realistic that in the future these modern tools/techniques could be incorporated by caregivers into rehabilitation plans and perhaps introduced at an earlier age through IEPs for a greater impact on the quality of life for visually impaired children.

Methods

Nationwide, it is estimated that over 800,000 people are diagnosed with a homonymous visual field defect (Costela et al.,2018). This study focused on the care providers of the homonymous hemianopsia population.

To conduct research for the development and usability of my project, caregivers and medical professionals of persons diagnosed with homonymous hemianopsia were asked to participate in an initial study, half of which were asked to participate in an additional usability study. All communication was completed virtually.

Survey Participants

All participants ages ranged from 18-64. 16 participants were asked to respond to an initial study that focused on gaining insight into their personal knowledge of homonymous hemianopsia, categorizing any relationships to individuals diagnosed with homonymous hemianopsia, and to share barriers they have encountered.

Respondents' demographics to Homonymous Hemianopsia patients three Parent/Guardians, seven Medical Professionals, four education providers, and two other care providers

Table 1

Demographics of each survey participant & experience w/ HH

Participant	Relationship	Experience w/ HH	Age Range
1	Parent/Guardian	Some Research / knowledge	35-44
2	Therapist / Rehab	Some Research / Knowledge	35-44
3	Teacher / Aide	Some Research / Knowledge	35-44
4	Therapist / Rehab	Little to None	35-44
5	Teacher / Aide	Little to None	18-24
6	Therapist / Rehab	Some Research / Knowledge	25-34
7	Teacher / Aide	Some Research / Knowledge	35-44
8	Extended Family	Some Research / Knowledge	55-64
9	Parent / Guardian	Some Research / Knowledge	35-44

10	Therapist / Rehab	Some Research / Knowledge	35-44
11	Other (Case Manager)	Some Research / Knowledge	35-44
12	Therapist / Rehab	Some Research / Knowledge	25-34
13	Therapist / Rehab	Some Research / Knowledge	45-54
14	Teacher / Aide	Some Research / Knowledge	35-44
15	Parent / Guardian	Some Research / Knowledge	35-44
16	Therapist / Rehab	Some Research / Knowledge	25-34

Usability Study Participants

8 participants who responded to the initial survey were asked to take part in an additional study on the practicality and usability of a digital prototype project able to simulate homonymous hemianopsia.

Respondents' demographics to HH, three parents/guardians, four medical professionals, one other care provider.

Table 2

Usability study participants and their relationship to an HH patient

Participant	Relationship
1	Extended Family
2	Parent
3	Teacher / Aide
4	Therapist / Rehab
5	Parent
6	Teacher / Aide
7	Parent
8	Therapist / Rehab

Materials

In each portion of the studies, a range of materials were used to gather data from participants. All invitations to study interviews and surveys were sent through email to participants. Surveys were conducted and collected using SurveyMonkey, an online survey tool. Users tested an interactive simulation prototype built for android devices, using a *Samsung galaxy tablet*. All prototype testing took place in-person, a smartphone audio app *Voice Recorder* was utilized to capture all session dialogue. The simulation prototype was developed using *Unity Game Engine.* All audio of user testing sessions transcribed using *Google Voice Tool*.

Design

Survey

The survey was designed to be taken by participants who have experience caring, educating, or rehabilitating individuals with homonymous hemianopsia. The intention of the design was to determine personal knowledge of the impairment, identify any assisting techniques or devices found useful in adjusting care for patients with HH, establish any visual challenges encountered while tailoring care/services to achieve set goals, and ascertain the availability of a device or program that can provide an interactive interpretation of what/how their homonymous hemianopsia patient sees.

Table 3

Survey Research Questions

#	Question
1	What is your age range?
2	What is your experience / knowledge of Homonymous Hemianopsia?
3	How would you / do you define homonymous hemianopsia?
4	About how many patients / children / students have you provided care for with homonymous hemianopsia?

5	What is your relationship to the person(s) with homonymous hemianopsia?
6	Patient age range(s)?
7	Do you currently have easy access (Accessible within 5 minutes) to any device/s or programs etc. that allow you to interpret what a homonymous hemianopsia patient would be seeing?
8	What are some of the visual challenges / barriers you have experienced in reaching the goals of the person with homonymous hemianopsia?
9	What kind of methods or strategies have you used in the past to adjust care for homonymous hemianopsia?
10	What would / does help you when working with a homonymous hemianopsia patient?
11	Would like to be considered for user testing a mobile simulation of a homonymous hemianopsia prototype?

Usability Study

The usability study was designed to test the effectiveness of a homonymous hemianopsia simulation prototype. The study consisted of use of the simulation prototype in a practical setting followed by the completion of a system usability scale. Participants were selected who have direct contact with caring, educating, or rehabilitating individuals with homonymous hemianopsia.

Prototype Evaluation

Participants were given time to familiarize themselves with the simulation prototype application before being directed to complete a set of predetermined tasks using both left and right hemianopsia view options. Participants were instructed to “think out loud" allowing real-time feedback to be recorded. All task objectives were designed to provide opportunities to encounter typical routines/activities of daily actions.

Table 4

Usability Study Tasks

#	Task
1	Explore the app
2	Using the app, attempt to read something. Both Left & Right
3	Look at an object close up, now look at the object from further away. Ask to comment
4	Try walking around your home or current surroundings by only looking at the tablet Both Left & Right
5	Using the app, can you tell me what homonymous hemianopsia is?
6	Do you feel like you have a better understanding of homonymous hemianopsia now that you have used this app

System Usability Scale

The System Usability Scale (SUS) was designed as a way to evaluate how the participants felt about the usability of the homonymous hemianopsia simulation prototype and determine a calculated score for usability. Users were asked to evaluate the simulation prototype and rate whether they strongly disagree to strongly agree with statements that are purposely negative and positive.

