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USING PRAISE TO INCREASE VISUAL ATTENDING IN AN ASYNCHRONOUS ONLINE LEARNING ENVIRONMENT: AN EYE TRACKING STUDY

Andrew J. Rozsa III
University of Southern Mississippi

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by

Andrew J. Rozsa III

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Approved by:

D. Joe Olmi, Ph.D., Committee Chair
Hans Stadthagen, Ph.D., Committee Member
Crystal Taylor, Ph.D., Committee Member

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ABSTRACT

With the emergence of online courses in the mid-1990s, the number of students enrolled in online courses has been growing at an exponential rate (Schwirzke, Vashaw, & Watson, 2018). This trend brings with it new problems, such as familiarity with evidence-supported behavioral techniques that will maintain student engagement and improve likelihood of academic success in online learning environments. The purpose of the present study was to examine how the use of praise may affect visual engagement with video lectures with the assistance of commercially available eye tracking technology. A secondary objective of the study was to identify how praise affects performance on post-lecture knowledge assessments of information delivered through online videos. Results indicated that three out of four undergraduate participants were visually engaged with the video lecture more when provided praise than in the absence of praise, while the fourth participant showed ceiling effects. Results also indicated that praise did not have a significant effect on post-lecture knowledge assessment accuracy. These results indicate that praise may have utility in improving visual engagement in online learning environments and that inexpensive eye tracking technology may be useful for measuring visual engagement in these environments.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

CHAPTER I - INTRODUCTION

Since the emergence of online courses in the mid-1990s, the number of students enrolled in at least one online course has been growing at an exponential rate (Hu, Arnesen, Barbour, & Leary, 2019; Schwirzke, Vashaw, & Watson, 2018). Between 2012 and 2016, postsecondary institutions in the U.S. saw a 17.2% growth in the number of students taking at least one course online (Seaman, Allen, & Seaman, 2018). As more students move to online learning, particularly in the wake of the coronavirus disease (COVID-19) epidemic which resulted in many schools moving to an exclusively online environment, strategies must also be developed to increase effective teaching strategies to increase engagement in these learning environments.

A pivotal step in assessing the effectiveness of teaching strategies is an ability to measure the target behaviors, oftentimes academic engagement. While traditional approaches to measuring behavior in classrooms may translate to online learning environments, multiple new obstacles have also arisen. For example, whereas teachers may previously have been able to continually observe their students' academic engagement by scanning the classroom, this may not be feasible when lectures and tasks are online and may be completed asynchronously from when first recorded or uploaded. Identifying when students are engaged in live environments may also be difficult when teachers are not only instructing students but also scanning thumbnails of students' videos. With the introduction of inexpensive, readily available eye tracking technology, many of these issues may be addressed. To understand why this is so important, it is necessary to see how online learning has evolved and is continuing to grow.

Evolution of Online Learning

According to a literature review by Singh and Thurman (2019), much confusion surrounds the definition of *online learning.* Many research articles use the term *online learning* interchangeably with other terms such as *distance learning* and *blended learning*, to name a few. The similarity in these terms and the partial overlap in their definitions is no coincidence. Their relation may best be understood when considered within their historical context.

Distance Learning

Online learning may be conceptualized as a form of distance learning, defined as:

"[A] method of education. Students can study in their own time, at the place of their choice (home, work, or learning center), and without face-to-face contact with a teacher. Technology is [the] critical element of distance education." (Bates, 2004, p. 5).

According to Bates (2004), online learning is the third generation of distance learning. The first generation made use of a single technology, with no direct student interaction with the institution. Print-based materials were the main form of correspondence between the institution and the student. The second generation of distance learning is defined by the integration of multiple media in the education process, specifically print and broadcasting, and communication being mediated by a third party, such as a tutor who is trained to use standardized teaching material. In the 1960s and 1970s, multiple autonomous teaching universities were developed specifically for distance learning, including The Open University in the United Kingdom, the Anadolu Open University in Turkey, and the Universidad Nacional de Educación a Distancia in Spain. The Open University was among the first to allow open access to degree-level distance learning using multimedia instruction and mass-produced standardized products (Bates, 2005).

Although one of the primary advantages of distance learning is the flexibility of allowing learners to study in their own time, and in an environment of their choice, there is still limited interaction between the original source of the teaching material and the student. The third generation of distance learning is based on the use of two-way communication between the original teaching source, such as an instructor, and the student. This may also allow for multiple students to be taught at once. Kaufman (1989) conceptualized these generations as being a progression in increased learner control, with increasing opportunities to engage in dialogue. The third generation of distance learning allows easier access for otherwise isolated learners to higher education and more cost-effective means of providing education. The greatest catalyst for the third generation of distance learning was the introduction of the World Wide Web in 1989, and the introduction of the Internet for general use to the public in 1993 (Couldry, 2012).

Multiple forms of online learning environments are currently available. When instructors and students both present during remote instruction, whether the learner can interact directly or not with the instructor, this is defined as *synchronous* learning. When the instruction materials are recorded at one time, then accessed at another time at the learner’s leisure, this is *asynchronous* learning. Distinguishing between the two concepts is important as the teaching strategies may need to be altered to accommodate different online learning models.

While online learning has become more common in education systems, at the time of this study, it was still used as a supplemental resource to classroom-based teaching for most institutions (Barbour, 2018). This trend has been identified as one of the top ten trends in the knowledge delivery industry and has been anticipated to become more common than either online or offline teaching alone (Rooney, 2003; Watson, 2008).

Despite the increasing trend in access to online learning models, much ambiguity still surrounds this medium as different institutions implement a variety of models that integrate some form of online instruction. For example, in higher education, online learning is often considered synonymous with completely online courses (Ryan, Kaufman, Greenhouse, She, & Shi, 2015). Many still assume that this implies synchronous online courses, which is still a largely North American approach (Barbour, 2019). Many institutions implement a variety of online learning experiences, including supplemental online content at the instructor's discretion (Means, Toyama, Murphy, & Bakia, 2013), the use vastly different forms of blended learning, such as adaptive programs that may tailor content and pacing to students' individual needs (Brodersen & Melluzzo, 2017; D'Mello, Dieterle, & Duckworth, 2017), live lectures, or group-led discussions.

