AN EYE-TRACKING STUDY OF A UNIVERSITY FOOD PROCESSING CENTER WEBSITE

By

MEGAN SILVEIRA

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Thesis Approved:

Dr. Dwayne Cartmell

Thesis Adviser

Dr. Greg Clare

Dr. Ruth Inman

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Name: MEGAN SILVEIRA

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Abstract: The Robert M. Kerr Food and Agricultural Products Center (FAPC) on the Oklahoma State University campus is dedicated to discovering, developing and delivering technical and business information that stimulates and supports the growth of value-added food and agricultural products and processing in Oklahoma. To connect with clients, the FAPC utilizes a website to provide factual information, dates and registration information for upcoming events at the center, relevant news of the food industry and more. In 2020, the FAPC not only went through a complete website redesign but also purchased Tobii Pro Glasses 3, a device with eye-tracking technology and the potential to conduct beneficial research within the food and agricultural industry. Neither the website nor the glasses had been evaluated by the center. This study simultaneously tested the usability of the FAPC's website and the usability of the eye-tracking technology. Eye-tracking data was collected from 46 food processors, entrepreneurs, or employees of food processors and entrepreneurs, who were tasked with locating specific information on the website. Data was collected by two different types of eye-tracking technology, including eye-tracking glasses and a screen-mounted eye-tracking system, using two devices, a laptop monitor and a cellphone display. The study revealed it took participants a minute or longer on average to complete the assigned search task, but no difference other than normal variance existed between data collected by both eye-tracking devices. The Tobii Pro Glasses 3 were found to be unsuccessful when used to collect eye-tracking data on a cellphone. Specific elements of the FAPC's website were labeled as "successful" or "unsuccessful" based on the amount of visual attention they gained or failed to gain from viewers.

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CHAPTER I

INTRODUCTION

Since first opening its doors on the Oklahoma State University campus located in Stillwater, Oklahoma, in 1997, the Robert M. Kerr Food and Agricultural Products Center (FAPC) has been devoted to helping further the development of successful, value-added enterprises in the state of Oklahoma to help "bring the products, jobs and dollars back home" (Escoubas, 2016, p. 6). While wheat and cattle are considered a rich part of Oklahoma's heritage and both play a significant role in supporting the state's economy, a large portion of these products are sent to other states or countries for further processing (Escoubas, 2016). It is the mission of faculty and staff at the FAPC to discover value-added products and processes and help enhance their value, while simultaneously supporting and stimulating the growth of the food and agriculture industry in the state of Oklahoma (Escoubas, 2016).

The FAPC is affiliated with the Division of Agricultural Sciences and Natural Resources at OSU (Escoubas, 2016) and aims to "discover, develop and deliver technical and business information that will stimulate and support the growth of value-added food and agricultural products and processing in Oklahoma" (Robert M. Kerr Food and Agricultural Products Center, 2020, para. 7). The 96,000 square-foot, state-of-the-art center contains animal harvesting, food manufacturing, grain milling, sensory profiling, food microbiology, analytical laboratory, and conference facilities (Robert M. Kerr Food and Agricultural Products Center, 2020). These service areas have allowed the center's faculty and staff to assist more than 1,000 Oklahoma clients and work with more than 3,000 technical and business projects (Robert M. Kerr Food and Agricultural Products Center, 2020). Individuals at the FAPC work to connect agricultural processors and entrepreneurs with emerging technology and business management practices through the use of research, pilot-processing facilities, laboratories, educational programs, and seminars (Robert M. Kerr Food and Agricultural Products Center, 2020).

Along with these services, the FAPC allows clients and visitors to work with experts specializing in facilities and equipment in the following topics: food processing; food safety, quality management, and sanitation; packaging and labeling; regulations, customer requirements, and compliance; and sustainability and environmental concerns (M. Gross, personal communication, September 23, 2020). These expertise sectors are further broken down into "focus areas" that serve as specific resources for clients of the FAPC (M. Gross, personal communication, September 23, 2020). The focus areas of the center are agribusiness economics, business marketing and communications, cereal chemistry, food engineering, food microbiology, food processing, food safety and quality assurance, horticulture processing, meat processing, milling and baking, oilseed processing, product development, and wood products (Robert M. Kerr Food and Agricultural Products Center, 2020).

Connections between the members of the Oklahoma food and agriculture industry and staff at the FAPC are created through the work of two main groups at the center – the communications team and the business and marketing team (M. Gross, personal communication, September 23, 2020). Mandy Gross serves as the center's Communication Services Manager and is assisted by a graduate communications assistant (Megan Silveira is filling this role from 2019-2021) (M. Gross, personal communication, September 23, 2020). The business and marketing team is made up of Chuck Willoughby, Business and Marketing Relations Manager; Andrea Graves, Business Planning and Marketing Specialist; and Erin Johnson, Business/Marketing Client Coordinator (M. Gross, personal communication, September 23, 2020).

To contact, connect with, advise and inform both current and potential clients, the FAPC has information published through a variety of platforms (M. Gross, personal communication, September 23, 2020). The communications team currently manages the center's Facebook, Twitter, LinkedIn, Instagram, and YouTube accounts (M. Gross, personal communication, September 23, 2020). In addition to these social media platforms, research data, upcoming events ,and food safety information are published in a combination of fact sheets, online newsletters, newS releases and feature stories (published in both digital and print formats), annual reports, research papers, brochures, infographics, and videos (M. Gross, personal communication, September 23, 2020).

While these publication methods are a vital part of the FAPC's communications strategy, a vast majority of the information and resources created by faculty and staff at the center are published and most easily found by the public on the center's website, food.okstate.edu. (M. Gross, personal communication, September 23, 2020). The electronic database is managed by Gross (M. Gross, personal communication, September 23, 2020). She explains, "A website is vital to the FAPC's overall communication plan because it helps communicate our mission, vision, and purpose" (M. Gross, personal communication, September 23, 2020). A presence on the web is essential in today's world for a business, company, or organization to succeed, and the FAPC is no exception (M. Gross, personal communication, September 23, 2020).

For nearly two decades, the FAPC has had an online presence (M. Gross, personal communication, September 23, 2020). The center has undergone four web redesign projects since first launching the site (M. Gross, personal communication, September 23, 2020). Each transition has altered the layout and content of the center's website, but changes made followed the branding and guidelines set by the marketing staff at OSU (M. Gross, personal communication, September 23, 2020).

The most recent update to the center's website was initiated after OSU announced the entire campus was shifting to an updated primary, institutional logo to be used across all university campuses, colleges, departments, and athletic teams July 1, 2019 (Oklahoma State University, 2020). With this redesign project, the communications team at the FAPC had to migrate their website to a new platform, OmniUpdate (M. Gross, personal communication, September 23, 2020). Gross (2020) describes the new platform as having a contemporary, modern look with the information presented in a user-friendly format, simpler than past versions.

When the university launched these rebranding efforts, the FAPC's communications team had a unique opportunity to satisfy the demands of their clients in regard to their online presence (M. Gross, personal communication, September 23, 2020). Since launching the FAPC's latest website in October 2020, the center's online presence is now more than ever before dedicated to focusing on the user and the information those individuals deem as most important (M. Gross, personal communication, September 23, 2020). The center believes it has created a website that is more easily navigated and visually pleasing to online viewers (M. Gross, personal communication, September 23, 2020).

Alongside the desire to connect with new and potential clients in the most effective way, the FAPC is also consistently looking for emerging technologies to provide to food processors, entrepreneurs and their employees (M. Gross, personal communication, September 23, 2020). From products and equipment made by the FAPC faculty and staff to tools purchased from outside sources, the center is dedicated to unveiling the best opportunities (M. Gross, personal communication, September 23, 2020). No matter what type of product or service a client offers or their chosen production method, marketing is a large part of an organization's success in the market (M. Gross, personal communication, September 23, 2020). Marketing factors include a product's visual impact on consumers, shelf placement, label design and so much more (M. Gross, personal communication, September 23, 2020). To help clients better understand those marketing areas, the FAPC recently purchased a pair of Tobii Pro Glasses 3 in August 2020. This device is equipped with the latest eye-tracking technology to track the eye movement of their wearers (M. Gross, personal communication, September 23, 2020). The center's staff plans to use the glasses to research product label design, shelf placement and more (M. Gross, personal communication, September 23, 2020).

As no data has been collected on either the new layout of the FAPC's website or the usability of the Tobii Pro Glasses 3, this study explored the visual impact the newly designed online presence of the center has on its viewers in both a desktop and mobile format, as well as compare and contrast the use of the glasses with older technologies previously used in eye-tracking research projects.

Statement of the Problem

Regardless of its origins, a website is expected to meet commercial and personal demands of visitors, offer a variety of technical and design options, and satisfy the continuing surge of interest and investment expressed by society, all while promoting the purpose intended by the website designer (Lawrence & Tavakol, 2007).

To help continuously improve the communication efforts between staff and faculty at the FAPC with their current and potential future clients and visitors, the center's website needs to effectively attract the visual attention of online visitors (M. Gross, personal communication, September 23, 2020). Since undergoing the most recent redesign, the ability of the mobile and desktop version of the website to attract visual attention is unknown. The newly acquired eye-tracking glasses have the capability of collecting data such as this, but the new technology has yet to be tested or used by the FAPC team.

Statement of the Purpose

The purpose of this study was to better understand how users navigate the FAPC's website when seeking out specific information relevant to the services offered by the facility. The study simultaneously tested the usability of the center's newly acquired eye-tracking technology, the Tobii Pro Glasses 3, by comparing data collected with the use of the glasses to data collected with the use of a mounted eye-tracking system.

Objectives of the Study

The following objectives were developed to help achieve the purpose previously stated:

1. Determine the average amount of time an individual will spend completing a specific task while visiting the FAPC's website on a laptop monitor.

2. Determine general successful and unsuccessful elements of the FAPC's new website through trends identified in the eye-tracking data.

3. Compare visual attention data collected by the varying types of eye-tracking devices to identify differences between the systems.

4. Test the utility of the Tobii Pro Glasses 3 for use on a mobile device.

Logical Assumptions

The following objectives were accepted for this study:

1. The two-step search task assigned to participants was chosen with assistance from the communications team at the FAPC because it highlighted one of the many vital services labeled as both the most useful and relevant by both FAPC clients and staff.

2. Participants were not aware of the prompt for website exploration before the study began.

3. Participants were largely unfamiliar with the new design of the FAPC website.

4. Participants were given free rein to explore the website once the prompt had been read.

Limitations

1. As the researcher visited the businesses of IAC members, the researcher had no control over the environment where the experiment was set up. While it was requested a private and quiet space be available for the study, there were some distractions present (individuals walking in and out of the room, verbal interruptions, etc.).
2. As the researcher visited the businesses of IAC members, the researcher had to utilize the hotspot on their mobile device to connect the laptop being used by the research participants, meaning the internet connection was sometimes slower than normal or spotty.

Definitions

1. Fixation: the most common feature looked at by eye-tracking researchers; "those times when our eyes essentially stop scanning about the scene, holding the central foveal vision in place so that the visual system can take in detailed information about what is being looked at" (Tobii, 2020)
2. Area of Interest (AOI): concept and tool that allows the eye-tracking research to calculate quantitative eye movement measures including fixation counts and durations; the researcher draws a boundary around a feature or element of the eye-tracking stimulus that the analyzation software (Pro Studio and Pro Lab) then

calculates desired metrics for within the boundary over the time interval of interest (Tobii, 2020)

3. Time of Interest (TOI): new analyzation tool in Pro Lab that allows researchers to organize recording data according to time intervals where meaningful behaviors and events take place (Tobii, 2020)
4. Events: "multipurpose markers that can be used to locate important occurrences on the eye-tracking timeline;" can be created by the researcher or generated automatically by Pro Lab (Tobii, 2020)

CHAPTER II

REVIEW OF LITERATURE

This chapter provides a review of the literature previously published relevant to the research in this study. Topics covered in this review include past research on the FAPC's communication efforts, visual communication, and website usability. The theoretical framework utilized for this study is also included in the review.

Insight on the FAPC

Industry Advisory Committee (IAC)

Before the construction of the FAPC was completed, the Oklahoma Legislature agreed an external advisory board was needed (Escoubas, 2016). Thus, the Industry Advisory Committee (IAC) was born in 1996 through Senate Bill 1030 (Escoubas, 2016). The IAC is designed to be a "consistent and broadly based oversight council that represented very specific sectors of the food and agribusiness industries in Oklahoma" (Escoubas, 2016, p. 26). The committee is composed of 15 individuals who are appointed by either the Governor's Office, Speaker of the House, President Pro Tempore of the Senate, or the DASNR Vice President for Agricultural Programs (Escoubas, 2016). The IAC must always have a committee chair, vice chair, and secretary who are all elected by a vote in a quorum meeting (Escoubas, 2016). Individuals serve three-year term limits (Escoubas, 2016).

The committee and its members follow the Oklahoma State Statute policies, meaning they do not receive compensation for service outside of their travel expenses (Escoubas, 2016). Tasks of the IAC members include advising on project evaluation and prioritization; setting fees for services and programs; creating and designing joint ventures and business programs; and acting on other issues as needed, such as the development and advancement of the production, processing, handling, and marketing of agricultural commodities (Escoubas, 2016).

Members of the IAC and employees of their food and agricultural businesses served as part of the population for this study.

Marketing, Communication Efforts and Past Research at the FAPC

With a deep-rooted history in the food and agriculture industry and a central location on the OSU campus, the FAPC has been the focus of several research projects in the past (M. Gross, personal communication, September 23, 2020).

Research in 2007 identified how frequently clients and stakeholders of the center visited to the FAPC's website and what information these individuals hoped to access when visiting (Stockstill, 2007). One hundred individuals, selected from a database maintained by Gross, responded to an instrument designed by the researcher to better understand the purpose and use of the FAPC's site in the eyes of its users (Stockstill, 2007). The database was composed of a combination of Basic Training Workshop participants, producers of Made In Oklahoma products, members of the IAC, parties who had expressed interest in being included on the center's mailing list, and industry professionals with interest in food and agricultural products within the state of Oklahoma (Stockstill, 2007).

Stockstill (2007) said her findings allowed her to discover, "Those who visit the FAPC website do so mainly to obtain general information about the FAPC or to check the calendar for updates and upcoming events" (p. 57). In addition to visiting the home page and calendar most frequently, individuals perceived these two sections to be of the most importance (Stockstill, 2007). 53% of respondents Stockstill's study reported they had never visited the center's website before, while a greater portion of the remaining respondents reported they only visited the website on a monthly basis (Stockstill, 2007). At the time of the study, a majority of respondents believed the site to be modern, up to date, and easily navigated (Stockstill, 2007).

To increase their desire to visit the FAPC's website, respondents had a few areas they identified as needing improvement (Stockstill, 2007). Clients and stakeholders expressed a desire to have access to the same information across all communication platforms (Stockstill, 2007), meaning content shared through print media, social media, or any other method should also be showcased on the center's website. Website visitors also reported a need for increased searchability, a continued focus on the provision of current information about the FAPC, and support for the prospect of hosting workshops or classes online (Stockstill, 2007).

The second study was completed by Willard (2011) and examined the characteristics of stakeholders and staff of the FAPC, as well as their perceptions of the center's brand. Stakeholders, along with clients, are likely to be the main users of the FAPC's website (M. Gross, personal communication, September 23, 2020). Understanding the background and opinions of these individuals can help the communications team at the center develop a website more suitable, useful, and attractive to them (M. Gross, personal communication, September 23, 2020).

Upon looking at the demographic characteristics for the FAPC stakeholder, Willard (2011) reported a majority of respondents shared several similarities (p. 59). The study found the majority of the FAPC's audience are white males, over the age of 61, with a college education (Willard, 2011). 60% of respondents were business owners with more than 20 years of experience with the food and agricultural industry (Metzger, 2011).

A focus group session of stakeholders revealed recognition, limited resources, uniqueness, university setting, and supporting Oklahoma as repeating themes in regard to individual's perception of the center's brand (Willard, 2011).

Most stakeholders believed the FAPC brand has the ability to distinguish the center from competitors and celebrate success (Willard, 2011). However, respondents also commented they believed the center does not actively promote this brand to the public (Willard, 2011), limiting the center's ability to communicate and reach the largest audience as possible. Willard (2011) reported stakeholders also consider the FAPC to be underfunded.

Respondents relate this to the center being in possession of limited resources, stating they believe both more staff and equipment are needed at the FAPC (Willard, 2011). Stakeholders do not view this as a negative or personal choice of the center, rather that the proper funding is just absent (Willard, 2011). Despite the belief the center lacks funding, stakeholders still hold the belief the FAPC offers "robust discipline and service offering," creating a unique organization capable of serving many areas of food production (Willard, 2011). Finally, Willard (2011) found stakeholders' perception of success at the center to be largely dependent upon the FAPC's activities for the state of Oklahoma. Stakeholders want to see a return on investment for both the state and clients when they choose to interact with or invest in the FAPC (Willard, 2011).

Visual Communication

Human Visual Attention

When an individual captures a glimpse of something worth studying further, they dedicate time to visual examining said object. This examination is an example of the overlying concept of visual attention. Human visual attention (HVA) is defined by psychologist William James as the "taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought" (Duchowski, 2017, p. 3).

Every moment their eyes are open, humans are forced to accept an overwhelming amount of visual data through sight (Xu, 2016). The human brain must then prioritize a subset of the data to focus on to avoid being overwhelmed by the influx of visual information (Xu, 2016). Focalization, concentration and consciousness are at the core of HVA, and the concept implies withdrawal from certain subjects in order for the viewer to focus more effectively on other subjects they deem vital (Duchowski, 2017). Explained on a purely anatomical level, Xu (2016) said attention is "facilitated by a retina with a high-resolution central fovea and a low-resolution periphery" (p. 1). In simpler terms, the human eye is guided to specific areas of interest of a scene to focus on through the shifting of visual attention (Xu, 2016).

Visual attention has been studied for over a century, and Duchowski (2017) said the relationships between vision, the concept of HVA and eye movement have been built upon over the years. Early studies looked at simple ocular observations when studying HVA (Duchowski, 2017). With this past research, HVA has come to be built on two main concepts – the "what" and the "where" (Duchowski, 2017).