Table 5

System Usability Scale Questions

#	Question	Strongly Disagree				Strongly Agree
1	I think that I would like to use this system frequently	1	2	3	4	5
2	I found the system unnecessarily complex	1	2	3	4	5
3	I thought the system was easy to use	1	2	3	4	5
4	I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5	I found the various functions in this system work well integrated	1	2	3	4	5
6	I thought there was too much inconsistency in this system	1	2	3	4	5
7	I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8	I found the system very cumbersome to use	1	2	3	4	5
9	I felt very confident using the system	1	2	3	4	5
10	I needed to learn a lot of things before I could get going with this system	1	2	3	4	5

Protocol

Survey

A short message of introduction was sent by email to a network of therapists, teachers, and parents of homonymous hemianopsia persons describing the objective of my research and requesting participation in an initial survey of their personal knowledge and experience with homonymous hemianopsia. Those interested in participating were requested to complete an attached consent form confirming that all participation is voluntary and could be discontinued at any time or any reason.

Utilizing *SurveyMonkey's* "email link" option, surveys were distributed to those who consented to participation.

Surveys were not time based, allowing all participants to complete questions at their own pace. At the conclusion of the survey all participants were asked if they would like to be considered for user testing a mobile simulation of a homonymous hemianopsia prototype.

Usability Study

To assure a variety of perspectives on the functionality of the simulating homonymous hemianopsia prototype an assortment of relationship types to persons with homonymous hemianopsia was required.

Participants of the previous study who indicated interest in user testing a mobile simulation of homonymous hemianopsia prototype were categorized based on relationship to individuals diagnosed with homonymous hemianopsia.

A message of inquiry was sent by email to the focused network of therapists, teachers, and parents of homonymous hemianopsia selected for an in-person usability study.

Those interested in participating were requested to confirm a date/time for an in-person user testing session, as well as complete an attached consent form confirming that all participation is voluntary and could be discontinued at any time or any reason.

During scheduled user testing sessions smartphone audio app *Voice Recorder* was utilized to capture all session dialogue. Participants were given an introductory tutorial on navigating the simulation application then granted access to the simulation of the homonymous hemianopsia prototype using a provided *Samsung Galaxy* tablet. Time was allocated for participants to familiarize themselves with the simulation prototype before being directed to complete a set of predetermined tasks using only the tablet screen to view the environment.

Instructions to "think out loud" were relayed to ensure real-time feedback could be recorded. Tasks were communicated one objective at a time with no expressed time limit allowing the user to experience performing each task at their own natural pace in both left and right hemianopsia simulation viewing options.

At the completion of all requested tasks in the usability study, each participant was asked to discuss their overall thoughts of the simulation application, identify if they would use this application including in what kind of setting, and comment on any additional recommendations they may have.

Finally, participants were asked to participate in the system usability scale survey to evaluate the simulation prototype and rate their experience while using the application.

All Prototype testing audio communication that was recorded using smartphone audio app *Voice Recorder* was then transcribed using *Google Voice Tool* and evaluated for results.

Results

Survey Results

Statistical Data

A total of 16 responses were received from the initial survey. With participants ages ranging from 18 to 64. All 16 participants confirmed a care provider relationship with at least one person diagnosed with homonymous hemianopsia. 43.75% of respondents reported being a therapist/rehabilitation specialist, 25% reported being a teacher / aid, 18.75% a parent / guardian, 6.25% extended family, and 6.25% other (Figure 16).

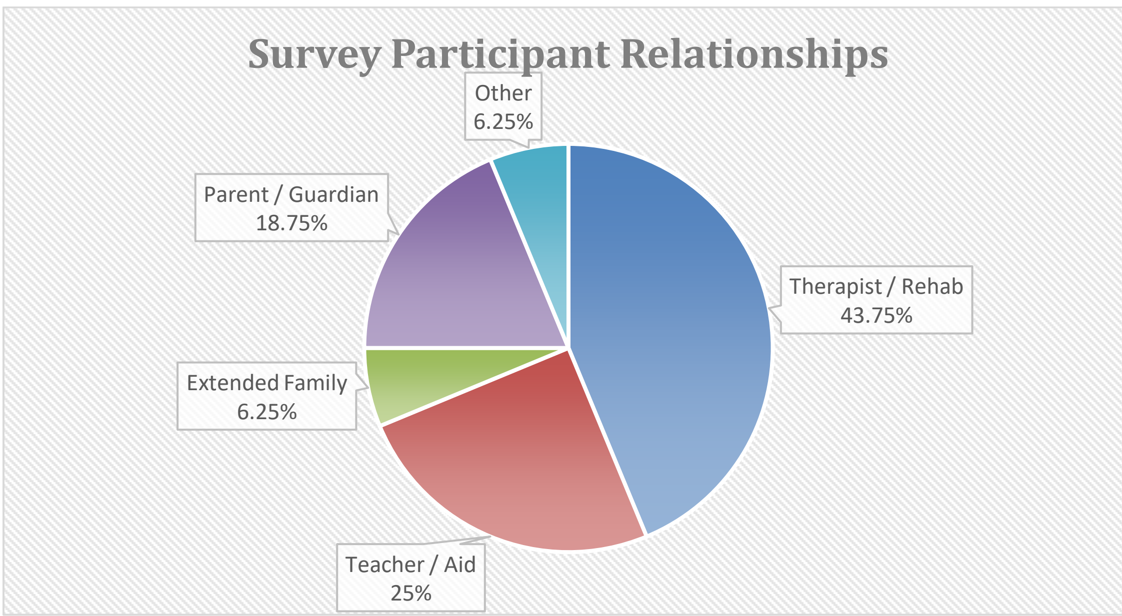


Figure 16. **Survey Participant Relationships Chart**

The responses revealed that 87.5% of respondents noted that they had done some research or had some knowledge of homonymous hemianopsia. 12.5% of participants responded as having little to no experience or knowledge of homonymous hemianopsia.