In an effort to increase the accessibility of online learning, higher education institutes are using more asynchronous teaching models, particularly pre-recorded lectures for online learning (Bos, Groeneveld, van Bruggen, & Brand-Gruwel, 2015; Evans, 2008; Morris, Swinnerton, & Coop, 2019). Although proponents of online learning argue that this form of instruction may allow for more personalized instruction, higher levels of motivation, increased access, and administrative efficiency (Berge & Clark, 2005), it is not necessarily guaranteed that all, or any, of these potential benefits will be realized (Barbour, 2010). Opponents of pre-recorded lectures claim that they may lead to procrastination (Griffin, Mitchell & Thompson, 2009; Gysbers, Johnston, Hancock & Denyer, 2011) and lower attendance at lectures in blended models (Gupta & Saks, 2013; Traphagan, Kucsera & Kishi, 2010).

Findings have been mixed when comparing grades between classroom-based and online courses (Barbour, 2019). For example, in one meta-analysis sponsored by the U.S. Department of Education, Means and colleagues (2010) analyzed 45 studies comparing online, blended, and face-to-face instruction modalities. The authors found that using blended learning had a moderate positive effect on student learning outcomes, while online only classes resulted in minimal positive effect compared to classroom-based instruction.

In one study of the use of pre-recorded videos in higher education, Bos and colleagues (2015) compared 397 students taking a biological psychology course. Students were able to attend lectures face-to-face, only watch the recorded lecture, or do both. Academic achievement was measured two times during the course. The first assessment covered content knowledge from the first 4 weeks. The second assessment covered the second 4 weeks and emphasized higher order thinking skills rather than knowledge. The authors found that following the first assessment, students tended to engage in more video viewing as a supplement to going to class or using videos only, without attending class. Subsequently, the number of students who only attended class, but did not view videos at all decreased. Students who supplemented lecture attendance with recordings performed better than the other groups on the first (knowledge) assessment. Individuals who only watched videos did not significantly differ from those in other groups. Bos and colleagues (2015) also compared time spent watching and/or attending lectures with performance on assessments and found that time spent only viewing recorded videos contributed the least to differences in assessments, while time spent attending class only or both attending class and watching videos contributed more to differences. On the second assessment, time spent watching videos and/or attending lectures did not significantly explain differences in assessment scores. The authors concluded that the modality of instruction only affected assessments of knowledge, but not higher order assessments. The results indicated that the change in attendance may be a result of familiarization with video topic and that individuals may significantly alter their study habits following the first assessment, potentially changing their group assignment. How group membership may have changed between individual lectures was also not examined, which may have resulted in incorrect group assignment for assessment correlations. Based on the large sample size, it may be reasonably surmised that at least the undergraduate sample in the study prefers video recordings over face-to-face instruction.

COVID-19 Pandemic Impact on Online Learning

Despite the increased use of and learner preference for online learning models in learning institutions, many institutions still do not offer online learning opportunities (Beaudoin, 2019). In early 2020, many countries throughout the world responded to the introduction of the COVID-19, caused by a new virus known as SARS-CoV-2, by mandating nationwide lockdowns. Many institutions in the world moved to online learning. By April of 2020, over 1.6 billion students of all ages across the world were being affected by school closures (UNESCO, 2021). With the move into online learning for a large number of classes that otherwise would have been face-to-face, many institutions and teachers found themselves ill-prepared for the sudden move to "emergency remote teaching" (Martin et al., 2020).

At the time of this study, the height of school closures was in April 2020. At that time, the United Nations Educational, Scientific, and Cultural Organization estimated around 80% of learners (including pre-Kindergarten through graduate school) were affected by world-wide school closures (UNESCO, 2020). Although not necessarily synonymous with a permanent shift to online learning, society's move to remote instruction during the COVID-19 pandemic highlighted a significant need for preparedness and emphasized other unexpected potential advantages of implementing online learning modes.

Student Engagement in Academics

Student participation and engagement in online settings are also a common point of contention in online learning research (Kebritchi, Lipschuetz, & Santiague, 2017). Engagement is generally considered a complex, multidimensional concept. The number and labels for dimensions varies between researchers. Among the most common labels for dimensions are academic, cognitive, behavioral, and psychological (Anderson, Christenson, Sinclair, & Lehr, 2004). Fredricks and colleagues (2011) proposed that engagement could be categorized into three dimensions: behavioral, emotional, and cognitive. Although no consensus exists regarding what makes up the entire conceptualization of engagement, behavioral engagement is a common component of them all.

According to Fredricks, Blumenfeld, and Paris (2004), behavioral engagement may be operationalized as observable participation. Behavioral engagement is most often defined in three ways. First, it may entail positive conduct, such as following school and classroom rules, as well as the absence of disruptive behaviors (Finn, 1993; Finn, Pannozzo, & Voelkl, 1995; Finn & Rock, 1997). Secondly, it may be defined as student involvement in learning and academic tasks, including behaviors such as persistence, attention (such as making eye contact or leaning forward during lectures) (Sinatra, Heddy, & Lombardi, 2015), asking questions, and engaging in class discussion (Birch & Ladd, 1997; Finn et al., 1995; Heddy, Sinatra, Seli, & Mukhopadhyay, 2014; Skinner & Belmont, 1993). Third, it may be defined as participation in school-related activities such as athletics (Finn, 1993; Finn et al., 1995).

Behavioral engagement has been identified as a primary component of academic engagement, and its impact on academic performance has a long history in education literature. For example, positive relationships have been identified between task-oriented classroom behaviors (e.g., attending, appropriate talk-to-teacher, volunteering information) with academic achievement (Cobb, 1972; Hecht, 1978; Lahaderne, 1968) in language, arithmetic, and reading. Additionally, inattentiveness/disruptive behavior (e.g., out-of-chair, play, inappropriate-talk-to-teacher) was significantly negatively correlated with these measures.

In studies of inattention during reading and lectures in the form of mind wandering, research has also shown that increased inattention was negatively correlated with memory for the source material (Lindquist & McLean, 2011; Risko, Anderson, Sarwal, Engelhardt, & Kingstone, 2012; Smallwood, Beach, Schooler, & Handy, 2008; Szpunar, Khan, & Schacter, 2013). Attending to instruction and work tasks has been identified as one of the most critical predictors of academic success (Carini, Kuh, &

Klein, 2006; Farrington et al., 2012; Fredricks, Blumenfeld, & Paris, 2004; Krause & Coates, 2008). Students that are actively engaged in the instructional process, such as responding to teacher questions, taking notes, or asking questions may encode information more easily for later retrieval (Baddeley, Lewis, Eldridge, & Thomson, 1984). With so much evidence indicating a positive correlation between student engagement with positive learning outcomes and academic success, identifying a reliable means of increasing attending behavior has become a primary focus in educational settings.