In 1925, Von Helmholtz was the first to dive into the inner workings of HVA (Duchowski, 2017). Von Helmholtz (1925) believed visual attention was an essential mechanism of visual perception. In defining the "where," his research explained visual attention can be consciously directed, but eye movement will inevitably reflect the viewer's will to inspect objects in fine detail (Duchowski, 2017). An individual's attention also has the tendency to wander, but Von Helmholtz said eye movement provides evidence of overt visual attention (Duchowski, 2017). Following Von Helmholtz's exploration of the "where" half of the HVA equation, James proposed the contrasting idea of the "what" that drives the movement of the human eye (Duchowski, 2017). James (1981) said attention was reliant upon the identity, meaning or expectation that was associated by the individual with what they are viewing. Essentially, James (1981) found that visual attention was drawn towards features in an image that are believed to help define what the viewer is looking at – meaning viewers direct their attention at images for the purpose of finding out "what" it is that they are looking at.

A majority of the research conducted in regard to HVA has been based on the factors "where" and "what" that drive eye movement (Duchowski, 2017). Eye movement has come to be understood and defined as a cyclical process, which Duchowski (2017) said means vision occurs in a cycle demonstrated through the following series of steps, presented in a bottom-up model:

1. Upon encountering a stimulus in the form of an image, an individual will view the entire scene in low resolution through their peripheral vision. Features deemed as being "interesting" by the individual's mind may start to stand out from other features in the scene, signaling the potential for an area of focus and concern to be identified. This area of focus will likely be given more and more specific attention by the individual.

2. Attention is directed from the original fixation area, and the gaze is relocated to the focus area or feature of the image that stood out in the first step.

3. As the eyes move to a new area of interest, attention is once again engaged so selected features can be examined at a higher resolution.

HVA and Eye-tracking Technology

From business marketing to personal relationships, the phrase "communication is key" rings true across many platforms. With no place on this planet providing an escape from at least some sort of visual image (Lester, 2006,), it is vital for communicators to understand how visual messages are perceived by the human eye. This realm of visual messages and their impact on consumers is referred to as "visual marketing" (Wedel & Pieters, 2008, p. 1). Wedel and Pieters (2008) define visual marketing as the "strategic utilization by firms of commercial and non-commercial visual signs and symbols to communicate with consumers in order to establish and maintain profitable relationships" (p. 1).

In an effort to better understand the way consumers react to visual communication efforts, eye-tracking research has become more and more popular (Xu, 2016). This type of research allows for gaze, or the direction and order an individual is looking, to be used as an accepted substitute for attention in natural human behavior (Xu, 2016). Harel (2010) describes gaze as a natural indicator of interest, so it has been used as an input to help measure visual attention of users looking at an interface. Several companies produce and offer various eye-tracking technology systems, and recent years have seen a shift away from expensive, fragile hardware to more modern, robust and affordable technology (Xu, 2016). Tobii (2020), the world leader in eye-tracking, defines the technology as a sensor "that makes it possible for a computer or other device to know where a person is looking." The company says eye-tracking technology can detect the presence, attention and focus of the users while simultaneously allowing for insight into human behavior (Tobii, 2020).

Since 2001, Tobii (2020) has been producing eye-tracking technology in three main business units: Tobii Dynavox, Tobii Pro and Tobii Tech. Dynavox focuses on assistive technology to work with disabled and special needs individuals; Pro creates specialized technology to provide a deeper insight and objectivity in human behavior research; and Tech provides technology for integration work with consumer electronics.

The Tobii (2020) company states there must be three vital parts in any type of high-performing, eye-tracking system. These include custom-designed sensors consisting of projectors, image sensors, optics and custom processing embedded with algorithms; advanced algorithms serving as “the brain of the system” that work to interpret the image stream generated by the sensors; and user-oriented applications that enable various applications of the technology (Tobii, 2020). The eye-tracking technology works by first using projectors to create a pattern of near-infrared light on the eyes (Tobii, 2020). Cameras then take high-resolution images of the user’s eyes and the pattern in which they travel (Tobii, 2020). Finally, machine learning, image processing and mathematical algorithms are used to detect gaze points and the position of the eyes (Tobii, 2020).

One of the Tobii eye-tracking products is the Tobii X2-30 Compact eye tracker, a screen-based mounted system (Tobii, 2020). This system captures data at 30 or 60 Hz. While the product has been discontinued and replaced with a newer version, it is still in use by many Oklahoma State University students for eye-tracking research (G. Clare, personal communication, March 10, 2020). The screen-based, mounted eye-tracking systems from Tobii are designed for researchers to take their studies outside of the lab environment (Tobii, 2020). The technology is compatible with most sizes of laptop screens, so research can be taken directly to the participants (Tobii, 2020). The company (2020) describes this software as being easy to use and requiring minimal effort or investment. The technology will pick up exactly where individual users are looking and is designed for fixation-based research (Tobii, 2020). The systems attach to the bottom of laptop screens with mounting plates and connect to a computer through a USB port

(Tobii, 2020). The program has a tolerance for head movements and varied lighting conditions and is compatible with corrective lenses (Tobii, 2020).

The newest addition to the Tobii (2020) technology family comes from Tobii Pro. The Tobii Pro Glasses 3 and is equipped with a scene camera to provide a wider field of vision and collects a larger set of comprehensive data on visual attention (Tobii, 2020). This is the third generation of wearable eye-tracking glasses. It has 16 illuminators and four eye cameras integrated into scratch-resistant lenses in comparison to older eye-tracking products (Tobii, 2020). The company (2020) says the glasses were built to be unobtrusive to the wearer's field of vision and capable of handling an individual's natural head and body movement. They describe the glasses as "discreet and lightweight" with a design that mimics regular eyewear, allowing for the possibility of natural behavior in all situations (Tobii, 2020). While these glasses can be utilized in a variety of scenarios and platforms, the Tobii company (2020) states they intend for the glasses to be utilized in an outdoor environment and everyday scenes. The glasses connect to a computer via WiFi for recording of eye-tracking data (M. Gross, personal communication, September 20, 2020). The glasses are compatible with corrective lenses (Tobii, 2020).

Duchowski (2017) warns raw data collected by technology like these Tobii products, however, is essentially useless. The goal of eye movement measurement and analysis is to "gain insight into the viewer's attentive behavior" by characterizing the signal gained by the fixations and saccades (rapid movement of the eye between fixation points) of a viewer's gaze, but initially collected data is uninformative until properly digested and analyzed by researchers (Duchowski, 2017, p. 141). Signals in eye movement will be approximated by linear filters to identify the fixations and pursuits in the viewer’s data that truly indicate locations of overt visual attention (Duchowski, 2017,). While all individuals view images and stimuli differently, Duchowski (2017) said the concept of visual search remains constant for all people. This basic understanding of HVA and eye movement serves as the basis for the eye-tracking research of today. Tobii Pro (2020) offers Tobii Pro Studio and Tobii Pro Lab to classify eye movements collected by Tobii Pro technology and its eye-tracking systems.

Website Usability

As internet usage continually increases in use and popularity, Ehmke and Wilson (2007) state viewers expect to have a positive experience when interacting with an online platform (p. 2). Defining or quantifying a website’s use and ease for viewers can be a subjective task. Nielsen (1999) said as websites have become a part of individual’s everyday routine, and if the sites are convenient, individuals will continue to use them, and if they are not, they will not be used.

To simplify and standardize the process, web usability is a large factor in determining the successfulness of a website (Chiew & Salim, 2003, p. 47). Usability is defined Nielsen (1999) as “a quality attribute relating to how easy something is to use. More specifically, it refers to how quickly people can learn to use something, how efficient they are while using it, how memorable it is, how error-prone it is, and how much users like using it. If people can’t or won’t use a feature, it might as well not exist.”

The guidelines offered by Nielsen (1999) for high quality website design are based on behavioral research and observation rather than opinion. User-testing models were employed based on observational studies, meaning individuals were given realistic tasks to perform on multiple online platforms while under observation. The following ground principles for website usability:

1. Page design: the surface appearance of websites or the most immediately visible part. Users do not typically visit a website to enjoy its design, rather the design is present to create easy access to online data. There are two rules of thumb: 1) content should account for at least 50% of the space, and 2) navigation should be kept below 20%. Design should focus on users' freedom and movement, as online visitors do not want to feel limited in their interactions. People do not usually wait more than 10 seconds, so large images should be avoided.
2. Page content: the way users scan or read information on a webpage. Users are described as goal-driven and sometimes impatient, so content is typically scanned rather than actually read. Being brief is key – concise sentences should be used, make text short, present one idea per paragraph, hyperlinks should be utilized, bulleted lists should be used to break up flow of text blocks and relevant words should be used.
3. Site design: the provision of logical and intuitive navigational systems to the user that reflects the site's structure and hierarchy. This refers to the architecture of information, and the site design should reflect views of the audience in its presentation of information and services. Users will want an indication of where they are on the site, where they can go next and where they have already been. A well-functioning search feature should be

available at all times, as many users dominantly use search options rather than links.

4. Intranet design: principles for content, goals, users and technical constraints. Lack of focus on this area can lead to loss of productivity.
5. Accessibility: considering disabilities with visual, auditory, speech, motor or cognitive troubles.
6. International use: knowing geographical boundaries of sites. Communicate with a visual language that can work well across borders and consider translations (Nielson, 1999).

Taking it a step further, Nielson (1999) postulates the acronym HOME-RUN for a summary of successful criteria on a website. The acronym stands for high-quality content, often updated, minimal download time, ease of use, relevant users' needs, unique to online medium and net-centric corporate culture (Nielson, 1999).

Chiew and Slaim (2003) propose the following tips for ease of use of a website:

1. Number of frames should be limited, as a division of display space into many smaller sections inhibits a comfortable reading experience for users.

2. Users should not have to scroll from side to side (left to right) while on the site, as this causes reading difficulty.

3. Browser capability should not be a concern for users, and technologies that might cause a computer to crash should be avoided.

4. Scrolling text, marquees, constant running animations or other “distracting” and “irritating” elements should not be used.
5. Links to the home page, indication of location (i.e., a site map or menu) and consistent placement of these elements should be used to avoid orphan pages.
6. The placement of a site map or menu should be consistent.
7. Information on the site should be able to be easily searched by users.
8. Links that have and have not been visited by users should be easily differentiated through the use of font color or other methods.
9. Outdated pages should be replaced so all information is up to date.
10. Download times should be a maximum of 15 seconds.
11. The back button should be available to be utilized by users to return to the previous page.
12. A small amount of new browser windows should be opened to avoid user confusion.
13. Standard use of the site should meet user expectations.
14. Elements similar in appearance to advertisements should be reduced.
15. Information should be presented in natural and logical order.
16. Destination pages of hyperlinks should be described using meaningful words.

17. Page layout, use of color, placement of page elements and other components of overall design should be consistent.

18. Colors should contrast and page elements should attract attention of users.

19. Blocks of text should be avoided, and headlines, sub headlines, bulleted lists, highlighted keywords and short paragraphs should be used to enhance the page's readability.

20. A sufficient number of navigational aids should be provided (50-51).

These 20 criteria are further classified into four categories (Chiew & Salim, 2003). The list includes content, organization and readability; navigation and links; user interface design; and performance and effectiveness (Chiew & Salim, 2003, p. 51). Data and information collected can fall into more than one of these categories (Chiew & Salim, 2003).

Mack and Nielsen (1994) offer one set of techniques to measure web usability and categorizes these evaluation methods into the following categories:

1. Automated: usability measures are computed by running a user specification through evaluation software.

2. Empirical: usability is assessed by testing the interface with real users.

3. Formal: using exact models and formulas to calculate usability measures.

4. Informal: based on rules of thumb and the general skill, knowledge and experience of the evaluators.

Benbunan-Fich (2001) pose these four alternative categories of evaluation methods:

1. Objective performance: measures the ability of website visitors to complete a specific task through the system in terms of time.
2. Subjective user preferences: measure the various preferences of the website users through the use of questionnaires to express their opinions and rating of the system.
3. Experimental: measurements based on controlled experiments designed to test hypotheses about the design of the web pages and their impact on users.
4. Direct observation: monitoring and inspection of the users' behavior as they interact with the web pages to directly detect usability problems.

Like all research and evaluation methods, each of these practices has its own unique set of strengths and weaknesses, and it is ultimately up to the researcher to select the most appropriate evaluation practices (Chiew & Salim, 2003, p. 48). Preece (1994) lists stage of the web system's design, novelty of the web design project, number of expected users, criticality of the web interface, total costs, time availability, and researcher experience as some of the factors that should be considered when selecting a suitable evaluation method in regard to web usability.

Website Usability and Eye-tracking Technology

Ehmke and Wilson (2003) state the demand for usability analyses of websites is high and the popularity of using eye-tracking technology in these types of studies has grown. But while interest from researchers has been high, Duchowski (2017) said actual data collection and discovery has been low.

Eye-tracking studies examining visual attention in relation to information presented in an online platform have not yet “revealed groundbreaking guidelines” in terms of effective web page layout or design (Duchowski, 2017, p. 11). Part of this lack of data, however, stems from the fact that a majority of eye-tracking studies have been conducted utilizing static images instead of interactive elements like websites (Xu, 2016). Wainwright (2009) said most research conducted with eye-tracking technology consists only of participants “free viewing” an image for a short amount of time (typically two to fifteen seconds).

Due to this gap in the literature, various questions such as variances of visual attention in an interactive environment (attention coordinated with the use of a keyboard and mouse, for example), the allocation of attention between tasks needed to complete a single task, and the differences between users and various media platforms still remain unanswered (Xu, 2016). When eye-tracking is utilized in a web usability study, there is a lack of general guidance in correlating eye-tracking patterns with usability problems (Ehmke & Wilson, 2003). Some usability practitioners focus on data such as long fixations, back track saccades, ignored web page elements, scanning behavior, rapid eye movement back and forth, reading choices, and interaction with text or images are all types of data often highlighted in eye-tracking web usability studies (Etre, 2006).

While Ehmke and Wilson (2003) propose a correlation scheme to assist in this type of study, they state researchers will still be left to make subjective judgement as they interpret eye-tracking data. The study attempts to link specific eye-tracking data to usability issues in a general correlation scheme (Ehmke & Wilson, 2003). Some highlights of usability problems addressed include expected information missing, ineffective presentation and too much information. These problems are respectively linked to eye-tracking patterns of many short fixations across the page where information is presented, very few fixations in general and scanning patterns across the entire page. (Ehmke & Wilson, 2003). View all the links developed by Ehmke and Wilson (2003) in Appendix B.

In addition to the need for researcher interpretation, another problem with usability studies utilizing eye-tracking technology arises in that the measurement of interactions between the human eye and a digital screen requires special equipment. While this web-specific equipment shares the same goal as other forms of eye-tracking technology, Butko and Movellan (2010) said it is limited in the context that it can only measure eye movement and fixation on the space of a computer screen and requires calibration before use by each individual participant. Tobii Pro Lab and Tobii Pro Studio are two types of analyzation software compatible with Tobii eye-tracking technology that offer a "complete solution for research human behavior" (Tobii, 2020). While the analyzation of data still relies on researcher interpretation and generalization of eye movements and user interaction, the possibility does exist for successful usability tests utilizing Tobii eye-tracking technology.

Theoretical Framework

In 1974, Mehrabian and Russell developed the Stimulus-Organism-Response theory. The researchers said (as cited in Jang & Namkung, 2009), “environmental stimuli (S) leads to an emotional reaction (O) that, in turn, drives consumers; behavioral responses (R) based on the stimulus-organism-response (S-O-R) paradigm” (p. 451). An individual’s emotional reaction is made of up pleasure, a combination of feelings like happiness and satisfaction (Graa & Dani-elKebir, 2011); arousal, a measurement of how ready an organism is to act (Graa & Dani-elKebir, 2011, p. 287); and dominance, a reflection of the level an individual feels overpowered by their environment (Graa & Dani-elKebir, 2011).

The S-O-R paradigm is believed to possess seven components, each representing a specific moment in the response of an organism to stimulus. Jacoby (2002) defines these as the following:

1. Encountered Environment: an encompassment of all things understood to be external stimuli; the package of interacting and competing stimuli.
2. Automatic Processing: the realm where individuals subconsciously process incoming or internally activated stimuli.
3. Experiential Storehouse: stockpiling location of an individual’s emotional and cognitive systems, commonly known as “long-term memory.”
4. Consciousness: an individual’s consciousness or awareness including their mental reactions and responses to stimuli.

5. Non-trace Stimulus-Response Events: a collection of reactions and responses that have never consciously or subconsciously reached an individual's physiological core.

6. Internal Responses: a collection of non-visible reactions and responses to stimuli.

7. External Responses: a collection of reactions and responses that are or can be made to be externally detectable, including nonverbal, verbal and behavioral responses (p. 54-55).

In 2002, Jacoby reimagined the format of this theory into a "three-dimensional Venn diagram," that allows for thoughts, feelings, internal responses, and more to occur, and the transition between all sectors of the S-O-R framework (p. 53-55). In this study, we will consider the stimulus to be functionality and interactive features of the FAPC's website, all of which are presumed to elicit a reaction as individuals attempt to discover a specific piece of information assigned to them.

CHAPTER III

METHODOLOGY

This chapter describes the methods and procedures used to conduct the study. The chapter will explain the process of gaining Institutional Review Board (IRB) approval, outline the design of the research, describe research subjects and detail the process of collecting the eye-tracking data.

Institutional Review Board

OSU requires all studies conducted with human subjects be reviewed and approved by the Institutional Review Board (IRB) before research can begin. The application included an identification of data collection methods, personal and professional characteristics form, participant consent form (Appendix C), and contact strategies (email forms and personal speech) for research participants (Appendix D and E). The study was assigned IRB-20-509 and approved by the IRB on November 17, 2020, after revisions were made.