When asked to define homonymous hemianopsia, 50% of respondents provided a general definition; however, missed key elements of the impairment. 37.5% of respondents provided a definition showing optimal understanding of the visual impairment, while 12.5% of definitions given by participants revealed a complete lack of understanding of the visual impairment (Figure 17).

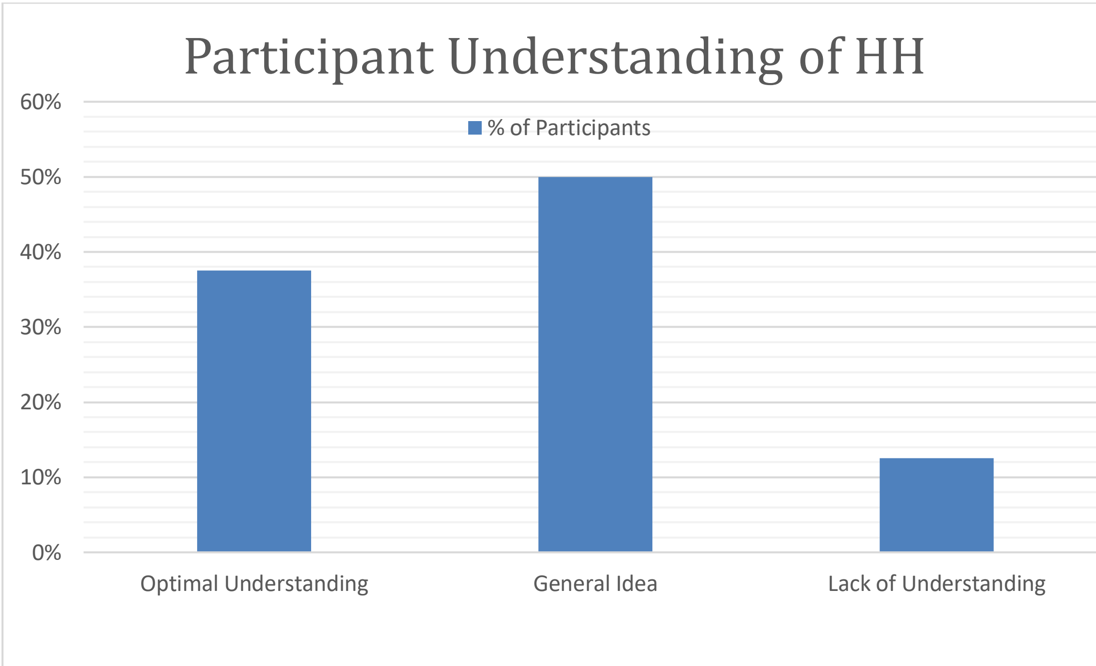


***Figure 17.* Survey Participant Understanding of HH Chart**

Comparing the accuracy of definition statistics to identified relationships

Of the 50% of the respondents who missed a key element of the definition 37.5% identified as being a therapist / rehabilitation specialist, 37.5% identified as teacher / aide, 12.5% identified as a parent / guardian, 12.5% identified as other. Additionally, the key element missed by 87.5% of these participants was that HH affects the visual field in both eyes.

Of the 37.5% of the respondents who provided an optional definition of HH, 50% identified as being a therapist / rehabilitation specialist, 33.33% identified as a parent / guardian, and 16.67% identified as a teacher / aide.

Of the 12.5% of responses that showed a lack of understanding of HH, 50% identified as extended family, and 50% identified as therapist / rehabilitation specialist.

The data revealed that 81.25% of participants are on a care team for at least one to five persons diagnosed with HH, 6.25% responded that they were on the care team for 10-15 persons, and 12.5% responded on the care team of 15+ individuals.

93% of participants answered that the individuals they care for are aged 18 years or younger.

When participants were asked if they had easy access (accessible within five minutes) to any device/s or programs etc. that would allow them to interpret what a homonymous hemianopsia patient would be seeing, 87.5% responded that they did not have any access, 6.25% responded that they did have access but not easily (within 5 minutes), and 6.25% responded they did have easy access to a device (Figure 18).