Engagement in the Online Learning Environment

When transitioning from the classroom to online learning environments, several issues surrounding measurement methodologies arise. In the classroom, more traditional face-to-face behavioral observation methods and technologies (e.g., Behavioral Observation of Students in Schools, 2013) are used to help inform behavioral intervention planning. However, many behaviors identified as being engaged are not readily observable (e.g., notetaking, talking to a peer about assigned material, looking at assignment, reading assignment). As a result, it may be more difficult to correctly identify when an individual is engaged in an online learning environment through direct observation alone. With the introduction of computers, several new measurement technologies have also evolved, including eye tracking, in which an individual's eye gaze toward stimuli is tracked. Measurement technology such as this allows for more continuous observation and recording behavior that was not previously feasible (Charlesworth & Spiker, 1975). Whereas human data collectors are susceptible to observer drift, or unintentional changes in how data are recorded over the course of an investigation, computers are bound by algorithms that dictate consistent data collection.

Praise in the Classroom

When access to a preferred stimulus is provided following a behavior, it is said to have reinforcing properties if that behavior occurs more often in the future in similar circumstances. In the classroom setting, this may take the form of attending to work tasks or other classroom-appropriate behavior such as staying seated. Among the most examined forms of reinforcement, the use of praise has received a large amount of attention. Decades of behavioral studies have found a positive correlation between praise and increased work accuracy and engagement and decreased disruptive behavior (Cooper, 2019). Although there is limited research on the ideal rate of praise, multiple studies have indicated that higher rates of praise have a positive effect on on-task behavior (Sutherland, Wehby, & Copeland, 2000).

Due to the difficulty for teachers to continually maintain such high rates of praise (Dufrene, Lestermau, & Zoder-Martell, 2014), recent research has investigated the impact of different rates of praise on student engagement. Rates as low as one praise statement per 2-minute intervals in K-12 classrooms have resulted in noticeable changes in student engagement and disruptive behavior (Blaze et al., 2014; O'Handley, 2016). O'Handley (2016) found that praise delivered every 4 minutes resulted in a decrease in disruptive behavior for some, but not all students, while engagement increased slightly or remained the same as baseline under this reinforcement schedule. By contrast, praise delivered once every 2 minutes resulted in a large increase in engagement and much lower rates of disruptive behavior compared to both baseline rates and the once-per-4-minute condition.

It should also be noted that while these studies have indicated positive outcomes for students in K-12 classrooms, this has not been studied with students in higher education.

Eye Tracking to Measure Attention

In the 1950s, psychological research began to transition from purely behavioral models to more cognitive models. Eye tracking also began to gain more popularity as a medium through which researchers could observe and quantify the "mind-eye" (Just & Carpenter, 1976). The relationship between attention and eye movements has been investigated for decades (e.g., Klein, 1980; Klein, Kingstone, & Pontefract, 1992; Rafal, Calabresi, Brennan, & Sciolto, 1989; Remington, 1980; Reuter-Lorenz & Fendrich, 1992; Shepherd, Findlay, & Hockey, 1986), but research into eye movements and its relationship with academic behaviors goes as far back as 1879 (Huey, 1908).

Until the 2010s, most eye tracking methodologies still incorporated the use of expensive, research-grade hardware. This limited the widespread availability of the technology outside research-based settings such as in university laboratories. With the advancements in technology such as more sensitive, cheap, commercially available webcams, laptop-integrated webcams, faster internet connection speeds, mainstreaming of personal computers, and invention of new forms of technology, researchers began to implement cheaper eye tracking technologies (Hutt, Mills, White, Donnelly, & D'Mello, 2016; Khorrami, Le, Hart, & Huang, 2014). As technology evolves, so does the ability to use computer-based recording techniques in a variety of settings.

For example, in a study of student gaze patterns in traditional, offline physical science lectures at a university, Rosengrant and colleagues (2011) used a revolutionary technology, eye tracking glasses. The authors found that students tracked their professor little for most of the lecture. Most of the eye gaze was toward PowerPoints or notes. However, whenever the professor wrote something on the board, engaged in more animated movements, or discussed something not in the slides, students' gaze significantly increased toward the professor. They found that student engagement increased when the class switched between activities. However, the researchers did not measure how students' attending behavior influenced learning behavior.

While most studies in educational settings have sought to manipulate environmental variables such as social presence (e.g., lecturer-controlled cursor, video representation of lecturer on screen) on attention and learning (e.g., Wang & Antonenko, 2017; Wang, Pi, & Hu, 2018), other studies have also indicated that providing reinforcement, most commonly monetary rewards, may also increase task performance and attending to various stimuli (Anderson, Laurent, & Yantis, 2011; Bucker & Theeuwes, 2014; Chelazzi et al., 2014; Engelmann & Pessoa, 2007; Failing & Theeuwes, 2014; Shomstein & Johnson, 2013). However, only a few studies have examined the use of praise on engagement and task accuracy in computer tasks (e.g., Hayward, Pereira, Otto, Ristic, 2018), and none in online learning environments. This dearth of research indicates a significant deficit in the literature on a topic with increasing relevance to today's educational landscape.

Summary

With the number of students in online learning environments increasing (Queens & Lewis, 2011; Taie & Goldring, 2017; Taie &Goldring, 2019; Taie & Goldring, 2020; U.S. Department of Education, 2004, 2008, 2012), the need for studies regarding successful online learning environments is all the more apparent. For more than half a century, behavioral studies and interventions have been based on classroom-based instruction, but little research has been conducted evaluating the effectiveness of these techniques in online learning environments.

Among the earliest and most studied forms of classroom-based reinforcements is socially mediated reinforcement, in particular praise (Hollingshead et al., 2016; Nelson et al., 2008; Teerlink, Caldarella, Anderson, Richardson, & Guzman, 2017). For decades, research indicated a positive correlation between praise and student engagement (Moore et al., 2018; Royer, Lane, Dunlap, & Ennis, 2019).