Research Design

This study was exploratory in nature. The study was a quantitative exploration of eye-tracking data collected on the FAPC's website and a comparison of the mounted eye-tracking device, Tobii X2-30, and the eye-tracking glasses, Tobii Pro 3. No controls were used.

Research Subjects

Current and potential clients of the FAPC, including both business owners of food and agricultural businesses (businesses connected to the FAPC through the IAC or through participation in the center's various workshops, and located in the state of Oklahoma) and their employees, served as the population of this study. A convenience sample of individuals fitting this description that were additionally located closest to Stillwater, Oklahoma, served as subjects for the study.

Data Collection

Research subjects were divided into three different groups for collection of eye-tracking data, but only data from Group 1 and Group 2 were analyzed in this report. Eye-tracking data collected from Group 3 was not analyzed, and the group will only be discussed in relation to Objective 5 in the remaining two chapters of this report. Groups 1 and 3 had 15 individuals and Group 2 had 16 individuals, but eye-tracking data was only analyzed from Groups 1 and 2 (n=31).

Group placement was determined by a first come, first serve basis, meaning the first 15 research subjects were placed in group one and the following 15 individuals in group two, and so on. Participants were either visiting the FAPC for participation in a training course or visited at their place of employment (J&M Farms in Miami, Oklahoma; Homeland Baking LLC in Claremore, Oklahoma; US Roasters Corp in Oklahoma City, Oklahoma; or Fresh Avenue in Oklahoma City; Oklahoma) directly by the researcher.

The three groups were as follows:

1. Individuals viewing the FAPC website through a desktop platform on an ASUS G74S laptop with 17.25-inch monitor, with eye-tracking data being collected by the Tobii X2-30 Compact (mounted device).

2. Individuals viewing the FAPC website through a desktop platform on an ASUS G74S laptop with 17.25-inch monitor, with eye-tracking data being collected by the Tobii Pro Glasses 3.

3. Individuals viewing the FAPC website through a mobile platform on an iPhone 8 (4.7-inch screen), with eye-tracking data being collected by the Tobii Pro Glasses 3.

The same two-step search task was assigned to each individual, regardless of group. The task assigned to participants was to find out how much it would cost an in-state resident to have the FAPC complete a process authority evaluation (the full prompt shown to participants is shown in Appendix F). After participants verbally indicated to the researcher they had read through the entire prompt, they were taken to the homepage of the FAPC's website. The same laptop and attached mouse were utilized on subjects in both groups.

For all groups and individuals, equipment and surfaces were sanitized in between each session. The researcher wore a face shield, face mask and gloves at each location. Hand sanitizer and tissues were available for participant use throughout the entire research process.

Group 1

Subjects designated to the first group were placed in a seated position an arm's length away from the table where the laptop was positioned. The laptop was connected to Wi-Fi through a hotspot on the researcher's cellphone. Before recording any eye-tracking data, the researcher explained the study procedures to participants and had them sign a consent form. Participants were then introduced to the calibration process and told a red dot would appear on a white screen that they were to follow with their eyes while keeping their head as still as possible. These procedures were created based on the distance requirements of the Tobii technology.

After the successful completion of the calibration process, the researcher pulled up the prompt for the study with the text presented in a white font on a black background and then started the eye-tracking recording. Participants read through the prompt for the study, and after alerting the researcher they had read through the prompt and were ready to proceed, the researcher pressed the space bar of the laptop which advanced the subject to the FAPC's website.

Subjects then had free rein to explore the website and complete the assigned prompt. Subjects were allowed to ask for a reminder of the prompt if necessary at any time during their exploration. Once the requested information was found by the subject, the researcher ended the eye-tracking recording and minimized the webpage. Research subjects were excused, equipment was cleaned, and the process was repeated. There was no time limit for each participant's exploration of the site. Notes regarding each individual participant's experience during the research are shown at the end of this chapter.

Group 2

Subjects designated to the second group were placed in a seated position an arm's length away from the table where the laptop was positioned. The laptop was connected to Wi-Fi through a hotspot on the user's cellphone. Before recording any eye-tracking data, the researcher explained the process of the study to participants and had them sign a consent form. Participants were asked to put on the Tobii Pro Glasses 3 and secure the device by tightening the band on the back of their head. These procedures were created based on the distance requirements of the Tobii technology.

Participants were then introduced to the calibration process and instructed to hold the provided calibration card above the laptop screen, an arm's distance from them, and focus on the dot in the inner circle of the card. After the successful completion of the calibration process, the researcher pulled up the same prompt used in the first group and started the eye-tracking recording. Participants read through the prompt for the study, and after alerting the researcher they had read through the prompt and were ready to proceed, the researcher pressed the space bar of the laptop which advanced the subject to the FAPC's website.

Subjects then had free rein to explore the website and complete the assigned prompt. Subjects were allowed to ask for a reminder of the prompt if necessary at any time during their exploration. Once the requested information was found by the subject, the researcher ended the eye-tracking recording and minimized the webpage. Research subjects were asked to remove the glasses before they were excused, equipment was cleaned, and the process was repeated. There was no time limit for each participant's exploration of the site. Notes regarding each individual participant's experience during the research are shown at the end of this chapter.

Group 3

Subjects designated to the third group were placed in a seated position an arm's length away from a full-length tripod holding the iPhone. Before recording any eye-tracking data, the researcher explained the process of the study to participants and had them sign a consent form. Participants were asked to put on the glasses and secure the device by tightening the band on the back of their head. These procedures were created based on the distance requirements of the Tobii technology.

Participants were then introduced to the calibration process, and the researcher held the calibration card above the phone screen, an arm's distance from participants who were to focus on the dot in the inner circle of the card. After the successful completion of the calibration process, the researcher pulled up the same prompt used in the previous two groups (formatted to fit the size of an iPhone screen using the Notes app) and started the eye-tracking recording. Participants read through the prompt for the study, and after alerting the researcher they had read through the prompt and were ready to proceed, the researcher opened the Safari app and advanced the subject to the FAPC's website.

Subjects then had free rein to explore the website and complete the assigned prompt. Subjects were allowed to ask for a reminder of the prompt if necessary at any time during their exploration. Once the requested information was found by the subject, the researcher ended the eye-tracking recording and locked the iPhone. Research subjects were asked to remove the glasses before they were excused, equipment was cleaned, and the process was repeated. There was no time limit for each participant's exploration of the site. Notes regarding each individual participant's experience during the research are shown at the end of this chapter. This group has been included in the data notes, but no data from this group was analyzed. It will only be discussed in regard to the fifth objective

Data Notes

Eye-tracking data collected from Group 3 was not analyzed, and the group will only be discussed in relation to Objective 5 in the remaining two chapters of this report.

Table 1

Data Notes

Group/ Participant Number	Calibration Attempts	Task Reminders	Notes
1-01	1	3	
1-02	3	1	Had to lower the chair to complete the calibration processes; interrupted by a single individual entering room during research
1-03	1	0	
1-04	2	1	Had to remove hat for calibration process to be successful
1-05	1	0	Spoke frequently throughout process; one pop-up on screen during session; RECORDING WAS MISSING FROM LAB

1-06	1	1	Did not read entire prompt at beginning of research
1-07	1	1	One pop-up on screen during session; interrupted by a single individual entering room during research; spoke frequently throughout process
1-08	3	0	Difficult to align eyes to calibration; not a strong reading on calibration; had to reset the program between calibration attempts 1 and 2; used search bar to get to Process Authority
2-01	1	0	Used search bar to get to Process Authority
1-09	1	1	
2-02	1	2	Attempted to use search bar
2-03	4	2	UNSUCCESSFUL; used over his own glasses; Tobii glasses did not calibrate; connected glasses twice; did not hold calibration card far away enough to be successful
2-04	1	1	
1-10	1	2	
1-11	1	2	
2-05	2	2	Did not put calibration card far enough away on first try; tried to use search bar
2-06	1	0	Lost service on computer halfway through; had to reconnect to WiFi; tried to use search bar
1-12	1	1	
2-07	1	1	Had to change battery in glasses after initial fitting; used over her own glasses; MISSING FROM LAB

2-08	1	0	
1-13	1	2	Didn’t finish typing name in before hitting enter to start the eye-tracking program
2-09	1	2	
2-10	1	2	
2-11	3	2	Used over personal glasses; had to readjust Tobii glasses before third calibration attempt
1-14	1	3	
2-12	1	2	
1-15	1	0	One pop-up on screen during session
2-13	1	2	Sat in room with participant 1-15 but was unable to see screen; tried to use search bar
2-14	2	0	Moved card during initial calibration attempt; slow WiFi
2-15	3	0	Tried to use Tobii glasses over personal glasses; eventually took reading glasses off and then had successful calibration
2-16	1	2	Recording screen froze on laptop during session, but glasses seemed to continue working and recording
3-01	4	3	UNSUCCESSFUL; Glasses did not calibrate; wouldn’t tighten strap enough; phone brightness faded halfway through; spoke frequently throughout process; one pop-up on screen during session
3-02	1	2	Re-read prompt; live recording stopped showing halfway through
3-03	3	1	Had to push glasses up nose further and move card closer to pass calibration; one pop-up on

			screen during session; live recording did not show on laptop
3-04	1	2	Explored website without knowledge of prompt (8 min) before asking for assistance
3-05	1	1	Tried to change window in browser
3-06	2	1	Had to bring calibration card closer; leaned closer to screen once recording began
3-07	2	1	Card was crooked in first calibration attempt
3-08	1	6+	Couldn't read English very well; coached through entire exploration process
3-09	3	3	Was sitting too far away from screen during calibration process; lost connection to glasses briefly after calibration but recording continued; phone went dark several times; sat at home screen for an extended period of time
3-10	1	3	UNSUCCESSFUL; did not read prompt; one pop-up on screen during session; lost connection to glasses as battery died halfway through recording
3-11	1	3	Moved very close to screen after calibration process; spoke frequently throughout process
3-12	4	1	UNSUCCESSFUL; could not calibrate; used over personal glasses
3-13	1	6+	Did not speak English very well; coached through entire exploration process

3-14	4	4	People were present in room during session; phone went dark during the prompt
3-15	1	3	Phone went dark during the prompt
3-16	5	0	Card was not straight during calibration process and spacing was off; one popup during session
3-17	1	2	
3-18	1	0	Phone went dark during prompt

Data Analysis

The Tobii Pro Lab was used to analyze data from Group 1, and Tobii Pro Studio was utilized to analyze data from Group 2, based on combability between the programs and the eye-tracking technology. Participants were assigned a two-step task, where they first had to find the webpage for Process Authority (identified as "Training" and "task one" for the remainder of this document) and then locate the fees section on the Process Authority page (identified as "Fees" and "task two" for the remainder of this document). The full prompt given to participants can be found in Appendix F. Areas of interest (AOIs) were drawn around the Process Authority forms panel (screenshot of webpage shown at Appendix G) under the title of "Testing" on the Training and Services page and the Fees section shown on the Process Authority page (screenshot of webpage shown at Appendix H). Custom events were created by the researcher before each of the AOIs first appeared to the participants. All data was used in the analyzation process, as outliers were attributed as normal variation. Missing data was not input into calculations, meaning it was eliminated rather than calculated as having a "zero" value.

It should be noted out of the combined 31 participants from both Groups 1 and 2, a total of five individuals attempted to use the search bar function of the website to complete the prompt. Only two individuals, however, were successful (participants 1-08 and 2-01). This data was not included in the following results, as the use of the search bar eliminated the opportunity for any data to be collected for task.

Additionally, error in the use of the eye-tracking technology by the researcher resulted in missing data from three individuals: participants 1-05, 2-03 and 2-07. As a result of this error, sufficient eye-tracking data was not collected from these individuals, and data from those three sessions was not calculated in the following results.

Missing data from any of the other 26 participants was naturally occurring. Missing data from these 26 participants was eliminated from calculations of range, mean and standard deviation rather than being input as zero. Major outliers were included in the calculation of the range, mean and standard deviation, as these outliers represent normal variation in user experience of the FAPC's website.

CHAPTER IV

FINDINGS

Findings for Objective 1

Objective 1 was designed to determine the average amount of time an individual would spend completing a specific task while visiting the FAPC's website on a laptop monitor. This objective was evaluated using the Time to First Fixation metric. Tobii (2020) defines this metric as, "the elapsed time between an interval start event until the first fixation occurs in that interval and in the target area of interest (AOI)." Events were created by the researcher through the use of Tobii Pro Studio. The researcher created these events for each individual participant, starting the event immediately before the AOI first appeared on the monitor screen and ending once it completely disappeared. AOIs for each task are defined in their respective sections below.

Task One of the Prompt

The AOI for this task was the entire Process Authority panel found on the Trainings and Services subpage of the FAPC's website (Appendix G). In Group 1, data from 10 out of 15 participants was used to calculate average time to first fixation, and data from 11 out 16 individuals in Group 2 was used. Complete results for time to first fixation in task one are presented in Table 2.

In comparing the two groups, participants from Group 2 took a significantly longer time on average to have their first fixation (*M* = 132.75, *SD* = 44.71) versus Group 1 (*M* = 50.72, *SD* = 37.06). Both groups on average took close to if not longer than one minute for their first fixation in this task.

Table 2

Time to First Fixation, Training

	Time to First Fixation (seconds)		
Group	*M*	*SD*	*Range*
1	50.72	37.06	91.1
2	132.75	44.71	134.23

Figure 1 shows a scatterplot of individual participants' times to first fixation from all 21 participants with analyzable data from Groups 1 and 2.

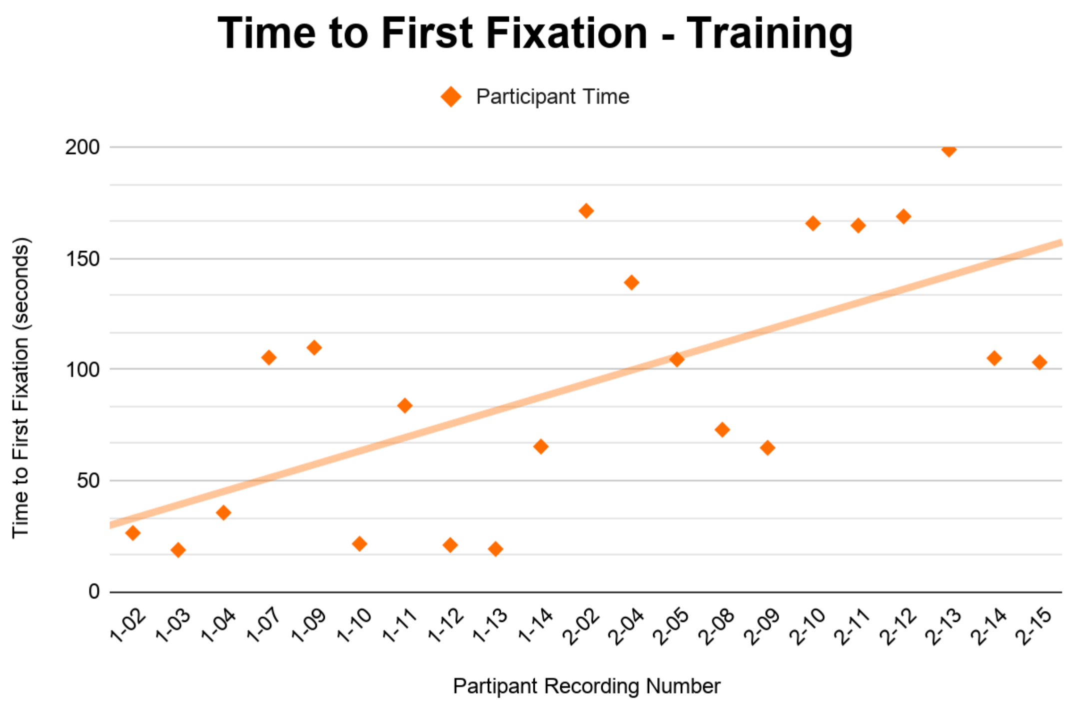

Figure 1. Time to First Fixation – Training.

Task Two of the Prompt

The AOI for this task was the Fees heading and description found on the Process Authority subpage of the FAPC's website (Appendix H). In Group 1, data from nine out of the 15 participants was used to calculate average time to first fixation, and data from 10 out 16 individuals in Group 2 was used. Complete results for time to first fixation in task one are presented in Table 3.

In comparing the two groups, participants from Group 2 took a significantly longer time on average to have their first fixation (*M* = 162.93, *SD* = 50.76) versus Group 1 (*M* = 20.43, *SD* = 10.74).

Table 3

Time to First Fixation, Fees

	Time to First Fixation (seconds)		
Group	*M*	*SD*	*Range*
1	20.43	10.74	36.06
2	162.93	50.76	133.34

Figure 2 shows a scatterplot of individual participants' times to first fixation from all 19 participants with analyzable data from Groups 1 and 2.

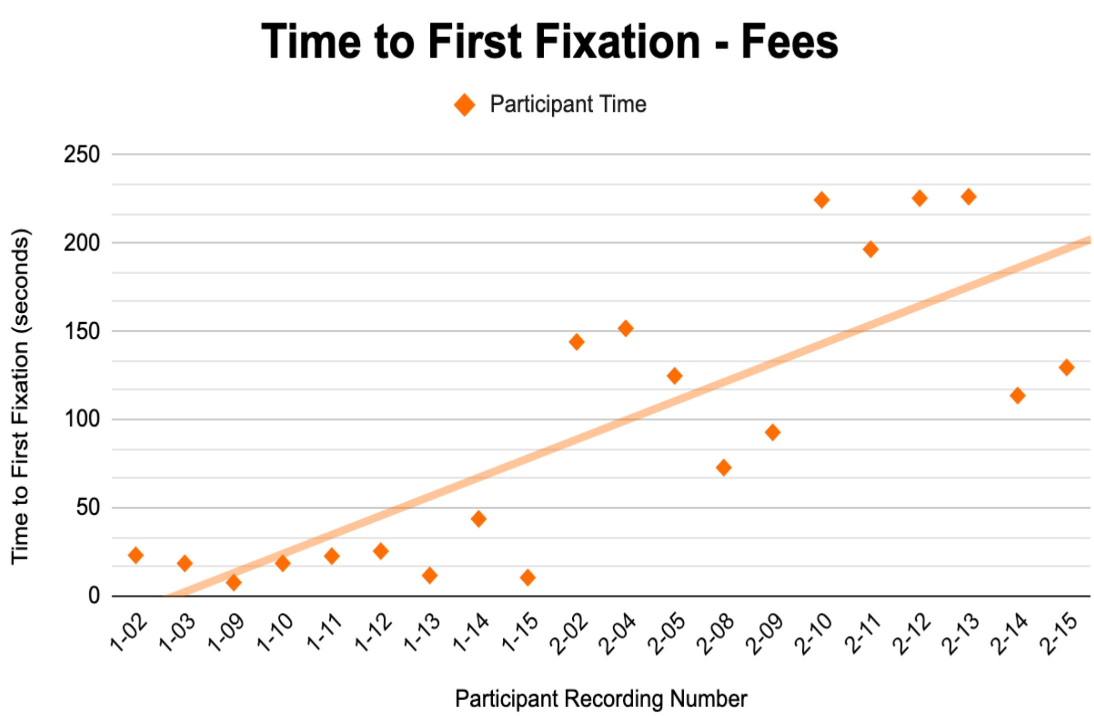

Figure 2. Time to First Fixation - Fees.