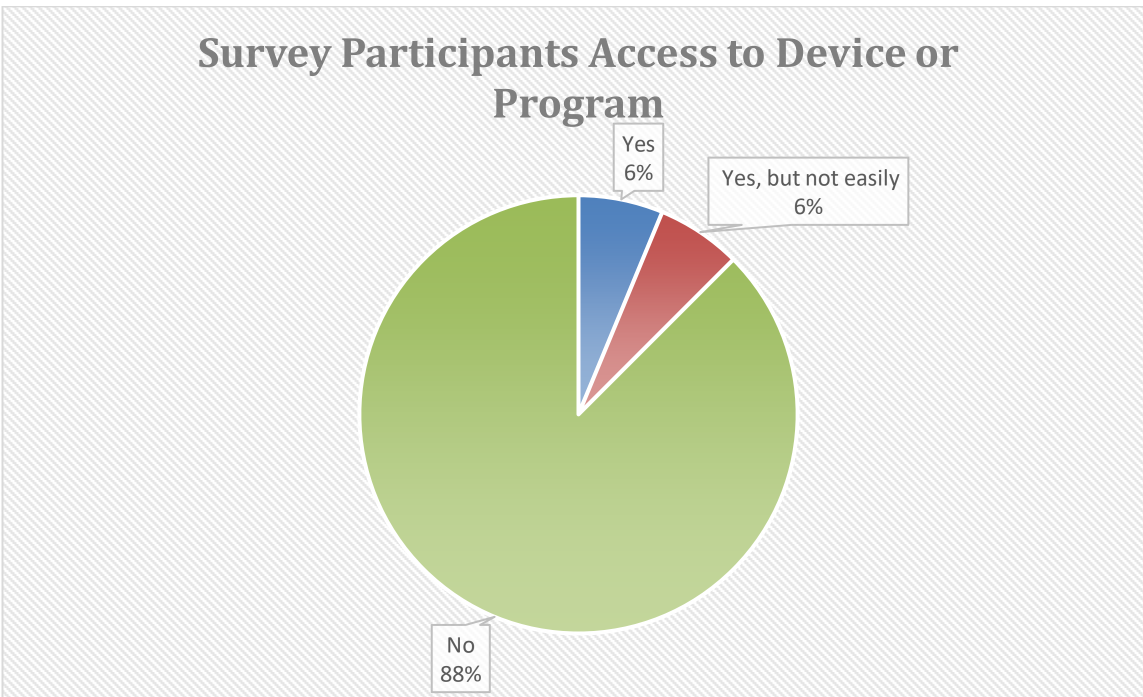


***Figure 18.* Survey Participants Access to Device or Program**

Discovered Barriers

Responses revealed that 56.35% of participants disclosed being uncertain with how to present or position materials for optimum viewing to someone with HH. 31.25% expressed concern over mobility / maneuverability safety associated with vision.

Neglection of the affected side was a mentioned concern for 12.5% of responses, and 6.25% mentioned funding /resources (Figure 19).

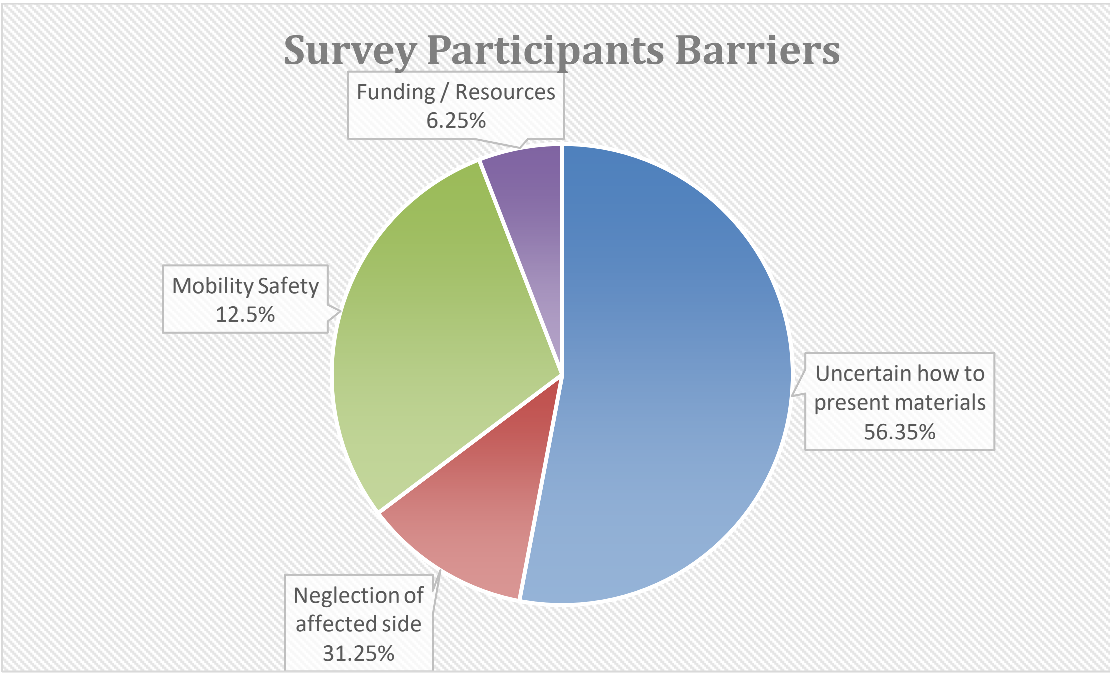


***Figure 19*. Survey Participants Barriers**

When participants were asked to identify what would help when working with individuals with homonymous hemianopsia, 68.75% noted that an authentic way to recreate how the person sees would be the most helpful to them.

Survey effect on prototype design

68.75% of participants relayed in the survey that they would like an accurate way to recreate how a person with HH visualizes their environment. A simulation prototype was developed. The initial prototype had a grayscale pixelated barrier representing the affected side of HH (Figure 20). This was replaced with a “blur” effect that allowed a more authentic representation of what the visual impairment looks like (Figure 21).

***Figure 20*. Original version of the left HH barrier**

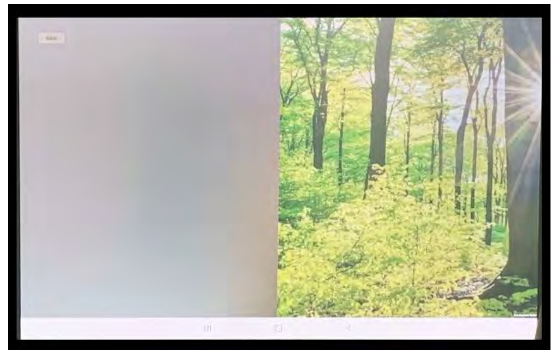


***Figure 21*. Final version of the left HH barrier**

To address the 62.5% of study participants that were not able to provide an optimal definition of HH a "More Information" button was added to the home screen of the simulation prototype. Added into this "More information" section, the definition of HH and a resource list (foundations, PDFs from conferences, etc.) (Figure 22)