The introduction of faster internet connections, more computers in households, and the appeal of online learning as a viable alternative to face-to-face instruction indicate a growing demand for accurate and valid online-based behavior measurement methodologies, particularly expected classroom behavior. For over a century, one of the most promising technologies for measuring attention during tasks in experimental settings has been eye gaze tracking. Until only a few years ago, most eye tracking had to be done using aftermarket cameras and proprietary software. With the ability to implement eye tracking technology using readily available webcams, engagement data may be collected more remotely, precisely, and more easily than requiring human observers to collect data manually.

Though recent research into computer-based instruction has also indicated that praise may be effective for increasing attending to screen and task performance (Hayward et al., 2018), no studies have been conducted evaluating the use of live praise reinforcement in an online-learning environment.

Purpose

The purpose of this study was to examine how remotely delivered noncontingent praise affected learners' visual attention to video lectures, as measured by using readily available eye tracking technology and the learners' own webcam, and subsequently if the use of a readily available eye tracking software may have practical application in online learning settings. As a result, the research questions were:

Research Question 1: Does delivering noncontingent praise on a fixed schedule by a third party during video instruction increase the percent of time participants look at a video lecture, as measured by eye tracking technology?

Research Question 2: Does delivering noncontingent praise on a fixed schedule by a third party during video instruction increase participants' accuracy on work tasks related to the video content compared to no praise?

CHAPTER II - METHODS

Participants and Setting

Prior to recruitment, the primary investigator received approval to conduct the study by the University of Southern Mississippi Institutional Review Board (Appendix A). Four undergraduate students attending The University of Southern Mississippi were recruited during the Summer 2021 academic semester. Participants responded to flyers (Appendix B) that were placed at student organizations on-campus or were emailed to them by professors in the Psychology department. Relevant participant demographic data may be found in Table 1. Because the eye tracking program relies on differentiating between the participant's pupil position and other facial features, artifacts near the eyes needed to be minimized. Thus, potential participants were required to confirm they were able to work at a computer for at least an hour without the aid of eyeglasses. Potential participants also completed a pre-study questionnaire (Appendix C) indicating how familiar they considered themselves with each of the video topics. Each topic was rated on a Likert scale from 0 to 3, with 0 being "not at all familiar" and 3 being "very familiar." Participants who indicated having little familiarity or no familiarity with 24 or more topics were contacted to go over the consent form (Appendix D) and discuss study expectations.

All sessions took place in a 10-foot by 8-foot room in the School Psychology department. The room contained a table and four chairs. On the table were multiple alternative sources of distraction from around the department including colorful toys, pamphlets about the university, various books, and two lamps. The two lamps were located behind the laptop's screen and the overhead light remained off during trials. The laptop screen was located 2 to 3 feet from the participant depending how they sat.

Table 1

Participant Demographics

Participants	Gender	Age	Major	Ethnicity
Amber	Female	20	Therapeutic Recreation	Caucasian
Bella	Female	19	Psychology	African American
Charlotte	Female	20	Criminal Justice	Caucasian
Diana	Female	21	Psychology	Caucasian

Materials

Computer Hardware

This study used a Dell Latitude 5580 and an N930AF 1080p webcam. The Dell Latitude 5580 ran on an i7-7820HQ processor at 2.9 GHz, had 16GB of RAM, and used the Microsoft Windows 10 Pro Education operating system. The screen's diagonal length was 15 inches. The researcher used an HP Envy x360, which ran on an AMD Ryzen 7 5700U processor at 1.8 GHz, had 8GB of RAM, and used Microsoft Windows 10 Home. Both laptops had an integrated webcam and microphone.

Video Stimuli

Videos were chosen from Khan Academy (http://www.khanacademy.com), a site that contains several video series that cover multiple academic subjects (e.g., history). Videos were chosen that implemented either a pencast-style in which the lecturer uses a tablet to draw or a cursor to guide attention to necessary visual supports such as text, timelines, pictures, or equations. Only videos covering the history of human civilizations between 5000 BCE and 2000 AD and lasting between 10 and 15 minutes were chosen. Twenty-nine videos were selected, averaging 11.79 minutes (*SD*=1.47). The videos chosen are listed in Appendix E.

WebGazer

Eye gaze data were recorded using the *WebGazer* eye tracking library, which was first used in a study by Papoutsaki (2016). This program is a client-side eye tracking library that is written entirely in JavaScript. Other more sophisticated eye tracking hardware and software uses 3D reasoning to create highly accurate eye tracking predictions. *WebGazer* differs in that it may be implemented through any website following a user consenting to allowing access to their webcam. *WebGazer* only needs access to the location of eyes to detect pupils and facial features. *WebGazer* uses cursor-gaze relationships, in which calibration is accomplished by identifying the position of eyes when the user clicks on points on the screen and position is compared with other points. By using a facial feature detection library, specifically tracking.js (Lundgren et al., 2015), the face and eyes are detected, and rectangular bounding boxes are formed within the video stream. A small-scale eye detection on the upper half of the detected face is performed in order to speed up gaze prediction and minimize false positives that may have occurred due to eye-like structures present elsewhere in the environment. If the program is unable to detect the face, full-image eye detection is used instead.

Upon detecting the eye regions, next the *WebGazer* program identifies the exact location of the pupil. This process makes three assumptions. First, the iris will be darker than its surrounding area. Second, the iris is circular in shape. Third, the pupil is located in the center of the eye. The authors conceded that these are not always true, such as the eyebrows may return false positives or the eyelid may obscure part of the eye. The pupil's location as a 2D feature may not properly capture nuances in the eye's features. When an individual changes their gaze from one side of a screen to the other, this may result in only a small change of the calculated coordinates of the pupil. To assist with this, *WebGazer* implements a linear regression algorithm that continually updates to learn the mapping of a pupil to points on the screen. This is done by first converting each eye region to a 6x10 pixel image which resizes the detected eye regions. The image is then grayscaled and a histogram normalization are used to make identifying the iris more salient. The resulting 120D (Two eyes with 6x10 pixels) feature vector is then fed to the linear regression algorithm described in Papoutsaki (2018).