Findings for Objective 2

Objective 2 was designed to determine the general successful and unsuccessful elements of the FAPC's new website through trends identified by the researcher in the eye-tracking data. Screenshots of the Tobii Pro Lab of Groups 2's results were used to identify elements where visual trends were observed in actions of participants. Heatmaps were used to present areas of fixation from participants for tasks one and two.

Layout and Design

Upon first opening the FAPC's website, participants' visual attention was first drawn to the navigation bar at the top of the page (Figure 3). Individuals did not often scroll on the home screen, but rather attempted to utilize the search bar or transitioned to a new subpage based on the options listed in the navigation bar.

Figure 3. Navigation Bar.

Participants were not frequently observed to scroll to the bottom of the website. As more time was spent on the site, the less likely participants were to explore the entirety of the webpage they were on. It should also be noted some participants were not aware they could scroll further on some of the webpages until they questioned the researcher. Notes documenting how many times each participant asked for help or reminders from the researcher can be found in Table 1.

Laying information out in a grid (Figure 4) or in columns (Figure 5) typically drew more attention than presenting it in paragraph form. When viewing grid style layouts or columns, participants typically first fixated on the information shown in the middle section before casting their gaze to the left and reading or scanning the information from left to right.

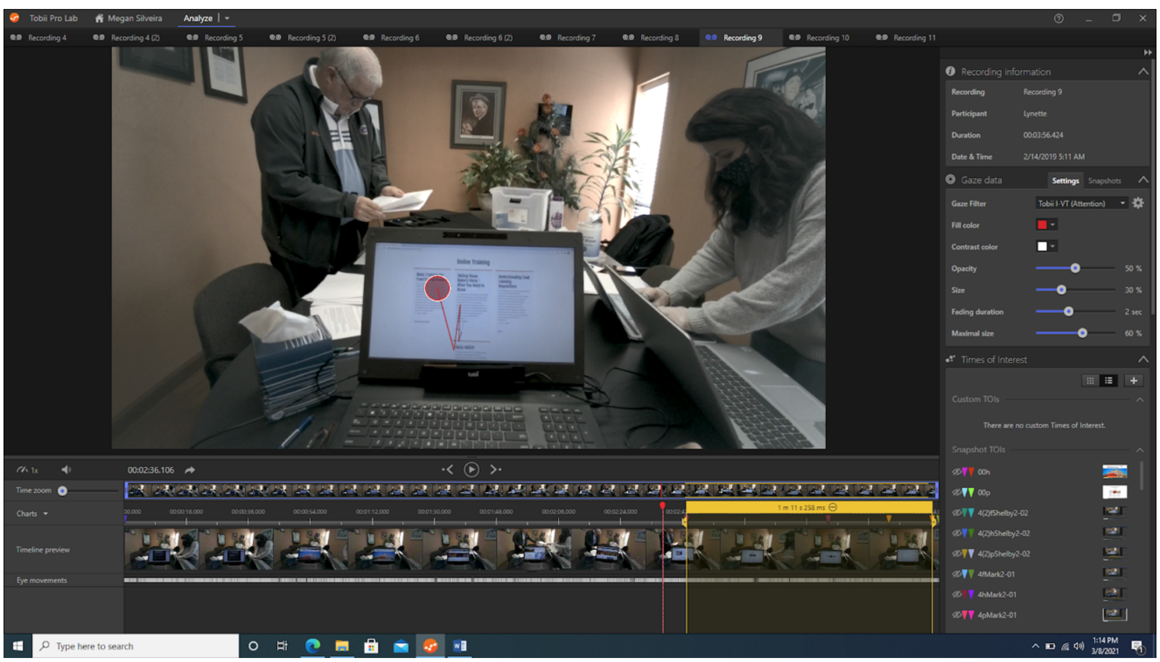

Figure 4. Grid Layout.

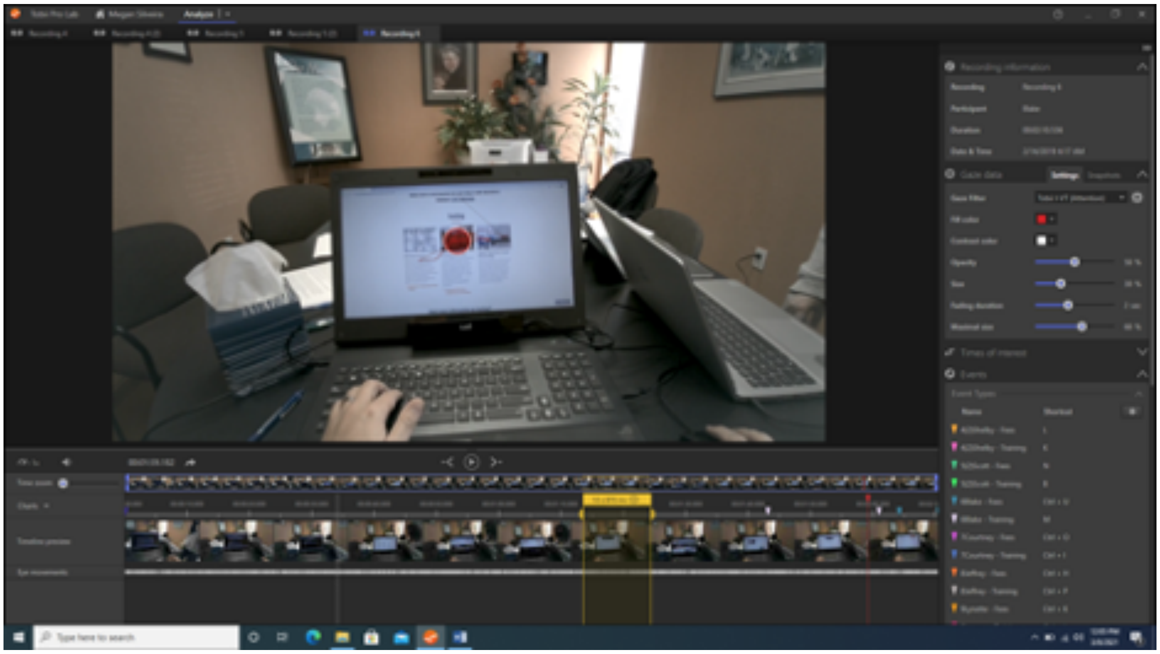

Figure 5. Column Layout.

The use of solid boxes with text overlay came in four forms: small orange boxes with white text under paragraphs (Figure 6), medium orange boxes placed on the bottom left corner of horizontal images used as page headings (Figure 7), large orange boxes placed in the upper right corner of webpages (Figure 7) and large black boxes placed in the upper right corner of webpages (Figure 8). The small and medium orange boxes were extremely successful in consistently gaining the visual attention of participants. The large boxes were consistently unsuccessful in gaining viewers' attention when orange in color. On the other hand, when the large boxes were black in color, they consistently drew viewers' attention.

Figure 6. Small Orange Boxes.

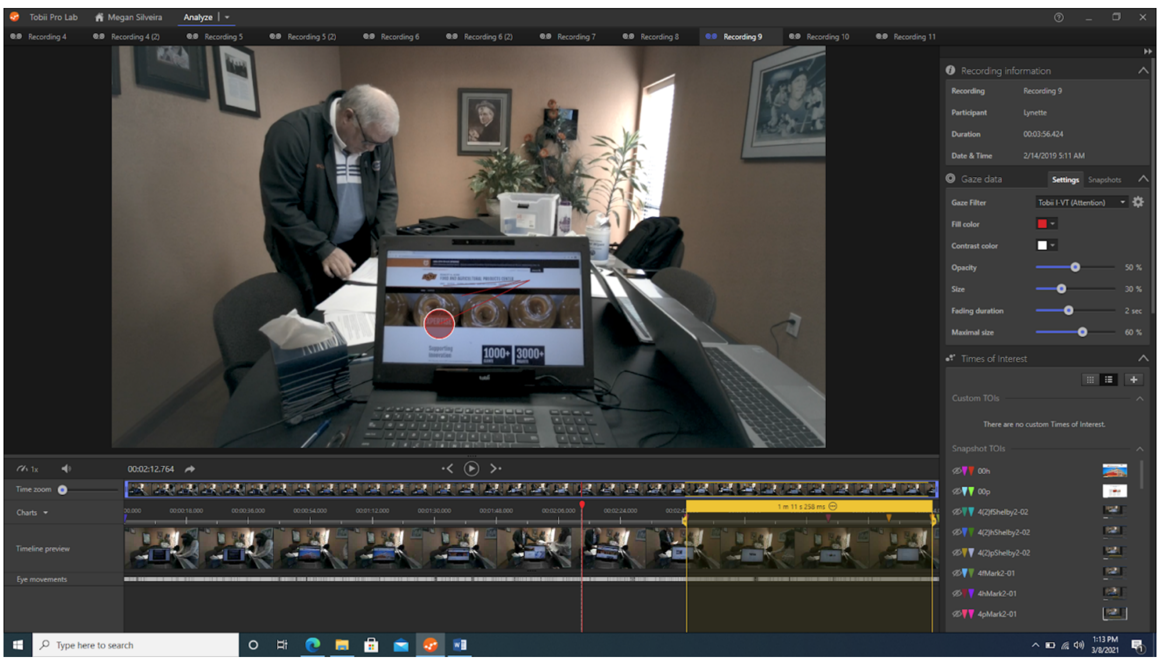

Figure 7. Medium Orange Boxes.

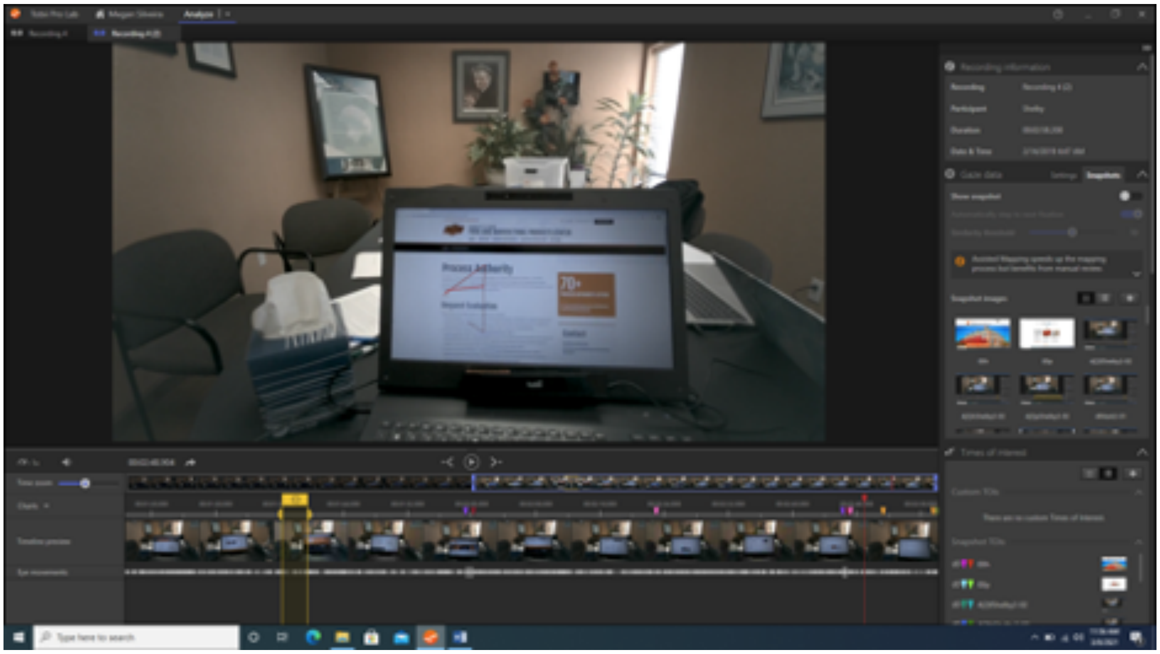

Figure 8. Large Orange Boxes.

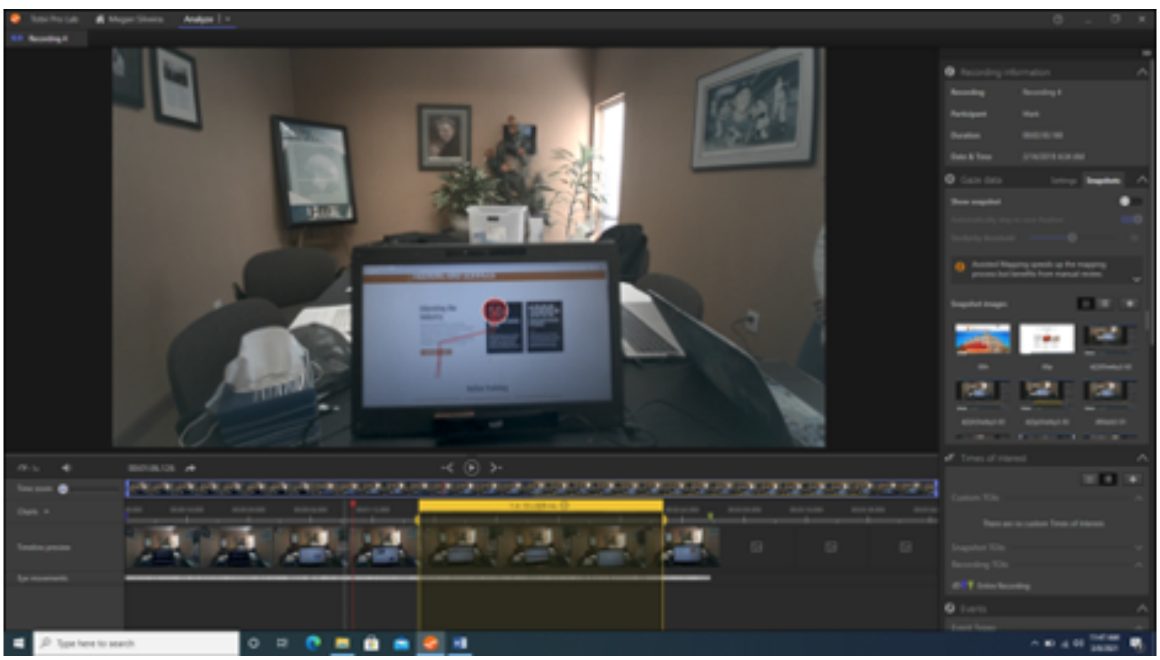

Figure 9. Large Black Boxes.

Use of Images and Icons

Horizontal, full-screen length images were utilized at the top of most pages of the FAPC's website as headings. Despite the size and central placement of these images, participants repeatedly spent little to no time looking at images, but rather directed a vast majority of their visual attention to the navigation bar above those heading images.

It should be noted on the home page, where the photo filled the entire frame of the screen (Figure 10), if participants did not scroll down, the orange box with white text did not appear (Figure 11). The same problem was observed in the headings placed on horizontal images presented as text overlaid on small orange boxes (can be seen in previously shown Figure 7). When the screen was split down the middle with text on one

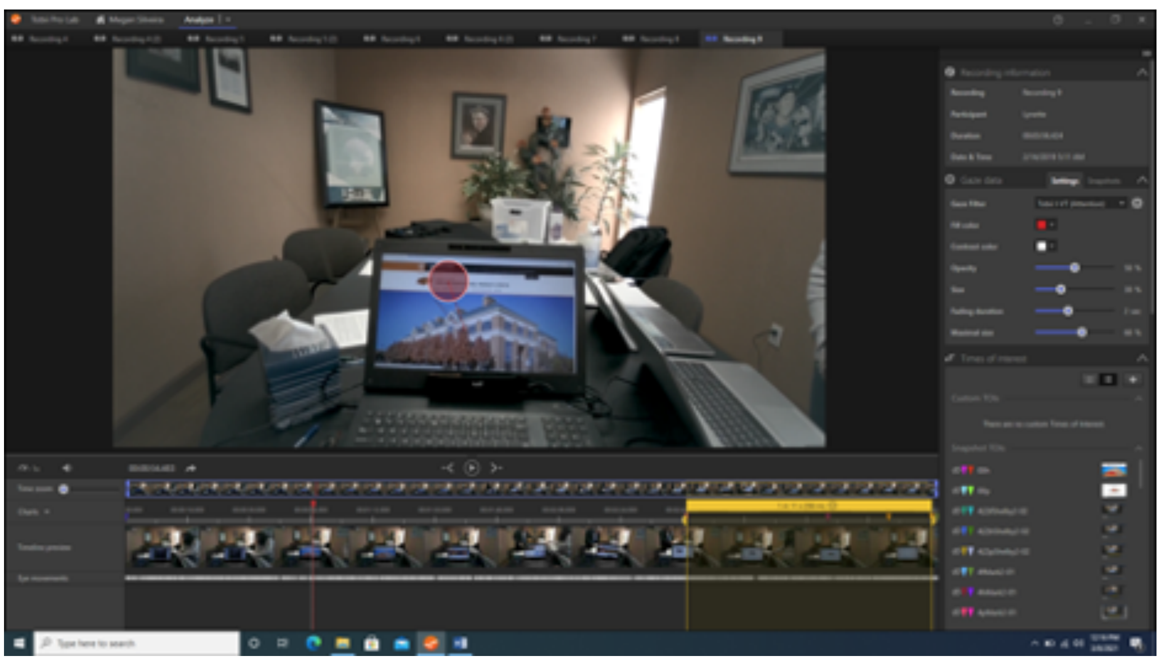

Figure 10. Home Screen Prior to Scrolling.

side and an image on the other (Figure 12), images were typically bypassed, and fixation was more commonly seen on the text. When viewing columns or grid style layouts, participants were more likely to fixate on icons (Figure 13) rather than images (can be seen in previously shown Figure 5).