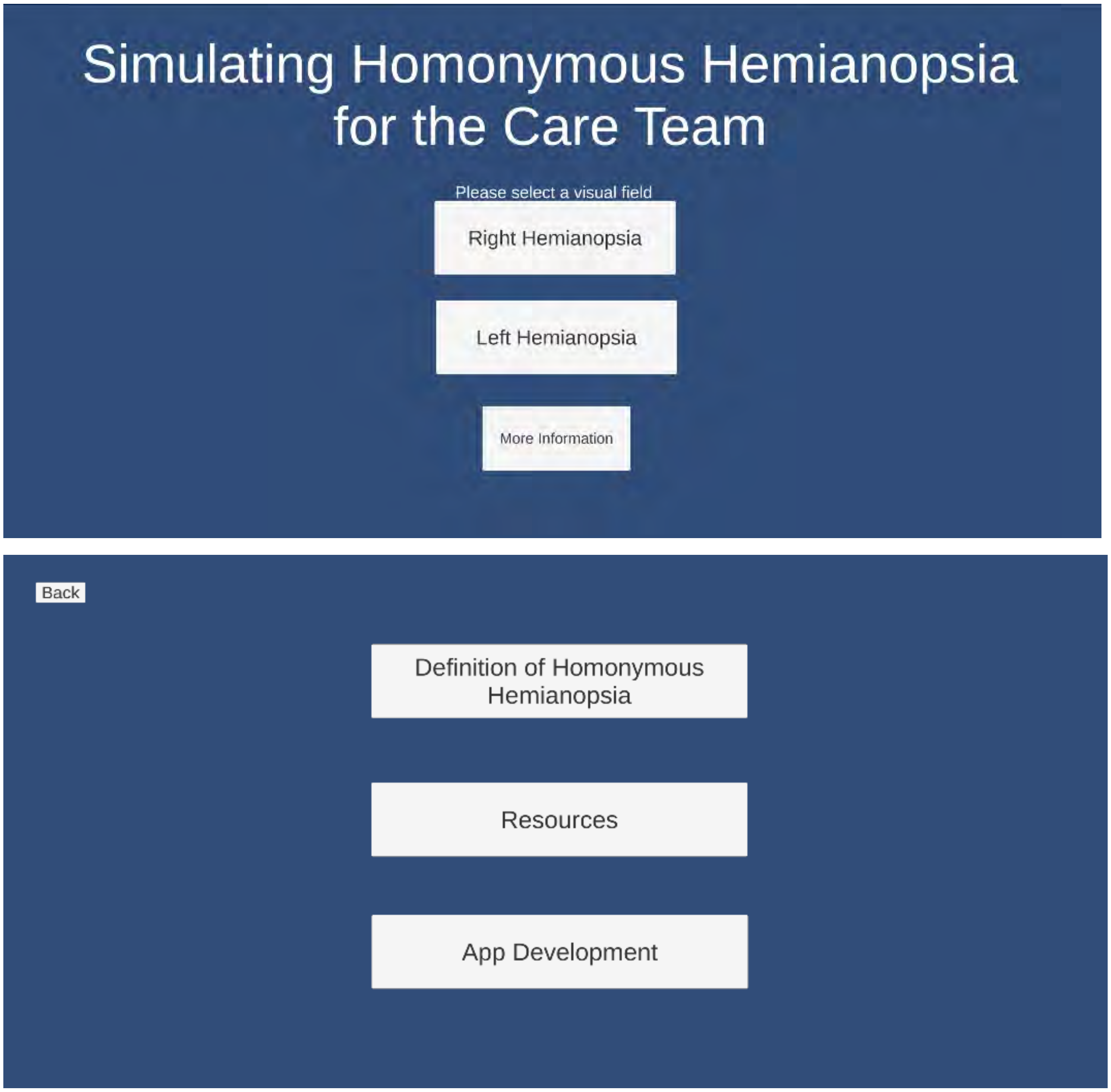


***Figure 22*. Home screen & More Information screen of the prototype**

Usability Study

Statistical Data

A total of 8 participants from the previous survey were elected to participate in a usability study of the mobile simulation of homonymous hemianopsia prototype.

37.5 % of participants reported being a parent / guardian, 25% reported being a teacher / aid, 24% reported being a therapist/rehabilitation specialist, 12.5% reported being extended family.

Task 1: Reading

Participants were asked to read a paragraph of arbitrary text utilizing only the simulation prototype as their visual view. This task was completed simulating both left and right HH. All participants verbally acknowledged the severity of difficulty of reading text while simulating HH. 87.5% of participants described reading while the missing the right visual field (right HH) as more challenging than with the left. 12.5% concluded it was more challenging to read text while simulating a left visual field loss (Left HH).

Task 2: Distance Viewing

Participants were asked to view an object close up then again from a distance utilizing the simulation prototype as their visual view.

All participants verbally acknowledged that despite knowing that HH has a complete visual field loss it was surprising the distance needed to be able to identify an entire object. 75% of participants were able to identify at least one scenario where this visual discrepancy explains a response they have encountered when working with a person diagnosed with HH.

Task 3: Maneuverability

Participants were asked to navigate and maneuver their current environmental surroundings. This task was completed simulating both left and right HH. All participants collided with objects while simulating HH. 62.5% participants incurred a majority of hurtles while maneuvering utilizing a left HH simulation, 37.5% incurred a majority of hurtles while maneuvering utilizing a right HH simulation. 87.5% participants incurred hurtles using both left and right simulations.

Post-User Experience Dialog

Participants were encouraged to participate in an open dialog about their user experience post utilizing the mobile simulation of homonymous hemianopsia prototype. 100% of participants report a significantly increased understanding of how a person with HH views their surroundings, 75% mentioned a constant feeling of disorientation while maneuvering because of the impairment. 62.5% of participants identified at least one element in their care setting they would be immediately updating after participating in this user experience study.

System Usability Scale Survey

Finally, participants were asked to participate in the system usability scale survey to evaluate the simulation prototype and rate their experience while using the application. The Simulating HH for the Care Team prototype application received a system usability scale score of 92.19.

Table 6

Participant SUS Scores (Full participant scores in Appendix D)

#	Raw SUS Score	Total SUS Score
1	37	92.5
2	35	87.5
3	40	100
4	38	85
5	35	87.5
6	36	90
7	35	87.5
8	39	97.5
Average	36.87	92.19

Discussion

Summary

The research and results from the initial survey and usability study suggest that there is a considerable need for an accessible simulation application capable of mimicking the visual field impairment HH. All participants (medical care professionals and home care providers alike) reported multiple immediate benefits from the availability of an application of this nature including orienting materials for optimum viewing, adjusting the environment to promote safer maneuverability, and identifying activities that require adaptations.