The 2D vector representing the pupils and the 120D vector of the computed eye features must then be mapped to the gaze coordinates on whatever screen is being used. More sophisticated and expensive hardware typically use 3D positioning and rotation of the head in comparison to the camera and screen to calculate this. However, *WebGazer* implements a simpler mapping between pupils, eye features, and display coordinates by detecting these vectors whenever the user interacts with on-screen stimuli. Although less robust than more expensive hardware and software approaches, Huang and colleagues (2011) showed that the average distance between the location of the cursor and where the gaze is located on-screen is about 74 pixels (or 1 inch in their study). This approach allows for continual calibration with every user interaction increasing the accuracy of the prediction model, with more recent interactions being more heavily weighted than past interactions. In the original Papoutsaki (2016) study, a 24-inch monitor was used. Predictions were estimated to have a mean error 175 of pixels, or about 3 cm, in remote online settings. Participants in the Papoutsaki (2016) study were seated 2 feet from the screen and they engaged in tasks that required at least 40 mouse clicks. This is the version that has been made freely available to researchers.

WebGazer Application

In the current study, the primary author created a script which incorporated the gaze predictions of *WebGazer* to determine when the participant was looking at the video. Although past applications of *WebGazer* typically employed a more active approach in which interactions during the task were continually updated as the individual interacted with the screen, the current study instead used a more passive approach in which we required 20 user interactions (clicking squares around the screen) to calibrate the eye tracker regression model prior to the task (i.e., the video). During the trial, the video appeared off-center, slightly skewed toward the lower right, with the right edge of the video 2 inches from the edge of the screen, and the bottom of the video 1 inch from the bottom of the screen. To determine if the participant was looking at the video, this application created a transparent dot on the screen where the participant was estimated to be looking. On average, the program calculated whether the participant's predicted eye gaze was within the boundaries of the video at an average of 32.83 (*SD*=2.65) times per second.

Pavlovia

A secure server was required to host the webpage which ran the *WebGazer* JavaScript. Pavlovia (https://pavlovia.org/docs/home/about) is an experiment hosting web server that is Health Insurance Portability and Accountability Act (HIPAA)-compliant and does not store any personally identifiable information. The service is provided for behavioral researchers to run, share, and explore experiments online. Experiments are written using a combination of the PsychoPy (https://www.psyc./hopy.org/) graphical user interface along with JavaScript and Python programming languages. The webpage was run on Firefox, a web browser that is readily available.

Timer

The researcher used a timer on the HP Envy x360 to track when to deliver verbal statements to the participant.

Zoom

The researcher and each participant used Zoom (Zoom Video Communications Inc., 2016), a third-party video conferencing software that is often used in online learning environments. This software allowed the researcher to see the participant's face and provide verbal feedback to the participant throughout the experiment.

Post-Lecture Declarative Knowledge Assessment

Each lecture was followed by a ten-question declarative knowledge assessment that corresponded with the material in the lecture (See Appendix F for an example). The assessment was conducted through Qualtrics (http://www.qualtrics.com). Questions were presented one at a time and had four possible answers. The ordering of questions as well as the ordering of answers were randomized between participants. At the end of each assessment a question with a sliding scale prompted the participant to estimate how many of the questions they knew before watching the lecture.

Data Sheet

A data sheet with 90 blank boxes (Appendix G) was used to identify in which 10-s interval the researcher delivered verbal feedback to the participant.

Piloting of Study Procedures

To anticipate any potential problems with the study protocol and to assess the validity and reliability of the *WebGazer*, the primary investigator conducted a piloting procedure that involved two phases of contrived trials in which study procedures were implemented in order to determine if changes in procedures would be necessary. During each pilot phase, participants were required to engage in behaviors that would allow the researcher to calibrate the software. The first phase involved his thesis director and one of his committee members as participants. Due to a large discrepancy between expected and measured time visually engaged determined during the first pilot phase, changes were made to control for potential sources of measurement error. First, because the original *WebGazer* program was designed to continually calibrate as the user interacted with material on-screen, if the participant moves from the original position during calibration trials, this may result in measurement errors. Second, because the program relies on differentiating between the pupil's location and other facial features, it was determined that artifacts such as shadows from lighting and the presence of eyeglasses may also hinder accurate measurement. The second phase of piloting involved 4 graduate student volunteers who did not require eyeglasses and were instructed to minimize head movements. The resulting actual measurements of percent time visually engaged did not significantly differ from the expected measurements. As a result, the protocol was changed to reflect these piloting trials.

Dependent Variables

Visual Engagement

The primary dependent variable for this study was percent time visually engaged. This was defined as the participant's eye gaze being directed toward the video during the lecture. Visual engagement was measured by a variation of the *WebGazer* JavaScript (Papoutsaki et al., 2016) using a momentary time sampling (MTS) procedure. For hand scoring, visual engagement was defined more explicitly by the absence of specific behaviors. A participant was scored as not being visually engaged in their eyes were closed for more than 3 seconds continuously, looking away from the screen so that the sclera of their eyes was not discernible, their eyes were not visible due to moving their face out of the video, or looking down toward the keyboard. Hand scoring was performed using a 10-second MTS procedure.

Percent Answers Correct

A secondary dependent variable, percent answers correct, was recorded following each lecture. This took the form of 10 questions, each with three distractors and one correct answer. The order of the four potential answers were automatically randomized. Each video had a corresponding set of 10 questions.

Procedures

Prior to beginning the study, participants were randomly assigned to experience the conditions in the order of Baseline-Neutral-Praise or Baseline-Praise-Neutral, counterbalanced so that only two participants experienced either ordering. Due to scheduling constraints and to minimize fatigue, participants chose one hour time slots during which trials were presented until the time slot ended. If a participant needed to leave early or arrived late, fewer trials may have been run than during other sessions.