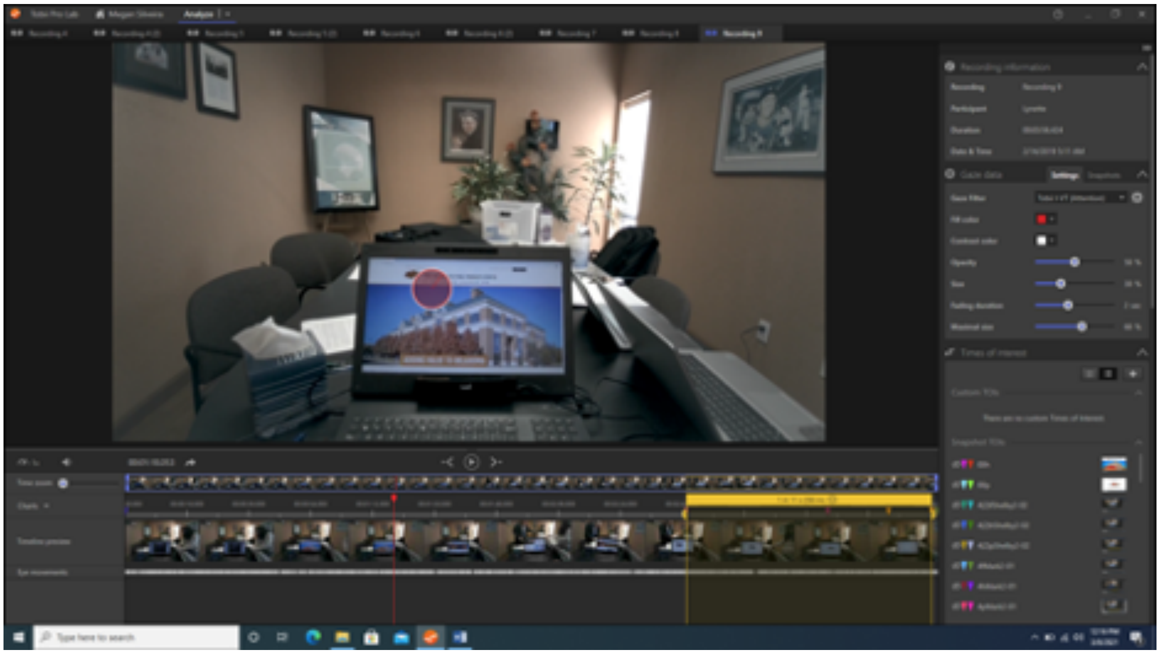

Figure 11. Home Screen After Scrolling.

Figure 12. Split Screen with Text and Image.

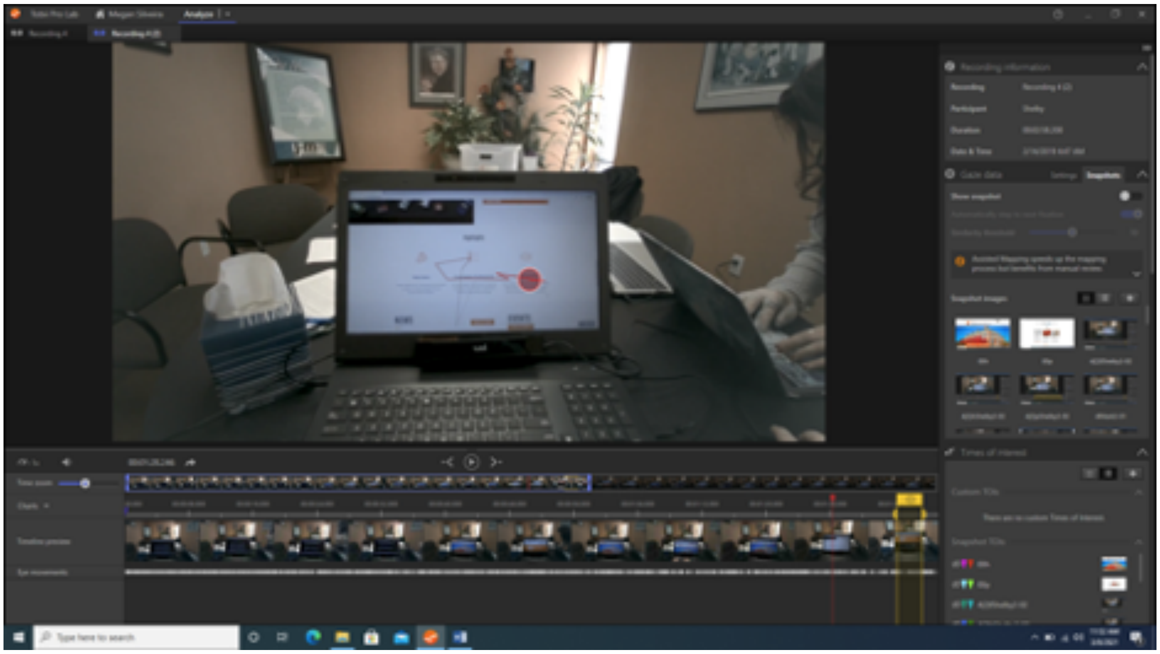

Figure 13. Column View with Icons.

Font Size and Color

The larger the font size utilized, the more fixation from viewers it received. Paragraphs were typically scanned by participants while actual fixations could be observed on text displayed as a paragraph heading or subheading.

Heat Maps

Heat maps were used to give a visualization of the entire webpages for tasks one and two. Green areas signify low amounts of fixation. Color slowly transitions to red as more fixations occurred in the area. Data shown through the heat maps supports the points addressed above with screenshots from the Tobii Pro Studio software.

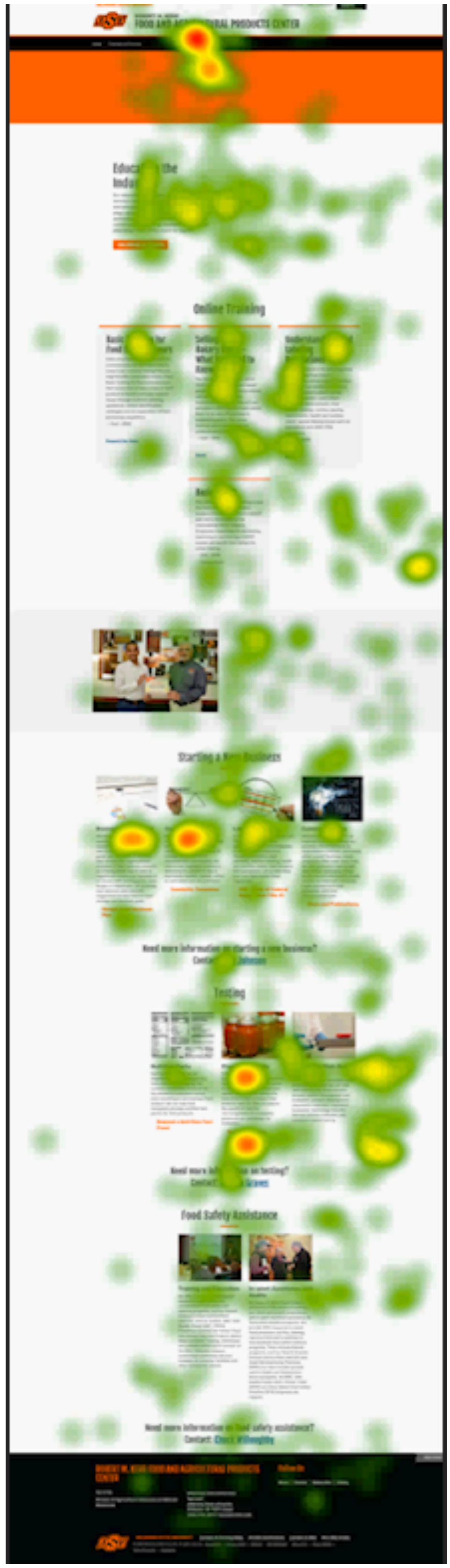

Figure 14. Heat Map - Task One, Group 1.

Figure 15. Heat Map - Task One, Group 2.

Figure 16. Heat Map - Task Two, Group 1.

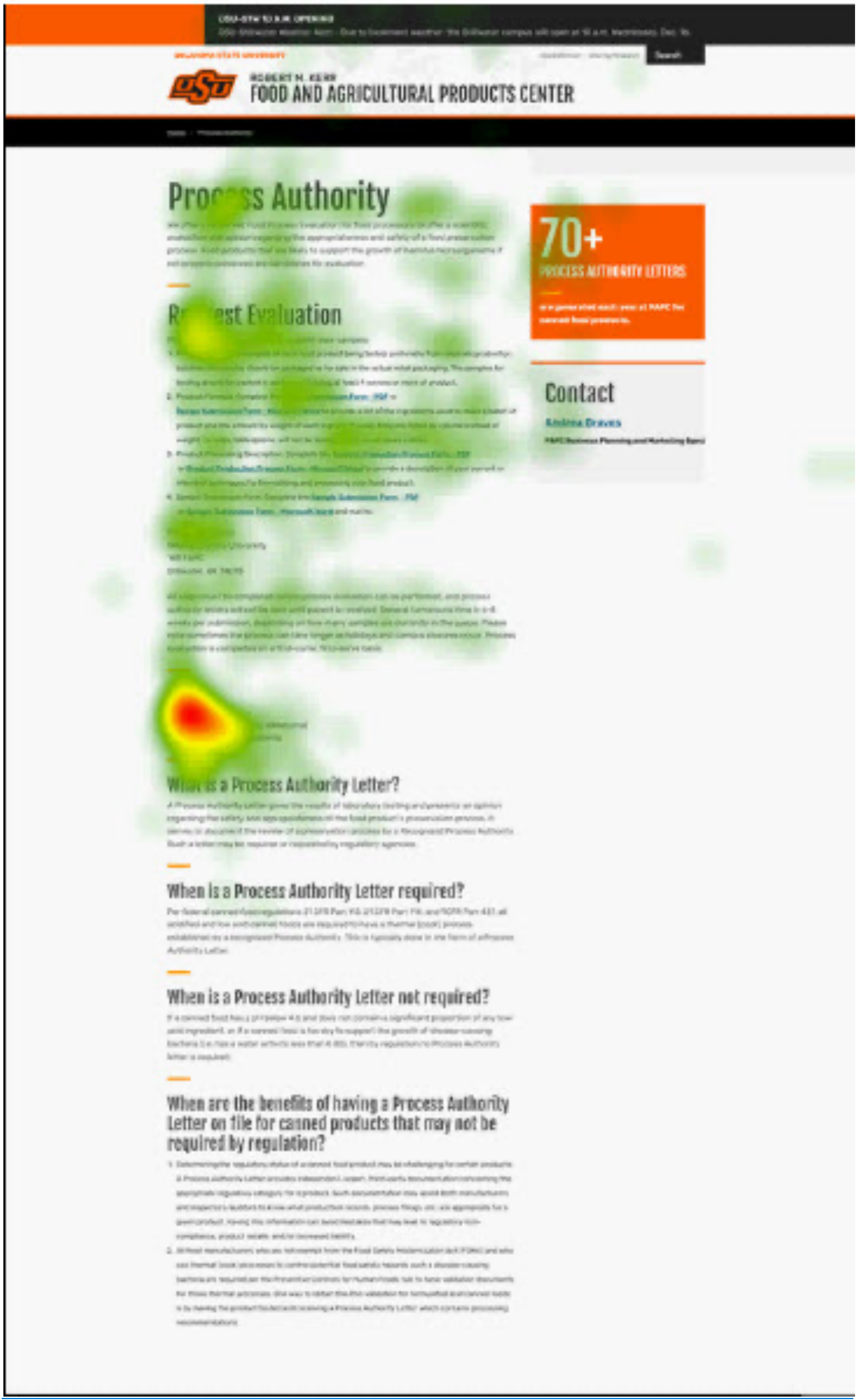

Figure 17. Heat Map - Task Two, Group 2.

Findings for Objective 3

Objective 3 was designed to compare visual attention data collected by the varying types of eye-tracking devices to identify differences between the systems. Four main calculations from the Tobii Pro Lab and Pro Studio are standardly used in eye-tracking studies: time to first fixation, total fixation during, visit count and fixation count (G. Clare, personal communication, March 4, 2021). Each metric will be defined in its respective section.

Time to First Fixation

As previously described in the prior section, Tobii (2020) defines this metric as, "the elapsed time between an interval start event until the first fixation occurs in that interval and in the target area of interest (AOI)."

Table 2 has been shown again to compare the differences between data collected on the two types of technology for task one. Ten out of 15 participants had analyzable data from Group 1, while 11 out of 16 had analyzable data from Group 2. Though differences can be seen in individual participant time to first fixation, both technologies collected similar amounts of analyzable data for this first task. A line graph (Figure 18) presents the differences in data collected for this metric between the two groups. Each individual mark in the graph is results from an individual participant, with the first group shown in gray and second group show in orange.

Table 3 has been shown again to compare the differences between data collected on the two types of technology for task two. Nine out of 15 participants had analyzable data from Group 1, while 10 out of 16 had analyzable data from Group 2. Though differences can be seen in individual participant time to first fixation, both technologies collected similar amounts of analyzable data for this first task. A line graph (Figure 19) presents the differences in data collected for this metric between the two groups.

Table 2

Time to First Fixation, Training

	Time to First Fixation (seconds)		
Group	*M*	*SD*	*Range*
1	50.72	37.06	91.1
2	132.75	44.71	134.23

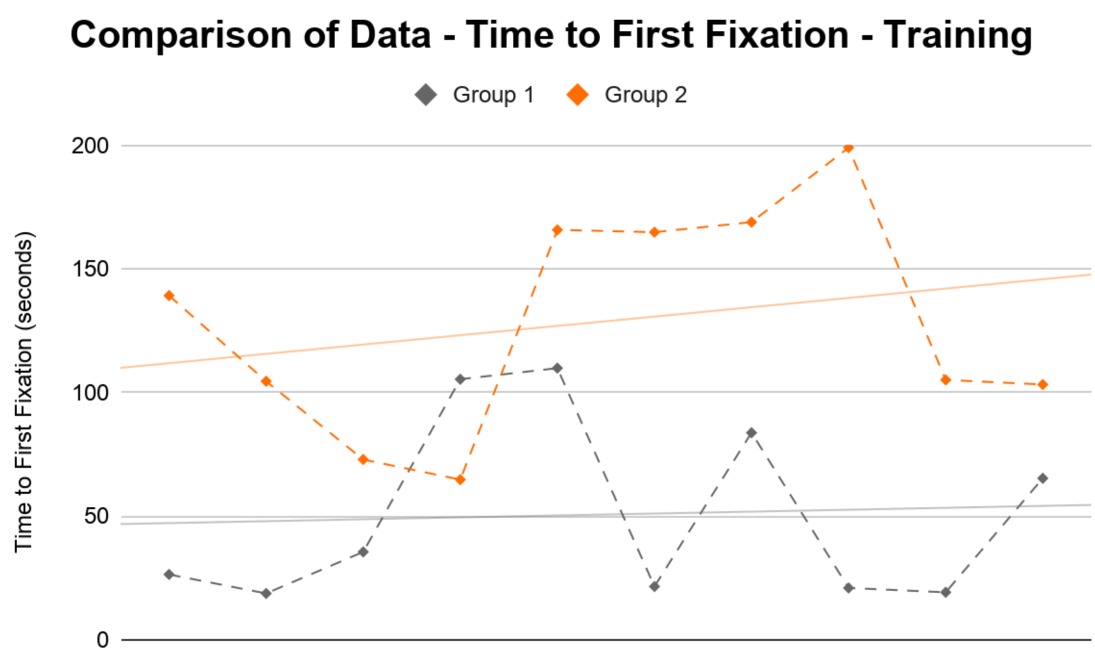

Figure 18. Comparison of Data - Time to First Fixation (Training).

Table 3

Time to First Fixation, Fees

	Time to First Fixation (seconds)		
Group	*M*	*SD*	*Range*
1	20.43	10.74	36.06
2	162.93	50.76	133.34

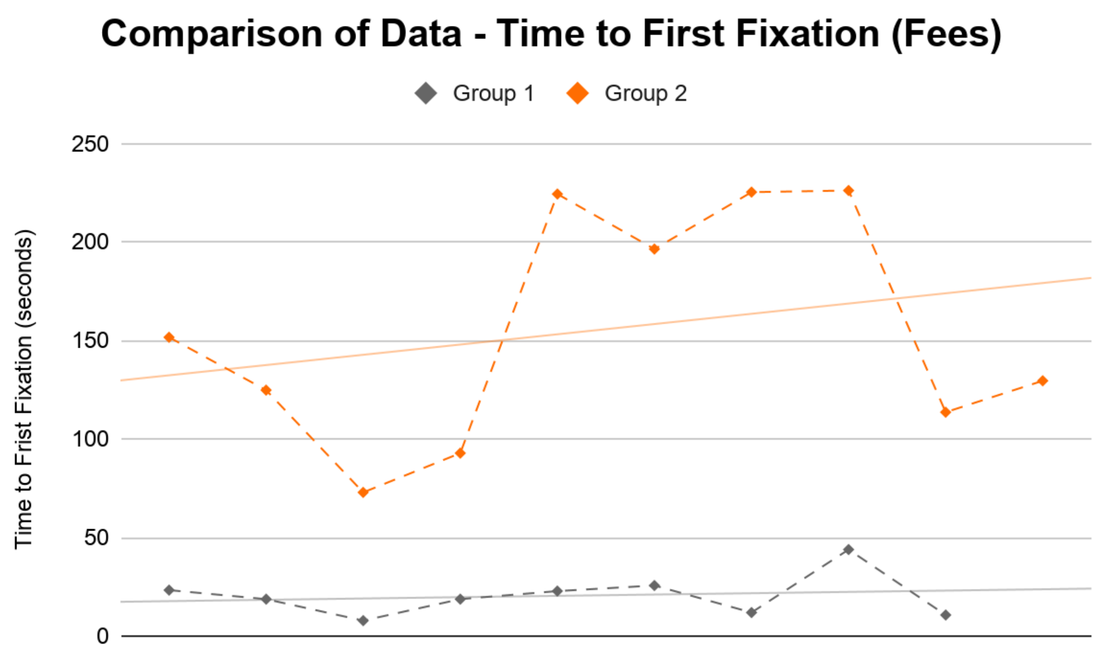

Figure 19. Comparison of Data - Time to First Fixation (Fees).