For interaction and medical simulation designers, all participants in both the initial study and the user experience testing report that simulating a visual impairment would be beneficial to their respective field, additionally participants surveyed on the usability of the simulation communicated the advantage of having an easily accessible resource section. Furthermore, participants expressed that a resource section would be helpful if included in other medical simulations as a standard of practice, a recommendation supported by the results of this study which conclude that just because a care provider assists with a person with a specific impairment it does not suggest that the care provider is an expert of the specific impairment. While the simulation prototype gave a more accurate understanding of HH it was noted that the users peripheral view on the simulated affected side could skew the experience, a potential solution discussed in recommendations section. Finally, participants appreciated the simplicity of the simulation prototype suggesting that medical simulations do not have to be complicated to be rated useful.

Interpretations

The results of the survey study gave interesting insight into the overall misunderstanding of the visual impairment HH. While 100% of participants confirmed a care provider relationship with a person diagnosed with HH, 62.5% could not provide an accurate definition/description of what HH is. The most prevailing inaccuracy was the lack of understanding that the impairment affects both eyes equally.

Additionally, although all these participants are involved directly in the planning of care for HH persons - only 6.25% reported having easy access to visually recreate what their patients see and 87.5% have no way of recreating the visual impairment for visually planning services, cares, or educational materials. It is astonishing that 56.35% of respondents listed being uncertain how to present materials to a person with HH as a primary barrier to goal achievement.

The usability study which had participants test the simulation of the HH application prototype was successful in increasing the understanding of HH as 100% of participants reported an increase in understanding how those with this visual impairment see. Furthermore, 75% of participants remarked on a consent feeling of disorientation while maneuvering because of the impairment using the HH simulation application - with 62.5% concluding that at least one element of their care setting they intended to change after participating in this user experience study.

Likewise, a 92.19 system usability scale survey (SUS) score denotes that the simulation application prototype was regarded as easy to use and would be utilized often.

Recommendations

This simulation prototype application was designed to recreate absolute HH for the care team assuming a full 50% visual field loss, it would be beneficial for the application to be customizable to different increments of field loss along with the ability to represent other visual impairments entirely.

With the implementation of additional visual impairments consulting a visual expert may provide valuable and constructive insight.

To combat the camera location's hindrance of reflecting the patient's head posture/position, explore the use of developing an external accessory that can attach to the mobile device to allow an understanding of head positioning while simulating the visual viewpoint.

Additionally, for providers wanting an increased authentic immersive experience that could allow a representation of the patient's head posture/position while simulating the loss of peripheral view of the affected side consider the use of a mobile device viewer that can be modified to allows for a user unaffected peripheral view to remain intact while blocking the affected side. For example, the Google Cardboard (Figure 23).

Figure 23. Google Cardboard

Lastly, develop the simulation application for iOS devices to reach a broader audience.

Implications

While research is available on how a person diagnosed with HH uses their vision, little is available to simulate the HH viewpoint for others to experience. The results of these studies demonstrated that there is a lack of simulation tools available for the care team to get an authentic understanding of how a person with HH views their surroundings, furthermore this lack of awareness impacts the planning and execution of care, educational, and rehabilitation goal achievement.

Limitations

Survey

While a cross section of care providers were invited to participate in the study, 93% of respondents reported being a care provider for primarily pediatric age groups. Results reflect the views of a pediatric care provider majority.

Usability Study

The simulation of HH application prototype was designed to give as close to an authentic view as possible of the visual impairment for the care teams; however, exact tones, colors, shading, and outlining in the affected visual field was unable to be personalized for each individual patient. Therefore, a general shading was utilized.

The current state of the application does not allow for the recreation of the unimpaired peripheral view nor visual field expansion as a result of prism lens use. Additionally, due to camera location on mobile devices, the position of the device does not accurately reflect the patient’s head posture/position at any given viewpoint.

Lastly, the prototype was only developed for Android devices. A broader audience would be reached if additionally developed for iOS devices.

Conclusion

These studies revealed that there is a disconnection between being a care provider who can only theorize on how persons with homonymous hemianopsia visualize the world and being able to physically experience a simulation of an actual homonymous hemianopsia point of view. The mobile design of the simulation application would allow caregivers an opportunity to easily access the literal point of view of who they are trying to help.

Educational providers, medical professionals, and parents have expressed the need to be able to develop, modify, and adapt materials to best meet the objectives and goals of their students / patients / children - this simulation application was able to provide a way to remove that barrier.

Instead of assuming proper positioning to present materials to remain in the visually impaired person's line of sight, the provider would be able to pre plan activity positioning to meet the needs of the individual. Identifying hazards when setting up clinic appointments, classrooms, and households for those with homonymous hemianopsia would be less of a challenge. Explaining to new members of the care team who are unfamiliar with homonymous hemianopsia would no longer be theoretical. Overall, the challenges currently blocking most care teams from fully understanding the homonymous hemianopsia impairment as identified in the initial survey study would be negated - allowing a greater opportunity for those diagnosed with homonymous hemianopsia to achieve a higher quality of rehabilitation to gain greater independence.