Sessions were two to four trials each, with an average of three trials (*SD*=.392) per session. Trials began from when the researcher delivered the initial instructions until the participant answered all post-lecture questions. Trials lasted between 12.38 and 18.97 minutes (*M*=15.07, *SD*=1.78). Prior to each trial, the researcher and participant ensured that the equipment was working properly and that the participant's face was visible to the camera. The participant indicated if they could hear the researcher's verbal feedback through the speakers. The researcher confirmed that the participant's video feed was enabled on the researcher's computer, while the researcher's video feed was disabled on the participant's computer. The study's website was placed on the screen by the researcher. The participant then input their assigned participant number and the current session number as indicated by the researcher. The researcher informed the participant to keep their speakers on, unmute themselves, to take no notes, stay at the computer, and to read all directions on the screen. The participant read aloud all instructions, then calibrated the eye tracking program by clicking on twenty squares presented in random locations on the screen. Upon the participant saying they were ready after calibration, the researcher informed the participant to "Press y." Following the participant pressing the y key, the trial-specific video was initiated. At the end of each video, the participant clicked on a link provided by the researcher that directed the participant to 10 questions specifically related to that trial's video content. Upon submitting all answers, the participant was automatically redirected back to the initial web page so that another trial could be run. The first condition change was determined to be made after at least five data points with either low variability or a decreasing trend. Subsequent condition changes for other participants from baseline occurred every three to four data points with low to moderate variability following the previous participant changing condition. The second condition change for each participant occurred following at least five data points with low to moderate responding stability.

Baseline

During this condition, the participant watched videos while the eye tracker assessed visual engagement in the absence of verbal feedback from the experimenter.

Praise Condition

During this condition, the researcher delivered praise after a fixed duration. Praise was defined as a verbal statement by the researcher indicating approval of the participant’s engagement (e.g., “You’re doing a great job watching the video,” “I love how you’re staying on task,” “Way to go keeping your eyes on the video”). Recent research has indicated that praise delivered at a rate of at least once per minute and as little as once per 2 minutes can have a positive effect on engaged behavior (e.g., Blaze, Olmi, Mercer, Dufrene, & Tingstrom, 2014). As a result, praise statements were provided on a fixed duration once every 2 minutes. The researcher told the participant to “Press y,” then delivered the first praise statement.

Neutral Verbalizations Condition

This condition was similar to the praise condition, except the researcher delivered neutral verbalizations instead of praise. Neutral verbalizations were defined as a verbal statement by the researcher that did not indicate approval or disapproval, but comments on general video content (e.g., “This video is about World War II,” “These historical figures are dead,” “This happened a long time ago”). The researcher told the participant to “Press y.” The researcher then delivered the first neutral verbalization.

Procedural Integrity and Interobserver Agreement

To assess for procedural integrity the primary investigator viewed all videos, recording using 10-second partial interval (Appendix G). After each condition change, a second observer coded at least 30% of the trials in the prior condition for procedural integrity (Appendix H, I, J) and interobserver agreement of the dependent variable (i.e., visual engagement). The observer was trained by the primary investigator to record engagement using one 10-minute sample video. The observer was required to have at least 90% agreement with the primary investigator in two videos. Interobserver agreement was determined using scored interval interobserver agreement (IOA). The number of intervals scored for visual engagement were compared between the observer and the primary investigator. The number of agreements were divided by total number intervals, then multiplied by 100. The observer achieved 100% and 94% with the primary investigator, requiring no retraining.

Interobserver agreement was also assessed for at least 30% of all post-lecture declarative knowledge assessments. For each assessment, item responses were automatically graded using Qualtrics. The second observer compared the reported number of correct responses as determined by Qualtrics to the actual recorded score. Agreement was calculated trial-by-trial, in which each item response was considered a single trial. IOA was calculated by subtracting the number of disagreements from agreements, divided by total number of items. IOA was determined to be 100% across all trials.

For Amber, IOA was calculated for 40% of baseline trials and, 40% of neutral verbalizations trials, and 40% of praise trials. For Bella, IOA was calculated for 30% of baseline trials, 40% of neutral verbalizations, and 40% of praise trials. For Charlotte, IOA was calculated for 36.4% of baseline trials, 40% of neutral verbalizations trials, and 40% of praise trials. For Diana, IOA was calculated for 37.5% of baseline trials, 42.9% of praise trials, and 40% of neutral verbalizations trials.

Interobserver agreement was also assessed for hand scoring of videos. Although not one of the original research questions, another aim of this study was to assess the use of eye tracking to measure visual engagement as an alternative to manual scoring. As such, all videos were hand scored. IOA was assessed for at least 36% of trials for each condition across all participants. If IOA was below 80% for any trial, the observer and second observer went over the trial with below 80% IOA and discussed discrepancies. Of Amber's trials, 40% of baseline, praise, and neutral verbalizations were assessed for IOA. Amber's mean IOA was 92.75% (range 85%-100%). IOA was conducted for 40% of Bella's baseline, neutral verbalizations, and praise conditions. Bella's mean IOA was 83.05% (range 65%-95%). The primary investigator and second observer discussed and recoded the 65% trial. This trial was also an outlier in the *WebGazer* measurements and will be discussed further later. For Charlotte, 36.4% of her baseline, 40% of her praise condition, and 40% of her neutral verbalizations condition were assessed for IOA. Mean IOA for Charlotte was 97.15% (range 95%-100%). Lastly, IOA was conducted for 37.5% of Diana's baseline condition, 42.9% of praise condition trials, and 40% of neutral verbalizations condition trials. Diana's mean IOA was 95.86% (range 91%-98%).

CHAPTER III – RESULTS

Visual Engagement

Amber's baseline indicated a decreasing trend (Figure 1). Her baseline data indicated variability (45.6%-84.0%) with a median visual engagement of 63.72%. Amber's data in the neutral verbalizations condition indicated a slight upward trend, less variability (80.15%-96.57%), and a higher level (median=87.15%) than baseline. Upon beginning the neutral verbalizations condition, her data exhibited an immediate increase. Sixty percent of data in the neutral verbalizations condition did not overlap with data in baseline. Amber's data in the praise condition indicated no discernible trend. Her data had lower variability (92.87%-95.98%) than during neutral verbalizations, and a higher level (median=93.57%) than neutral verbalizations. There was an immediate increase upon entering the praise condition. None of the data in the praise condition did not overlap with data in the neutral verbalizations condition. Due to high baseline variability and a high neutral verbalizations level, potential effects may have been minimized based on nonoverlap of data alone.