Total Fixation During

Tobii (2020) defines this metric as, “when all the gaze points that constitute the fixation are located within the time of interest (TOI). i.e., either the fixation starts or ends outside the TOI interval.”

Table 4 compares the differences between data collected on the two types of technology for task one. Ten out of 15 participants had analyzable data from Group 1, while 11 out of 16 had analyzable data from Group 2. Though differences can be seen in individual participant total fixation time, both technologies collected similar amounts of analyzable data for this first task. A line graph (Figure 20) presents the differences in data collected for this metric between the two groups.

Table 4

Total Fixation During, Training

	Total Fixation During (seconds)		
Group	*M*	*SD*	*Range*
1	4.24	3.15	11.33
2	7.87	6.29	19.54

Table 5 compares the differences between data collected on the two types of technology for task two. Nine out of 15 participants had analyzable data from Group 1, while 10 out of 16 had analyzable data from Group 2. Though differences can be seen in individual participant total fixation time, both technologies collected similar amounts of analyzable data for this first task. A line graph (Figure 21) presents the differences in data collected for this metric between the two groups. Each individual mark in the graph is results from an individual participant, with the first group shown in gray and second group show in orange.

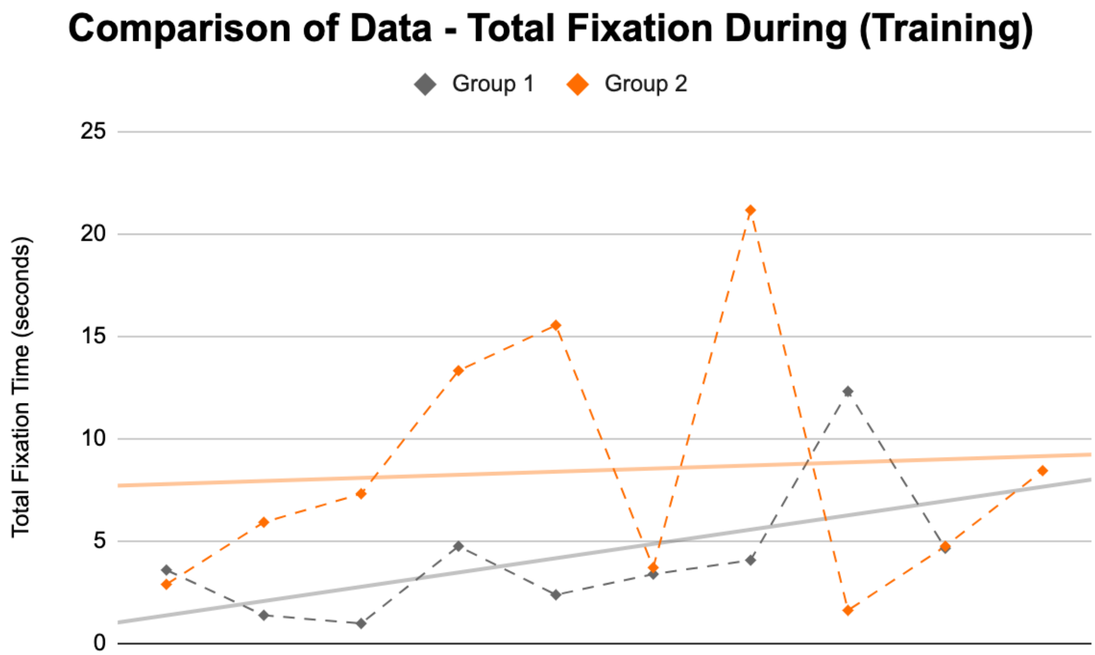

Figure 20. Comparison of Data - Total Fixation During (Training.)

Table 5

Total Fixation During, Fees

	Total Fixation During (seconds)		
Group	*M*	*SD*	*Range*
1	4.03	2.16	5.77
2	3.32	2.80	8.52

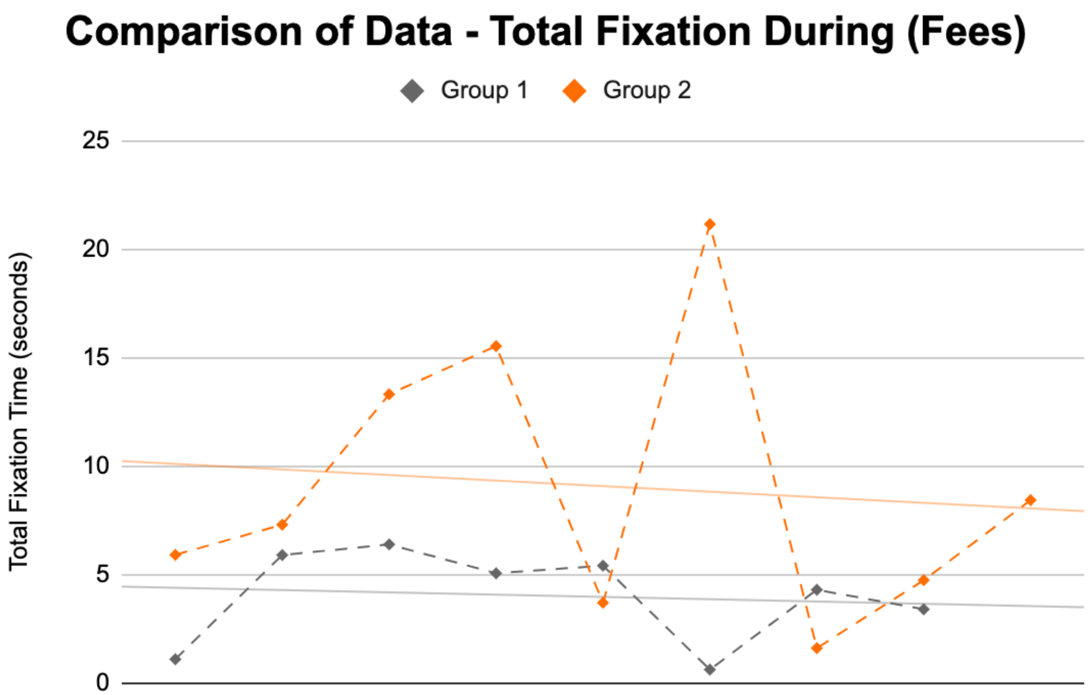

Figure 21. Comparison of Data - Total Fixation During (Fees)

Visit Count

Tobii (2020) defines this metric as the, "number of visits that occur during an interval of time, and specific to a target AOI."

Table 6 compares the differences between data collected on the two types of technology for task one. Ten out of 15 participants had analyzable data from Group 1, while 11 out of 16 had analyzable data from Group 2. Though differences can be seen in the number of visit counts per individual participant, both technologies collected similar amounts of analyzable data for this first task. A line graph (Figure 22) presents the differences in data collected for this metric between the two groups. Each individual mark in the graph is results from an individual participant, with the first group shown in gray and second group show in orange.

Table 6

Visit Count (Training)

	Visit Count		
Group	*M*	*SD*	*Range*
1	4.60	1.71	6.00
2	12.18	5.72	20.00

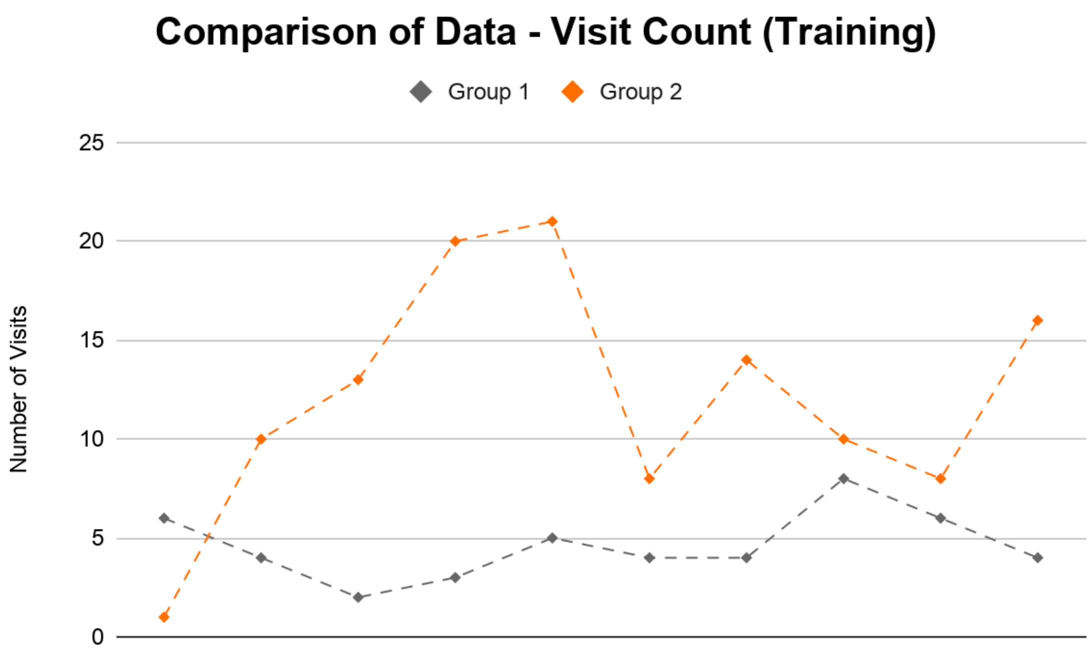

Figure 22. Comparison of Data - Visit Count (Training).

Table 7 compares the differences between data collected on the two types of technology for task two. Nine out of 15 participants had analyzable data from Group 1, while 10 out of 16 had analyzable data from Group 2. Though differences can be seen in the number of visit counts per individual participant, both technologies collected similar amounts of analyzable data for this first task. A line graph (Figure 23) presents the differences in data collected for this metric between the two groups.

Table 7

Visit Count (Fees)

	Visit Count		
Group	*M*	*SD*	*Range*
1	3.11	1.54	5.00
2	6.50	2.72	9.00

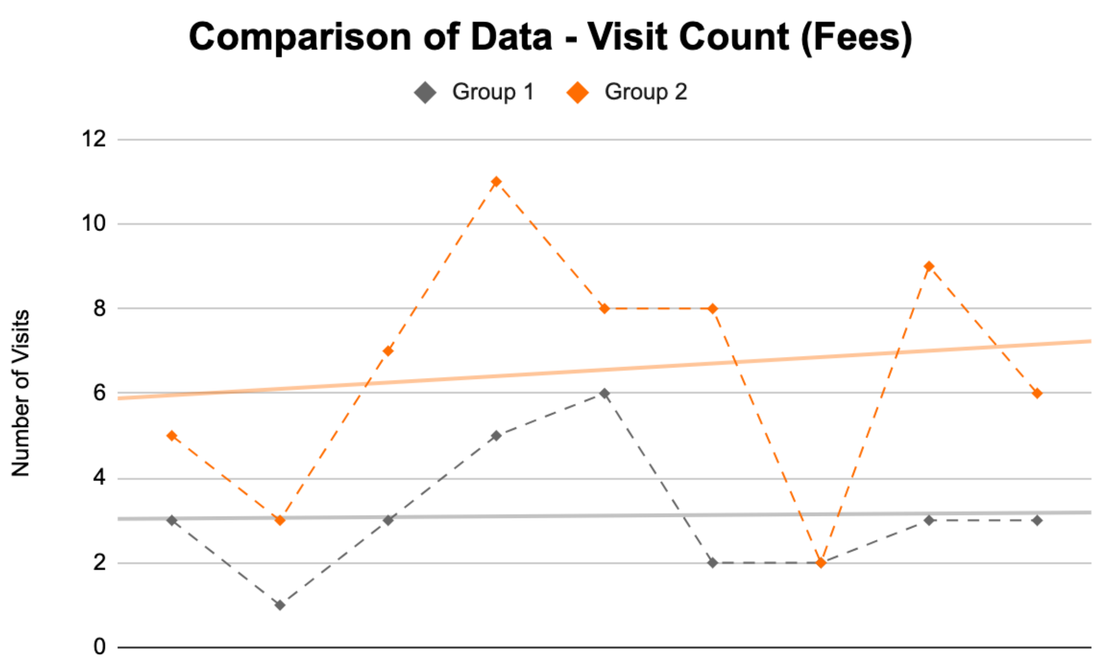

Figure 23. Comparison of Data - Visit Count (Fees)

Fixation Count

Tobii (2020) defines this metric as the, "number of fixations that occur during an interval of time, and in a target AOI."

Table 8 compares the differences between data collected on the two types of technology for task one. Ten out of 15 participants had analyzable data from Group 1, while 11 out of 16 had analyzable data from Group 2. Though differences can be seen in the number of fixation counts per individual participant, both technologies collected similar amounts of analyzable data for this first task. A line graph (Figure 24) presents the differences in data collected for this metric between the two groups. Each individual mark in the graph is results from an individual participant, with the first group shown in gray and second group show in orange.

Table 8

Fixation Count (Training)

	Fixation Count		
Group	*M*	*SD*	*Range*
1	11.30	6.48	22.00
2	31.36	22.62	65.00

Table 9 compares the differences between data collected on the two types of technology for task two. Nine out of 15 participants had analyzable data from Group 1, while 10 out of 16 had analyzable data from Group 2. Though differences can be seen in the number of fixation counts per individual participant, both technologies collect similar amounts of analyzable data for this first task. A line graph (Figure 25) presents the differences in data collected for this metric between the two groups.

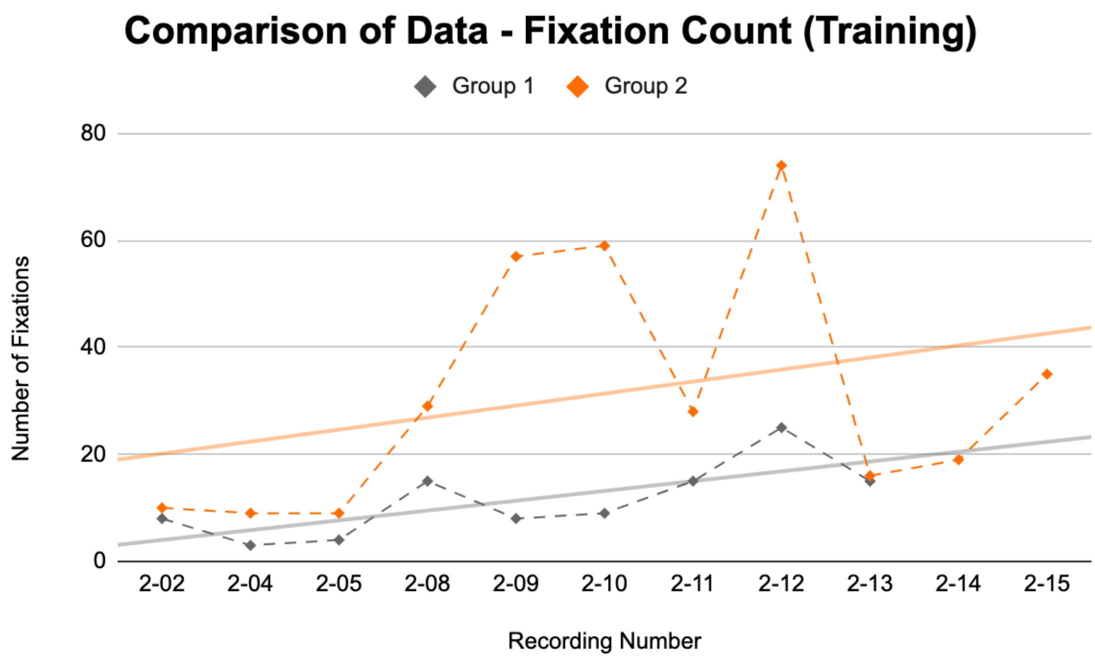

Figure 24. Comparison of Data - Fixation Count (Training).