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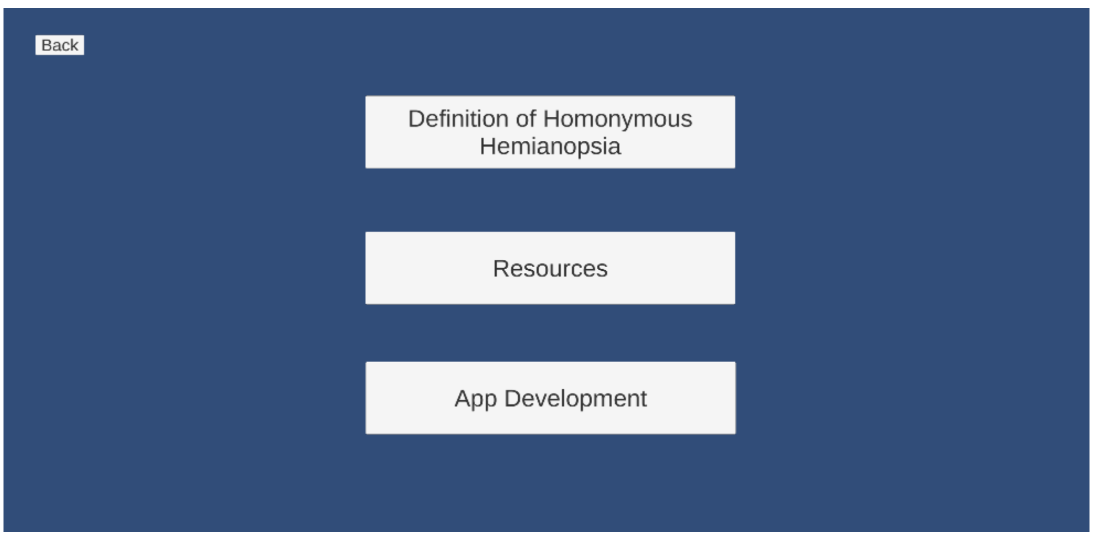
Appendix A: Survey Research Questions

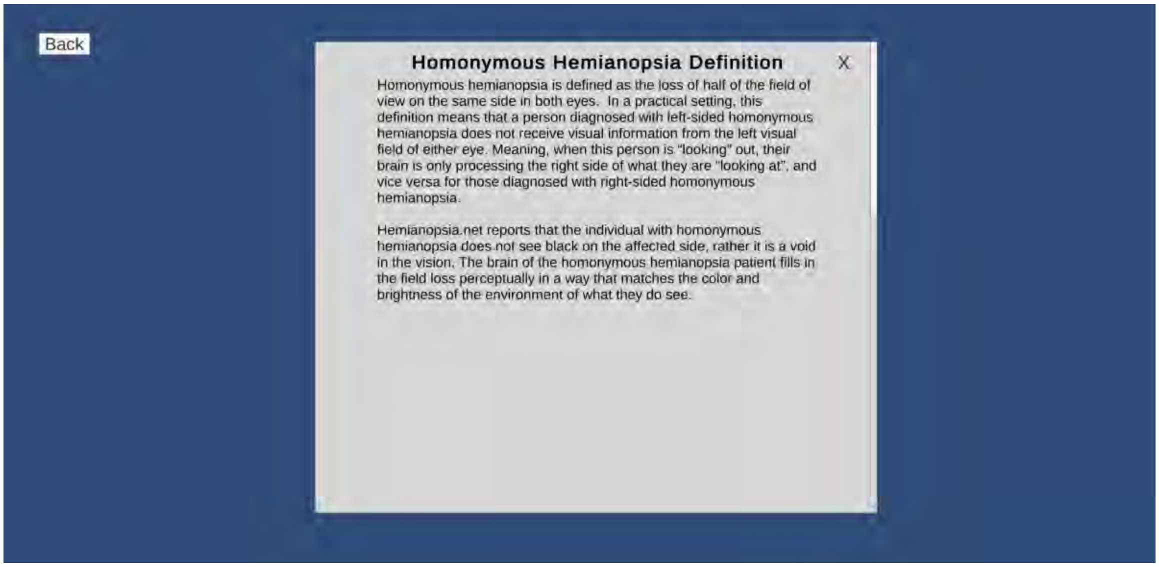
#	Question
1	What is your age range?
2	What is your experience / knowledge of Homonymous Hemianopsia?
3	How would you / do you define homonymous hemianopsia?
4	About how many patients / children / students have you provided care for with homonymous hemianopsia?
5	What is your relationship to the person(s) with homonymous hemianopsia?
6	Patient age range(s)?
7	Do you currently have easy access (Accessible within 5 minutes) to any device/s or programs etc. that allow you to interpret what a homonymous hemianopsia patient would be seeing?
8	What are some of the visual challenges / barriers you have experienced in reaching the goals of the person with homonymous hemianopsia?
9	What kind of methods or strategies have you used in the past to adjust care for homonymous hemianopsia?
10	What would / does help you when working with a homonymous hemianopsia patient?
11	Would like to be considered for user testing a mobile simulation of a homonymous hemianopsia prototype?