Diana's baseline, overall, demonstrated no trend. Her baseline data exhibited moderate variability (69.40%-99.05%) and a level of 90.30% (median) (Figure 1). Diana's praise condition data demonstrated a slightly decreasing trend. Her praise data exhibited slightly less variability (72.76%-98.70%) and a lower level (median=87.39%) compared to baseline. Her data did not exhibit an immediate change upon beginning the praise condition. None of the data in the praise condition did not overlap with baseline data. Diana's neutral verbalizations data demonstrated a slightly increasing trend. Her neutral verbalizations data exhibited less variability (81.78%-98.12%) and a slightly higher level (median=89.09%) than praise condition. Her data exhibited no immediate change upon beginning the neutral verbalizations condition. None of Diana's neutral verbalizations condition data did not overlap with data in the praise condition. Due to high baseline levels and neutral verbalizations levels, a ceiling effect may have masked any potential treatment effects based on nonoverlap of data alone.

Charlotte's baseline demonstrated an increasing trend. Her baseline level (median=86.29%) had moderate variability (57.68%-98.88%) (Figure 1). Charlotte's neutral verbalizations condition data demonstrated a slightly decreasing trend. Her data demonstrated less variability (81.60%-99.17%) and a higher level (median=89.70%) than baseline. Her data did not exhibit an immediate change upon beginning the neutral verbalizations condition. Of her data during the neutral verbalizations condition, 14.29% of her data did not overlap with data in the baseline condition. Charlotte's data during the praise condition demonstrated no trend, as well as less variability (89.43%-98.48%) and a higher level (median=96.17%) than neutral verbalizations condition data. Her praise condition data exhibited an immediate increase upon starting the praise condition. Of Charlotte's data during neutral verbalizations, none of her data did not overlap with data in the neutral verbalizations condition. Due to high baseline levels and neutral verbalizations levels, a ceiling effect may have masked any potential treatment effects based on nonoverlap of data alone.

Bella's baseline data showed no discernible trend. Her baseline data indicated and level (median=70.15%) with high variability (6.47%-94.34%) (Figure 1). Bella's praise condition data showed no changing trend. Her data indicated less variability (68.61%-87.60%) and a higher level (median=81.49%) than during baseline. Her data exhibited an immediate increase upon beginning the praise condition. None of her praise condition data did not overlap with baseline data. Bella's neutral verbalizations data showed a decreasing trend. Her data indicated more variability (57.56%-85.63%) and a lower level (median=71.22%) than during the praise condition. Her data did not exhibit an immediate upon beginning the neutral verbalizations condition. During the neutral verbalizations condition, 40% of her data did not overlap (i.e., were below) with data in the praise condition. Due to high baseline variability and high neutral verbalizations levels, a ceiling effect may have masked any potential treatment effects based on nonoverlap of data alone.

Percent Visual Engagement by Participant

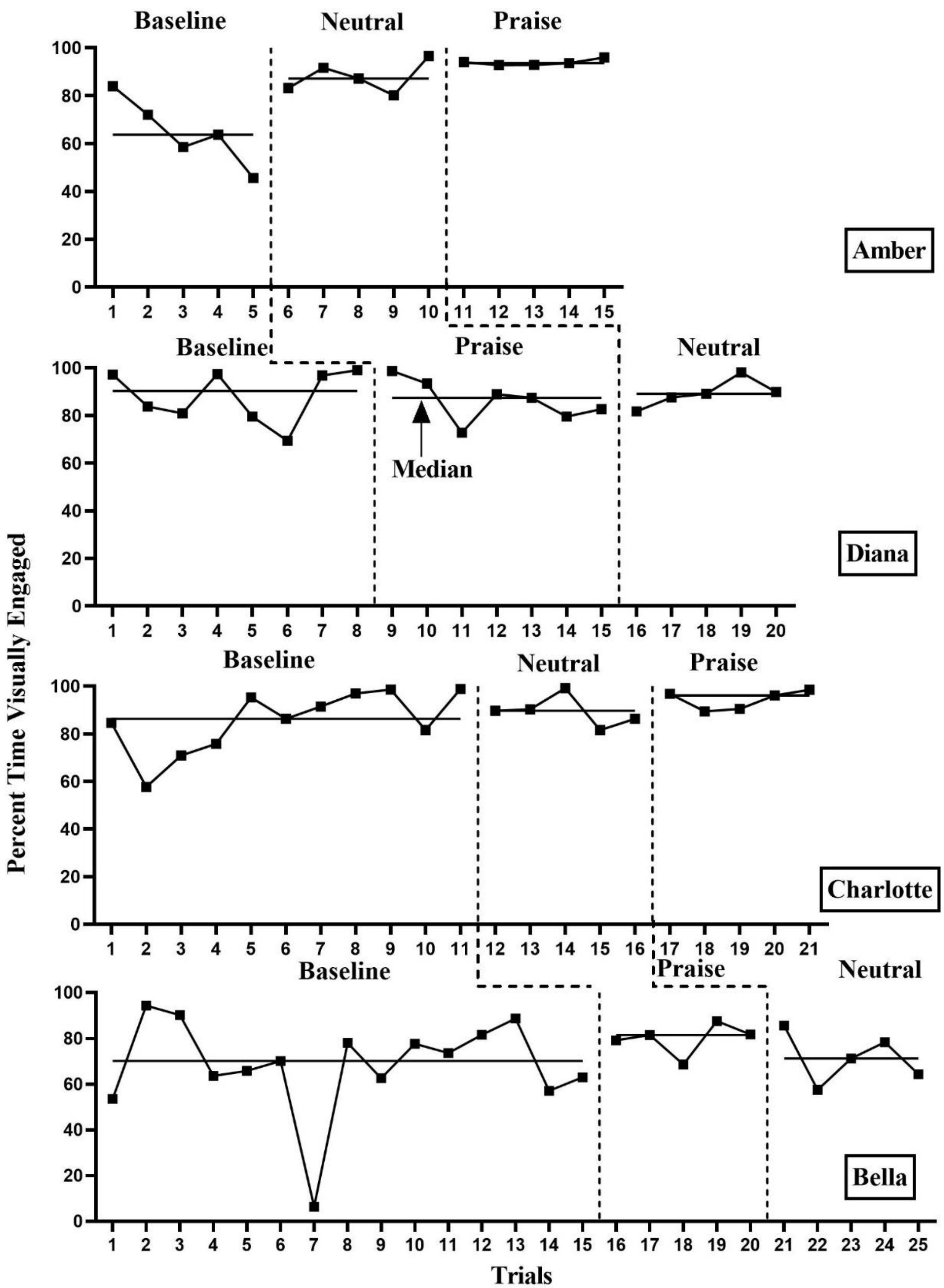


Figure 1. Percent Visually Engaged measured by WebGazer application

Percent Answers Correct

All participants' percent answers correct averages are located in Table 2 and graphed in Figure 2. Upon visual inspection, no apparent differences were present.