Table 9

Fixation Count (Fees)

	Fixation Count		
Group	*M*	*SD*	*Range*
1	9.22	5.54	16.00
2	13.60	10.22	36.00

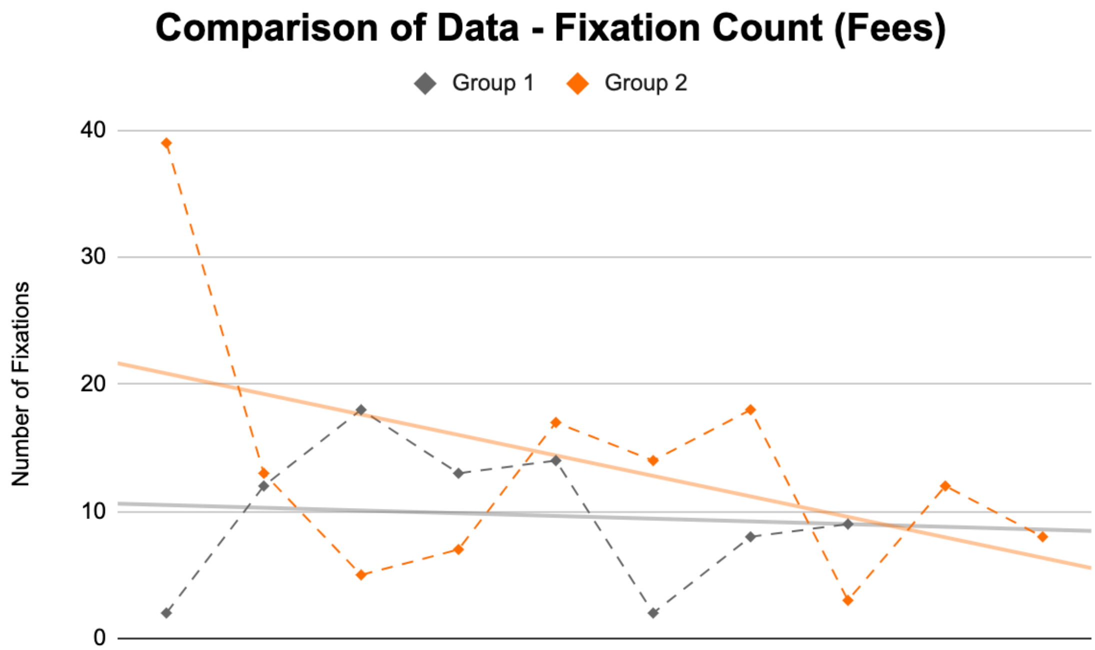

Figure 25. Comparison of Data - Fixation Count (Fees)

Findings for Objective 4

Objective 4 was designed to test the utility of the Tobii Pro Glasses 3 for use on a mobile device. Data used to form Group 3 was collected on 18 individuals. The recordings from the eye-tracking glasses were uploaded into the Tobii Pro Studio application to be analyzed. Upon inspection, however, the resolution of the videos recorded by the Tobii Pro 3 glasses was too low to be properly analyzed.

While larger fonts utilized in headings and subheadings (Figure 26), text presented on a black background (Figure 27), text presented on an orange background (Figure 28), and images (Figure 29) could easily be viewed in the recordings, the smaller font of paragraphs and general text (Figure 30) was unreadable in the recordings.

Figure 26. Phone Usage - Larger Fonts

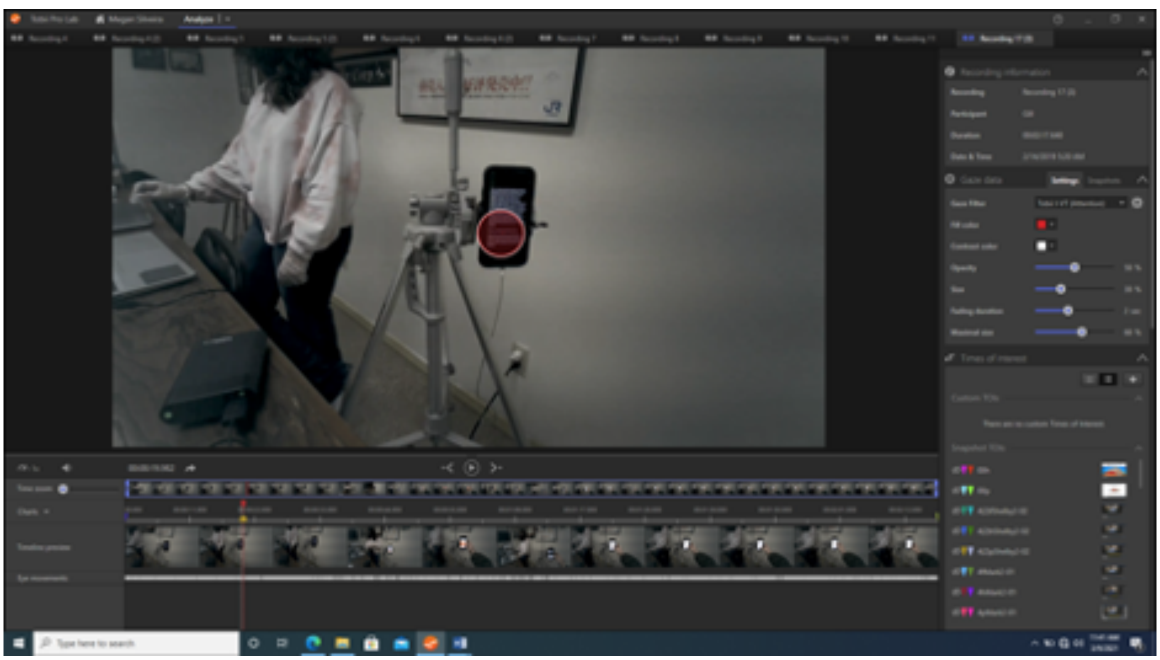

Figure 27. Phone Usage - Text on Black Background.

Figure 28. Phone Usage - Text on Orange Background.

Figure 29. Phone Usage - Images.

Figure 30. Phone Usage - Small Text in Paragraphs.

CHAPTER V

CONCLUSIONS, RECOMMENDATIONS AND DISCUSSION

Conclusions and Implications

Conclusions and Implications for Objective 1

This objective was designed to determine the average amount of time an individual would spend completing a specific task while visiting the FAPC website on a laptop monitor.

Major differences can be seen between times to complete tasks one and two from participants in both groups. In both cases, participants from Group 1 were able to complete the tasks in a substantially shorter amount of time compared to participants from Group 2. While drastic, these differences are the results of normal variation of participants.

The initial task took close to if not longer than a minute on average for all participants. The attention span of the average adult is only eight seconds, and both groups spent much longer than that trying to complete both tasks. While the first task of finding the Process Authority page was chosen as it required some searching (M. Gross, personal communication, September 23, 2020) by participants (meaning it would require the participants to click on several linked items on the website and the information was not located at the top of a webpage but rather the bottom), it still took individuals an extremely long amount of time to complete the task at hand. The FAPC team will likely need to consider making a few key changes to the website so that relevant information is placed near the tops of webpages or simplify the navigation process online visitors must take to find information regarding services and events of the FAPC.

The second task should have been much simpler to complete, as participants only had to scroll down two headings to find the fees section. Many participants from both groups, however, read through all the information first shown on the page. This likely explains the length of time to first fixation in task two but shows that placement of relevant information like fees or maybe even contact information should be placed at the top of webpages rather than the middle or lower sections.

On average, neither task was completed in what would be considered a timely manner by participants. This does imply that the current structure and navigational options of the FAPC's new website are not the most user friendly for the intended audience. While the center has provided a plethora of important information relevant to members of the food and agriculture industry, audience members do struggle to find information pertinent to their individual needs. By adjusting the placement of prioritized information on the pages of the website and considering other navigation options, the FAPC website can improve the usability of their site.

As individuals interacted with the FAPC's website, they were searching for specific elements of the site relevant to the assigned search task. These elements would create a positive emotional reaction in the participants, and they would in turn then interact with that element to work at completing the assigned search task. The FAPC team wants to make the total time between the occurrence of each of the steps introduced in the S-O-R paradigm for participants. By shortening the length of time from when a participant encounters an element of the site to the moment when they feel a positive emotion and then chose to interact with that element, the website can be more effective at providing a positive experience for the FAPC's online viewers.

Conclusions and Implications for Objective 2

This objective was designed to determine the general successful and unsuccessful elements of the FAPC's new website through trends identified in the eye-tracking data. If the researcher observed participants expressing a positive emotional reaction to an element of the website and respond to that emotion by interacting with the element (expressing visual attention, clicking a link, reading the text, etc.), then the element was be labeled as successful. On the other hand, if the researcher observed participants expressing a negative emotional reaction or not completing the S-O-R paradigm by not interacting with an element of the website, then that element was labeled as unsuccessful.

In regard to the layout and design elements of the site, several key elements were identified as successful while others failed to gain the visual attention of viewers. When online visitors first access the FAPC's website, the large image of the center gains slight attention, but most viewers immediately seek out the navigation bar. Despite the visual attention dedicated to this tool, it is clear by the conclusions and implications discussed for objective 2 that the word choice of these subpages might not be clear to audience members. Consideration about altering or simplifying some of the verbiage in the navigation bar might need to be had by the FAPC team Additionally, it should be noted that some of the elements crucial to the home screen do not automatically appear on certain monitors due to transitional effects when users first open the site, specifically the orange bar with the subheading "ADDING VALUE TO OKLAHOMA." This web element required visitors to scroll down before appearing, meaning some visitors were unaware more information was available to them on the homepage of the FAPC's website. The FAPC team should look into the design of the site and see if these transitional effects can be edited or removed, as they currently eliminate consistency when it comes to visitor' experience of the website. This trend could be seen on several subpages of the FAPC website as well. As many participants of this study did not scroll down on many of the webpages, this is a significant issue that impacts more than one location of the website. With many participants being observed choosing to not scroll through more than half of the webpages, the FAPC team should ensure the information their audience would consider to be the most relevant and important is placed at the top of webpages rather than the bottom.

Information was presented on the site in three main layouts: paragraph form, a grid layout or a column layout. When presented with text in a paragraph, participants typically looked first to the headings, scanned through the first few sentences and then moved on to the next area that gained their interest. The only time this trend differs is during the second task, when participants knew they were on the right page of the site and were searching for a specific piece of information, task two of the study. It can then be concluded that a majority of online visitors will not read much of the text presented in a paragraph. The FAPC team should consider potentially minimizing the use of paragraphs to present information. On the other hand, when the paragraphs were placed in a grid or column style layout, participants were much more likely to scan through at least half of the information. This suggests that those previously utilized paragraphs should be transferred into either the grid or column layout. When viewing this type of layout, viewers would first fixate on the middle area, before then reading the information from left to right. This allows for the conclusion that the information believed to be the most pertinent should be placed in the center of the grid or column, the second most pertinent information on the left side and the least pertinent information on the right side.

Boxes with text overlay are frequently used to identify headings or other snippets of information, and this style choice gained high amounts of fixation from a majority of participants. These boxes came in three forms: small orange boxes (typically used to identify links or pull-down menu bars), medium orange boxes (typically used to identify headings or subheadings), and large orange and black boxes (typically used to identify specific numbers or statistics relevant to the subpage). The small orange boxes were extremely successful at gaining viewers' attention, and many participants were observed interacting with this particular element. The FAPC team should consider utilizing this element to identify all links and pull-down menu bars on the website, as currently some links are just presented in an orange text without a box. This would not only improve consistency on the site but also emphasize these interactive elements and hopefully gain more visual attention from visitors. The medium orange boxes, despite containing headings in a significantly larger font size, typically did not receive much fixation from viewers. The same can be said for the larger orange boxes. The black boxes, however, were consistently successful in gaining viewers' attention. The FAPC team might consider eliminating both the medium and large sized orange boxes with text overlay. Both options might be replaced with the black box.

Interestingly, images on the FAPC website were continually observed as having lower amounts of fixations compared to text, no matter what the presentation style was. These results varied from previous data collected in past website usability studies (Nielsen, 1999). This contrast could be in part due to the nature of the study as participants knew the information they were assigned to find would be located in text, not an image. However, even the largest pictures presented (like the image of the center used on the homepage that took up a majority of the monitor screen) did not gain much visual attention from viewers. Smaller visuals were often placed above subheadings in the grid and column style layouts. While images were not seen to gain much attention from viewers icon images were seen to have some higher levels of visual attention. This suggests that some of the images on the website should be eliminated or even replaced with other visuals like icons or graphics to allow for online visitors to immediately be presented with the type of online information they typically fixate on. Some images might also need to be scaled down, to put text in areas of higher visual impact.

In regard to the size of text, trends identified in this study reflect previous information known about website usability (Nielsen, 1999), meaning that typically the larger the font size, the more visual attention gained from online viewers.

Conclusions and Implications for Objective 3

This objective was designed to determine if a difference exists in the visual attention data collected in the varying types of eye-tracking devices.

For both tasks in all four metrics, more analyzable data was collected from the eye-tracking glasses compared to the mounted system, though Group 2 did have one more total participant than Group 1. Times in the groups were vastly different, but this is a reflection of normal variance in participants rather than the capabilities of the eye-tracking technology. For future web usability studies and use of the Tobii Pro Glasses 3, researcher preference and study design will be the main factors used to determine which type of eye-tracking technology should be used. More information about the use and capabilities of the glasses will be discussed in the next section, conclusions and implications for objective 4.

Conclusions and Implications for Objective 4

This objective was designed to test the utility of the Tobii Pro Glasses 3 for use on a mobile device.

In this study, a tripod was placed almost a full arm's length away from the participant to hold the cell phone, as this would eliminate the participant moving both their head and the phone during the study (as previously discussed, this type of movement drastically complicates the data analyzation process). While participants in person could easily read the information on the mobile device's screen from this distance, the wide field of vision of the glasses made the phone appear exceptionally small in the recordings. The glasses' recordings were not at a high enough resolution for the small text used on the FAPC's website to be read or, in some cases, even visible in the videos.

For these reasons, the glasses might not be the best option for collecting eye-tracking data on a mobile device.

Recommendations for Future Research

Recommendations for Objective 1

This research was a pilot study that supports future research examining the usability of the FAPC website. For these potential future studies, it is recommended several A/B tests be conducted to test various layouts on both the placement of the Process Authority panel and the Fees section on their respective webpages. This would allow the FAPC team to discover which layout option (paragraph, columns, grids, boxes, etc.) and placement of elements on the webpage (top of the webpage, bottom of the webpage, left hand side, right hand side, etc.) would result in the lowest time to first fixation amongst viewers.

Another consideration in future website usability tests would be to compare time to first fixation with general demographic information (age, gender, etc.) to discover any correlation between an individual's demographics and amount of time they require to complete a specific task on the FAPC's website. A supporting power analysis would ensure sample sizes were adequate to compare those demographic characteristics.

Recommendations for Objective 2

This research was a pilot study that supports future research examining the usability of the FAPC website. For these potential future studies, it is recommended several A/B tests be conducted to compare fixation amounts on specific elements of the website. These tests could be done on the host website or presented as screenshots to the participant. For example, an image of a webpage utilizing the large orange boxes could first be shown to participants and followed by the same image with a black box instead of the orange box. Information could also be presented in two different layouts, such as the column and grid style or individual paragraph form and paragraph alongside a picture. Data could be gathered to see what elements are consistently effectively drawing the visual attention of viewers, so information can be presented in the best manner on the FAPC's website.

Recommendations for Objective 3

This study revealed enough similarities between the subjects for there to not be a major need for future research dedicated solely to comparing a mounted eye-tracking system and the Tobii Pro Glasses 3.

Recommendations for Objective 4

Future research should either consider redesigning the entire methodology used in this study or find a different eye-tracking device to collect data so that data is recorded with a high enough resolution to be useful and analyzable. To ensure adequate signal processing is achieved between the user and the smart phone interface, including the ability to specify AOIs. It is recommended future researchers pre-test the eye-tracking research design prior to data collection to ensure the appropriate AOI specifications are achieved.

Discussion

The eye-tracking glasses had not been used by personnel at OSU or the FAPC before this project, so in addition to the four other objectives, this study was designed to serve as a trial of the new technology. This area will discuss their use and researcher experience as well as observation of participant experience.

The project allowed for information to be gathered on the general usage of the glasses; the identification of specific metrics and requirements needed to establish the connection between the glasses and the laptop; the groundwork to be laid for a relationship between staff and faculty at the FAPC and Tobii; and for the completion of a pilot test to help build a foundation for future research to be conducted in regard to the usability of the FAPC's website and the usage of the eye-tracking glasses.

The glasses are lightweight and comfortable, making them easy to fit on users' faces. Use of these glasses does require participants to put their hands on the technology, which could be a general concern in the future as the researcher does not have much power to protect the device once the user has put them on. The glasses can be worn and successfully used over personal eyeglasses if they have a small enough frame. If the glasses do not easily fit under the Tobii Pro Glasses 3, the FAPC team did purchase a lens kit with lenses that can easily be temporarily attached to the glasses. Participants will have to know their prescription prior to the study, however, for the lens kit to be useful. Participants can have various types of headgear on with the glasses without altering the ability of the technology to complete calibration or collect data.

The calibration process for the glasses is extremely efficient and simple, especially when compared to the calibration process required for the mounted eye-tracking system. For the glasses, only a small card must be held an arm's length away from the participant's face. It is critical that the card be held away from the participant as close to an arm's length as possible for the successful completion of the calibration process. Participants should also sit facing the calibration card directly for the best calibration results.

The glasses are a mobile version of eye-tracking technology, a feature that could benefit a lot of future clients or partners of the FAPC. For a website usability study, however, this actually proved to be a challenging feature rather than a benefit. As no individual sits perfectly still while looking a computer screen, the Tobii Pro Glasses 3 recordings showed a lot of minute and drastic movements from participants. This was not a problem during the collection of data but proved to add a lot of labor and time to the data analyzation process, as the AOIs on the webpage had to be continually adjusted to match the movements of the wearer. The glasses also are credited with having a wide field of vision – another perceived benefit that worked against the researcher in this type of study. The recordings showed the computer monitor as a very small part of the wearers' overall visual experience, which again complicated the data analyzation process.

When purchasing the glasses, the FAPC team also acquired a laptop computer where the device would wirelessly connect with to record data (this is also the device on which data was analyzed). The glasses connect to this laptop through the Wi-Fi connection option, which means the laptop cannot be used to simultaneously access the internet and record data. For a website usability study, this means the researcher will need two laptop devices to successfully collect data.

While the Tobii Pro Glasses 3 are a high-quality piece of technology that will prove to be extremely useful and beneficial in regard to field research in the future, they are not the best option for web usability studies. Other options, like the mounted system, should continue to be the first option for this type of research. For eye-tracking studies in a real time environment, however, these glasses will offer a detailed, extensive look in the visual experience of consumers.

As these glasses are still fairly new and have yet to be used by many individuals on the OSU campus or faculty and staff of the FAPC, it is recommended detailed notes are reported in future research. These notes should include any observations or recommendations regarding the use of, general information about the functions of, and/or malfunctions or troubleshooting with the Tobii Pro 3 Glasses. This will help continue to help improve the ability of individuals to successfully utilize this form of technology as well as simplify future research that includes the use of the eye-tracking glasses.