Appendix B: Interactive Prototype

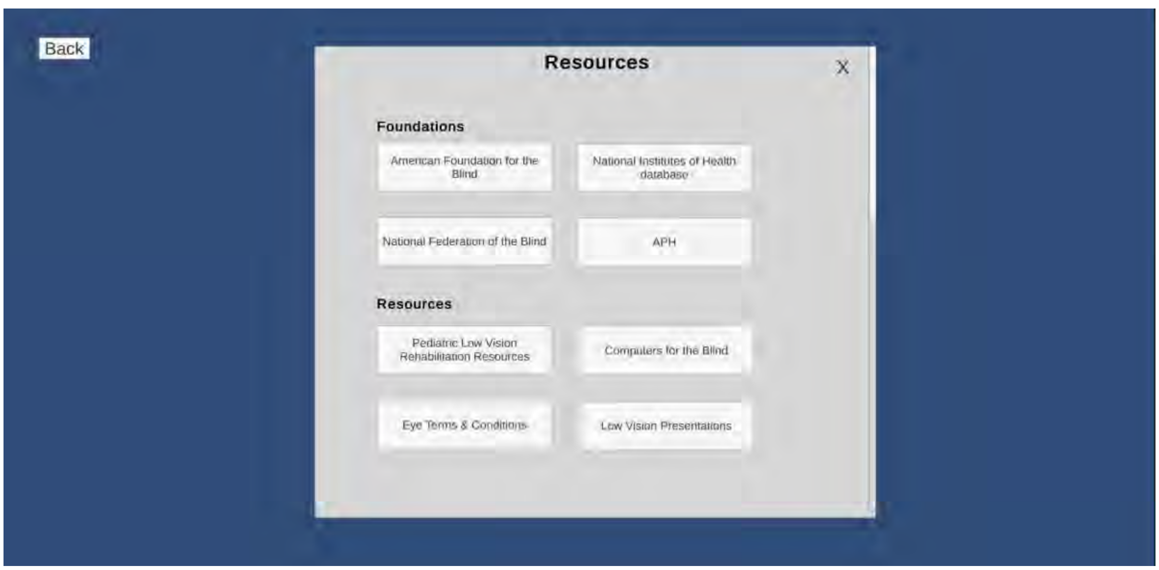
Home screen of the prototype



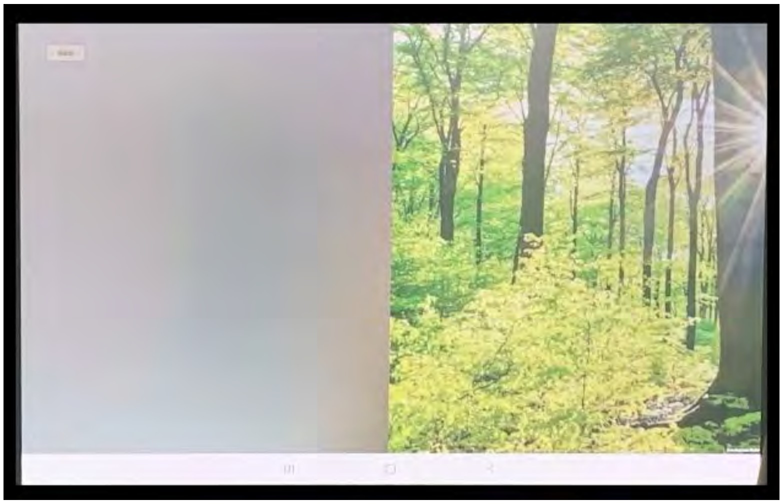
More Information screen of the prototype



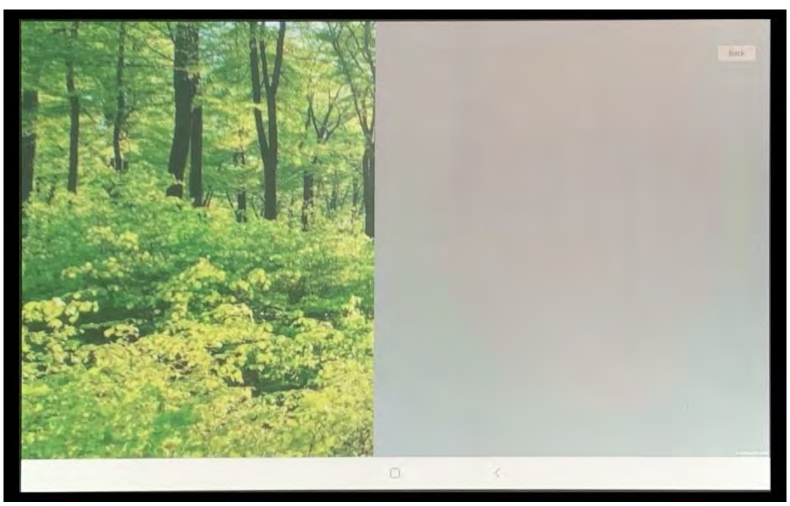
Definition of Homonymous Hemianopsia screen



Resources screen



Example of left Homonymous Hemianopsia simulation



Example of right Homonymous Hemianopsia simulation

Appendix C: Usability Study Tasks

#	Task
1	Explore the app
2	Using the app, attempt to read something. Both Left & Right
3	Look at an object close up, now look at the object from further away. Ask to comment
4	Try walking around your home or current surroundings by only looking at the tablet Both Left & Right
5	Using the app, can you tell me what homonymous hemianopsia is?
6	Do you feel like you have a better understanding of homonymous hemianopsia now that you have used this app

Appendix D: System Usability Scale Questions & Scores

#	Question	Strongly Disagree				Strongly Agree
1	I think that I would like to use this system frequently	1	2	3	4	5
2	I found the system unnecessarily complex	1	2	3	4	5
3	I thought the system was easy to use	1	2	3	4	5
4	I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5	I found the various functions in this system work well integrated	1	2	3	4	5
6	I thought there was too much inconsistency in this system	1	2	3	4	5
7	I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8	I found the system very cumbersome to use	1	2	3	4	5
9	I felt very confident using the system	1	2	3	4	5
10	I needed to learn a lot of things before I could get going with this system	1	2	3	4	5

Participant	1	2	3	4	5	6	7	8	9	10	RAW	Total
1	4	1	5	1	4	1	5	1	4	1	37	92.5
2	4	1	5	2	4	1	5	1	3	1	35	87.5
3	5	1	5	1	5	1	5	1	5	1	40	100
4	3	1	5	1	5	1	5	1	5	1	38	95
5	4	2	5	2	5	2	5	1	5	2	35	87.5
6	2	1	5	1	4	1	5	1	5	1	36	90
7	3	1	5	2	5	1	4	1	5	2	35	87.5
8	5	1	5	1	5	1	5	1	5	2	39	97.5
										AVG	36.87	92.19

Appendix E: Downloadable Prototype Link

Link to folder containing the downloadable prototype and an accompanying Read_Me file with directions.

https://drive.google.com/drive/folders/1MK8fdYbCSGE4dVTa3roAN81VzI9d_2SK?usp=sharing