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APPENDICES

APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL

IRB Office <irb@okstate.edu> Tue, Nov 17, 2020, 3:52 PM
to Megan, DWAYNE

Dear Megan Silveira,

The Oklahoma State University Institutional Review Board (IRB) has approved the following application:

Application Number: IRB-20-509
PI: Megan Silveira
Title: Robert M. Kerr Food and Agricultural Products Center: An Eye Tracking Study
Review Level: Expedited

You will find a copy of your Approval Letter in IRBManager. Click IRB - Initial Submission to go directly to the event page. Please click attachments in the upper left of the screen. The approval letter is under "Generated Docs." Stamped recruitment and consent documents can also be found in this location under "Attachments". Only the approved versions of these documents may be used during the conduct of your research.

As Principal Investigator, it is your responsibility to do the following:

- Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted for IRB approval before implementation.
- Submit a request for continuation if the study extends beyond the approval period.
- Report any adverse events to the IRB Chair within 5 days. Adverse events are those which are unanticipated and impact the subjects during the course of the research; and
- Notify the IRB office when your research project is complete by submitting a closure form via IRBManager.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact the IRB office at 405-744-3377 or irb@okstate.edu.

Best of luck with your research,

Sincerely,

Dawnett Watkins, CIP

Oklahoma State University
Institutional Review Board
Office of University Research Compliance
223 Scott Hall, Stillwater, OK 74078
Website: https://irb.okstate.edu/
Ph: 405-744-3377 | Fax: 405-744-4335| irb@okstate.edu

APPENDIX B

EHMKE AND WILSON SUMMARY

Table 1: Summary of eye-movement metrics and related usability problems, reported in the literature

Eye-movement metrics	Cognitive process or usability problem	Reference
Fixation-related		
Time to first fixation on target	Good (if short) or bad (if long) attention getting properties	Byrne et al., 1999 (cited by Poole & Ball, 2005 [15])
Fixation spatial density	Focussed efficient searching OR widespread inefficient search	Cowen, Ball, & Delin, 2002 [4]
Fixation duration, Fixation length	Difficulty in extracting information OR more engaging; voluntary (>320 ms) and involuntary (<240 ms) fixations; needs further investigation	Just & Carpenter, 1976 (cited by Poole & Ball, 2005 [15]); Graf & Kruger, 1989 (cited by Jacob & Karn 2003 [9])
Fixations on target divided by total number of fixations	Low search efficiency	Goldberg & Kotval, 1999 [7]
Number of fixations overall	Less efficient search due to sub optimal layout	Goldberg & Kotval, 1999 [7]
Repeat fixations (post-target fixation)	Lack of meaningfulness or visibility	Goldberg & Kotval, 1999 [7]
Fixations per area of interest	Element/area more noticeable OR element/area more important	Jacob & Karn, 2003 [9]; and Poole, Ball, & Phillips, 2004 [16]
Percentage of participants fixating on area of interest	Attention-getting properties of an interface element	Albert, 2002 (cited by Jacob & Karn, 2003 [9] and Poole & Ball, 2005 [15])
Fixations per area of interest adjusted for text length	Element harder to recognise	Poole, Ball, & Phillips, 2004 [16]
Saccade/fixation ratio	More processing or less searching	Goldberg & Kotval, 1999 [7]
Saccade-related		
Number of saccades	More searching if more saccades	Goldberg & Kotval, 1999 [7]
Saccades revealing marked directional shifts	User's goals changed OR interface layout does not match user's expectations	Cowen, 2005 [3]
Saccade amplitude	Meaningful visual clues if larger saccades	Goldberg, Stimson, Lewenstein, Scott, and Wichansky, 2002 [8]
Regressive saccades (backtracks/regressions)	No meaningful visual clues, changes in goals, mismatch between users' expectation and the observed interface layout	Sibert & Jacob, 2000 [18]; Poole & Ball, 2005 [15]; Goldberg & Kotval, 1999 [7]
Saccade duration	Low image quality such as blurred or low contrast	Vuori, Olkkonen, Pölönen, Siren & Häkkinen, 2004 [20]
Scanpath-related		
Longer scanpath duration	Less efficient scanning	Goldberg & Kotval, 1999 [7]
Scanpath direction	Indication of search strategy	Altonen et al. (1998, cited by Poole & Ball, 2005 [15])
Longer scanpath length	Less efficient searching	Goldberg, Stimson, Lewenstein, Scott, &Wichansky, 2002 [8]
Small spatial density of scanpath	More direct search	Goldberg & Kotval, 1999 [7]
Scanpath regularity	Search problems due to lack of training or interface layout problems	Goldberg & Kotval, 1999 [7]
Transition matrix (back and forth between areas)	Uncertainty in search OR search order efficient and direct	Goldberg & Kotval, 1999 [7]
Transition probability between AOIs	Efficiency of arrangements of elements in user interface	Fitts, Jones and Milton, 1950 and Hendrickson, 1989 (cited by Jacob & Karn, 2003 [9])
Gaze-related		
Gaze (dwell)	Measure of anticipation OR attention distribution between targets	Mello-Thomas et al., 2004; Hauland, 2003 (cited by Renshaw, Finlay, Ward, & Tyfa, 2003 [17])
Gaze orientation	Feedback about success of design features	Renshaw, Finlay, Ward, & Tyfa 2003 [17]
Gaze duration on AOI	Difficulty extracting or interpreting information from element	Several studies cited by Jacob and Karn 2003 [9]
Number of gaze per AOI	Possible importance of element	Several studies cited by Jacob and Karn 2003 [9]
Spatial coverage calculated with convex hull area	Scanning in a localised or larger area	Goldberg & Kotval, 1999 [7]

APPENDIX C

PARTICIPANT CONSENT FORM

SILVEIRA EYE TRACKING THESIS RESEARCH

Participant Consent Form

Investigators: Megan Silveira and Dr. Dwayne Cartmell, Agricultural Communication and International Agricultural Programs

Purpose: The purpose of this study is to determine the FAPC's updated website's ability to effectively draw the visual attention of online viewers as they visit the homepage.

What to Expect: You will be placed into one of three categories (predetermined by the researcher). All participants will be given the same prompt to help direct you through the newly redesigned FAPC website. You will be viewing the website either on a computer monitor or mobile device, and the movement of your eyes will be tracked through the use of eyeglasses or a built-in program on the computer. The process will take 15-30 minutes. You will also be asked to complete a survey for the FAPC staff after the completion of the eye-tracking portion.

Risks: Participants will be required to wear a mask at all times during the data collection process. During the initial set up and calibration process of this eye tracking study, investigator Megan Silveira will be within six feet of the participant. Proper safety gear will be worn for your protection including a face shield, face mask and gloves. Sanitizer will be provided for participant use both before and after data collection. All equipment used in the data collection process will be sanitized in between participant use utilizing a sanitizer liquid or wipe.

Benefits: This study will expose you to innovative eye tracking technology being utilized for the first time on the Oklahoma State University campus.

Your Rights: Participation in this study is completely voluntary. There is no penalty for choosing to not participate. You are able to withdraw your consent or cancel your participation at any time.

Confidentiality: Your eye tracking data and survey answers will remain anonymous to protect your privacy. Results will be written in aggregate without the inclusion of any identifying factors or information. Data collected in the study will be collected and stored on password-protected computers in a locked laboratory or on a password-protected online data base or account. Access to your records and results will be limited to the researchers in volved with this study.

Contacts: If you have any questions, you may contact Megan Silveira (megan.silveira@okstate.edu) or Dr. Cartmell (dwayne.cartmell@okstate.edu). If you have any questions about your rights as a research volunteer, you may contact the IRB Office at 223 Scott Hall, Stillwater, OK 74078; 405-744-3377; or irb@okstate.edu.

Participant Agreement: *I have read the procedures described above. I voluntarily agree to participate in this study and understand that by signing below, I am consenting to both being at least 18 years of age and participate in this study.*

Participant Signature   Date

APPENDIX D

EMAIL FORM

Hello,

My name is Megan Silveira, and I am in need of your assistance! I am a graduate student at Oklahoma State University and am working on collecting eye tracking data to help evaluate the website of the Robert M. Kerr Food and Agricultural Products Center (FAPC).

The primary purpose of this study is to determine the FAPC's updated website's ability to effectively draw the visual attention of online viewer, test the usability of the website and receive feedback on the new design. The results of this study will be valuable in accessing the effectiveness of the redesign of the center's website as well as understanding new eye tracking technology recently acquired by the center. With the data collected, we aim to improve the usefulness of the website and its ability to meet your needs as one of vital clients.

The Business and Marketing team here at the FAPC provided me with your contact information, and I am reaching out to you to see if I could visit your company to have your staff participate in my study. I know your company is extremely busy, but if you or any of your employees could take time out of your day to assist me during the month of December, please let me know by signing up electronically for a date for me to visit you using this link: https://calendly.com/megan-silveira/eye-tracking-study.

This study will take close to 15-30 minutes for each participant. I will bring all equipment necessary for the study to your business and will only need a small desk space to set up the equipment.

Participation will require individuals to come in contact with equipment shared by all participants and at points, be closer than six feet apart from me as I calibrate the eye track technology. Please know that both proper safety equipment and cleaning practices will be employed at all times. You are able to withdraw or cancel your participation at any point in time.

Your data will be treated confidentially. Only myself and my research committee will have access to your data, and it will be kept on a password-protected computer here at the FAPC.

Thank you for taking time from your busy schedule to assist with this study. Without your assistance, it would be impossible to acquire this information.

Yours,
Megan Silveira
FAPC Graduate Communications Assistant

APPENDIX E

SPEECH

SILVEIRA EYE TRACKING THESIS RESEARCH

Participant Consent Form

Investigators: Megan Silveira and Dr. Dwayne Cartmell, Agricultural Communication and International Agricultural Programs

Purpose: The purpose of this study is to determine the FAPC's updated website's ability to effectively draw the visual attention of online viewers as they visit the homepage.

What to Expect: You will be placed into one of three categories (predetermined by the researcher). All participants will be given the same prompt to help direct you through the newly redesigned FAPC website. You will be viewing the website either on a computer monitor or mobile device, and the movement of your eyes will be tracked through the use of eyeglasses or a built-in program on the computer. The process will take 15-30 minutes. You will also be asked to complete a survey for the FAPC staff after the completion of the eye-tracking portion.

Risks: Participants will be required to wear a mask at all times during the data collection process. During the initial set up and calibration process of this eye tracking study, investigator Megan Silveira will be within six feet of the participant. Proper safety gear will be worn for your protection including a face shield, face mask and gloves. Sanitizer will be provided for participant use both before and after data collection. All equipment used in the data collection process will be sanitized in between participant use utilizing a sanitizer liquid or wipe.

Benefits: This study will expose you to innovative eye tracking technology being utilized for the first time on the Oklahoma State University campus.

Your Rights: Participation in this study is completely voluntary. There is no penalty for choosing to not participate. You are able to withdraw your consent or cancel your participation at any time.

Confidentiality: Your eye tracking data and survey answers will remain anonymous to protect your privacy. Results will be written in aggregate without the inclusion of any identifying factors or information. Data collected in the study will be collected and stored on password-protected computers in a locked laboratory or on a password-protected online data base or account. Access to your records and results will be limited to the researchers in volved with this study.

Contacts: If you have any questions, you may contact Megan Silveira (megan.silveira@okstate.edu) or Dr. Cartmell (dwayne.cartmell@okstate.edu). If you have any questions about your rights as a research volunteer, you may contact the IRB Office at 223 Scott Hall, Stillwater, OK 74078; 405-744-3377; or irb@okstate.edu.

Participant Agreement: *I have read the procedures described above. I voluntarily agree to participate in this study and understand that by signing below, I am consenting to both being at least 18 years of age and participate in this study.*

____

Participant Signature　　　　　　　　　　　　　　Date

APPENDIX F

PROMPT

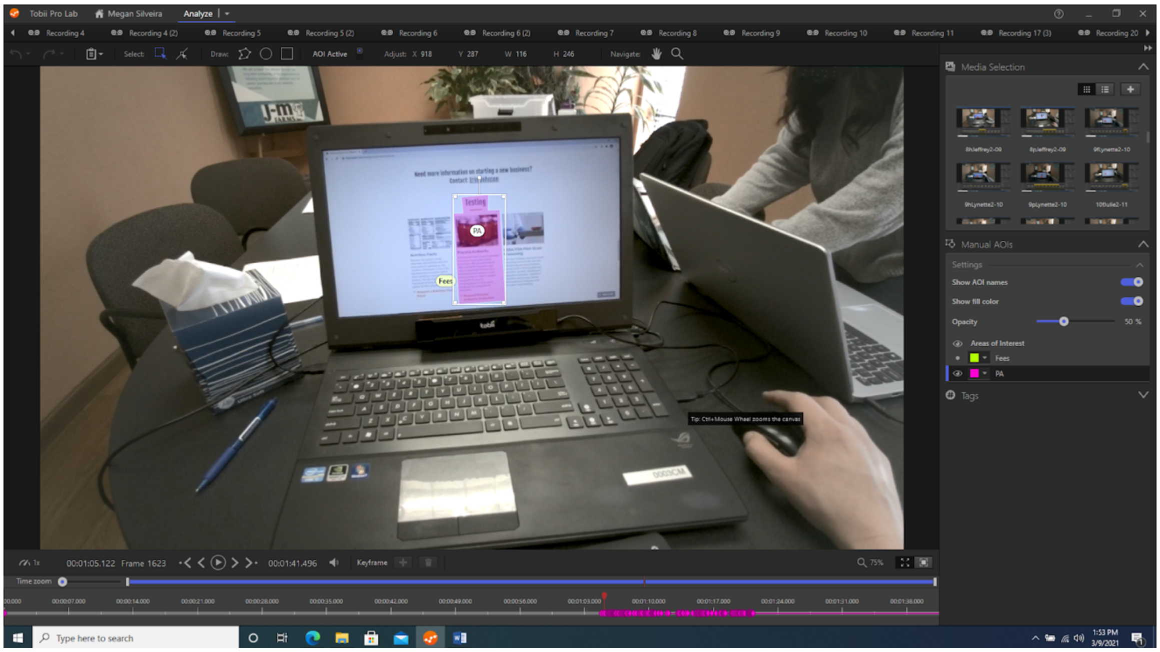
You are being asked to explore the newly redesigned website of the Robert M. Kerr Food and Agricultural Products Center (FAPC) to assist in the research of Oklahoma State University graduate student, Megan Silveira. You are allowed to interact freely with the website, so long as your actions are aimed towards completed the prompt listed below. There are no right or wrong methods to completing this task.

Please complete the following prompt:

> *Navigate to food.okstate.edu. FAPC offers the service of performing process authority evaluations. Find out how much it would cost an in-state resident to have the FAPC complete this service for their business.*

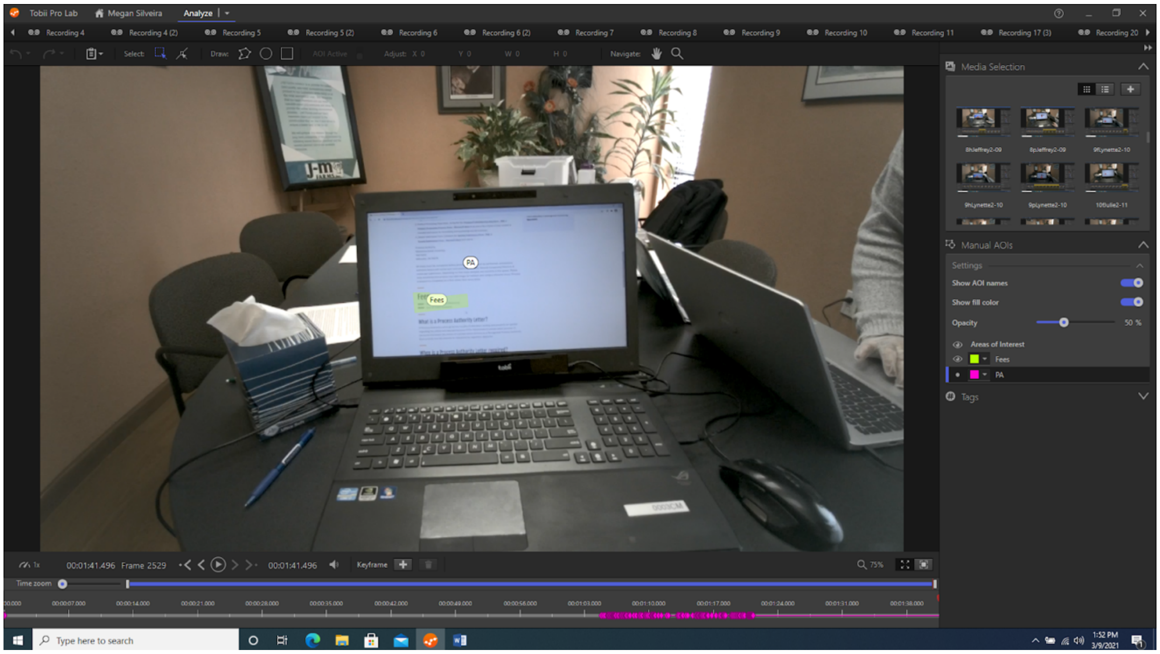
APPENDIX G

PROCESS AUTHORITY PANEL



APPENDIX H

FEES SECTION



VITA

Megan Lyn Silveira

Candidate for the Degree of

Master of Science

Thesis: THROUGH THE LOOKING GLASSES: AN EYE-TRACKING STUDY

Major Field: Agricultural Communications

Biographical:

Education:

Completed the requirements for the Master of Science in Agricultural Communications at Oklahoma State University, Stillwater, Oklahoma in May, 2021.

Completed the requirements for the Bachelor of Science in Agricultural Communications/Agribusiness at Oklahoma State University, Stillwater, Oklahoma in May, 2019.

Experience:

Served as the Communications graduate assistant at the Robert M. Kerr Food and Agricultural Products Center at Oklahoma State University in Stillwater, Oklahoma, from June 2019 – May 2021.