Table 2

Percent Answers Correct Averages and Standard Deviations

	Condition			
	Baseline	Neutral	Praise	Overall
Amber	*M* = 64% (*SD* = 16.73)	*M* = 54% (*SD* = 13.42)	*M* = 54% (*SD* = 15.17)	*M* = 57.5% (*SD* = 14.37)
Bella	*M* = 23.33% (*SD* = 11.75)	*M* = 28% (*SD* = 13.04)	*M* = 30% (*SD* = 21.21)	*M* = 25.2% (*SD* = 12.94)
Charlotte	*M* = 56% (*SD* = 21.19)	*M* = 41.67% (*SD* = 30.61)	*M* = 66% (*SD* = 15.17)	*M* = 53.2% (*SD* = 23.22)
Diana	*M* = 60% (*SD* = 13.09)	*M* = 45.71% (*SD* = 27.60)	*M* = 46% (*SD* = 15.17)	*M* = 51.82% (*SD* = 19.18)

Percent Answers Correct

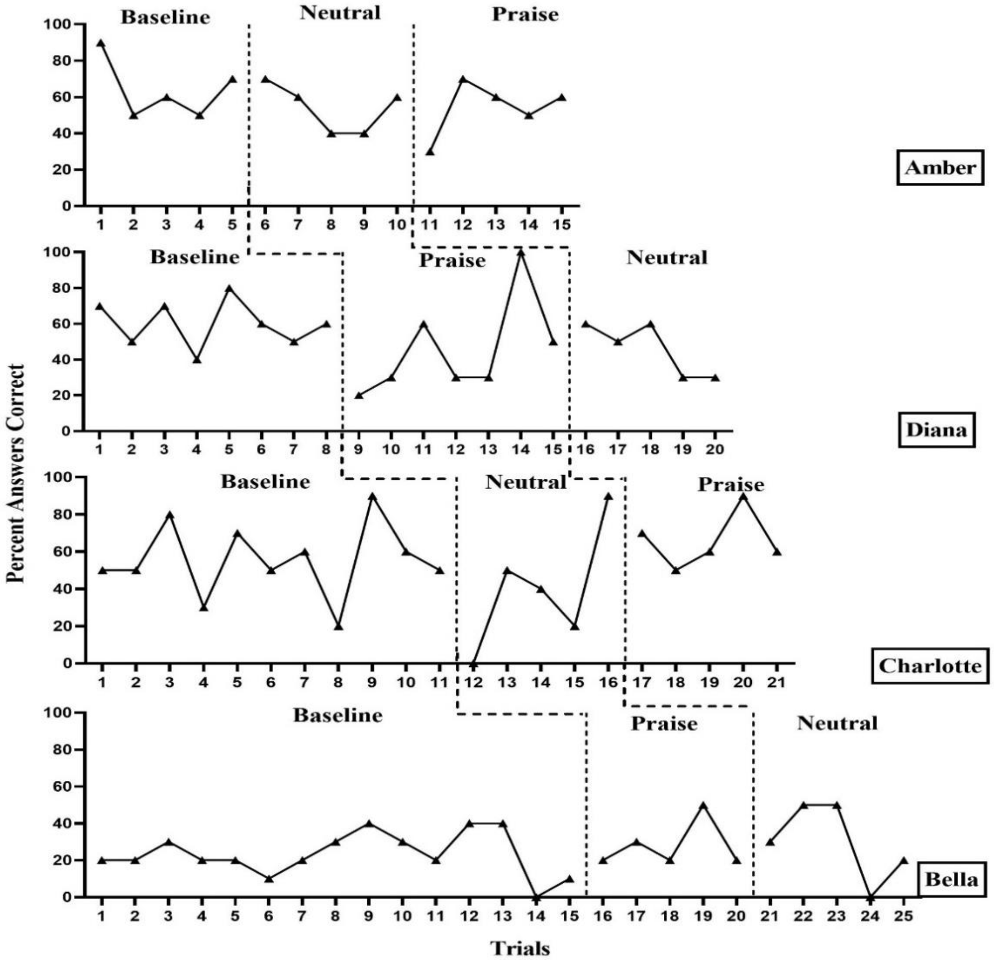


Figure 2. Percent Answers Correct

Visual Engagement Scored by Hand Versus *WebGazer*

Although not an initial research question, another aim of the study was to identify the extent to which *WebGazer* may be used as an alternative to traditional scoring strategies performed by an observer. Due to less frequent coding by a human observer compared to the program, differences were expected. These measurements are graphed in Figure 3. Most conditions showed similar variability and trend between the hand scored and computer scored data. The largest discrepancy was in relation to the level, specifically for Amber's baseline condition and Bella's neutral verbalizations condition.

Amber's baseline data differed in level, with *WebGazer* calculating a median visual engagement of 63.72% and hand scoring resulting in a median of 88.71%. The data paths had similar shapes, but the trends were dissimilar. A simple linear regression resulted a slope of -2.04 for hand scored measurement and a slope of -8.51 for *WebGazer* measurement, indicating data trending more than four times faster for the *WebGazer* measurement than hand score measurement.

Bella's neutral verbalizations data differed in level, with *WebGazer* calculating a median visual engagement of 71.22% and hand scoring resulting in a median of 55.22%. The data paths had similar shapes, but the trends were dissimilar. A simple linear regression resulted in a slope of 1.66 for hand scored measurement and a slope of -2.17 for *WebGazer* measurement, indicating that while hand scored measurement data were slightly trending upward while *WebGazer* data were slightly trending downward.

Due to the low number of sessions, however, these lines may be more heavily influenced by outliers and the fewer observations per session may also have resulted in missed occurrences of the participant exhibiting a lack of visual engagement. Overall, the majority of conditions across all participants exhibited similar medians and trends between *WebGazer* and hand scored measurements, indicating promising use of automated measurements for visual engagement instead of more traditional hand scoring observation methods.

Percent Visually Engaged *WebGazer* versus Observer

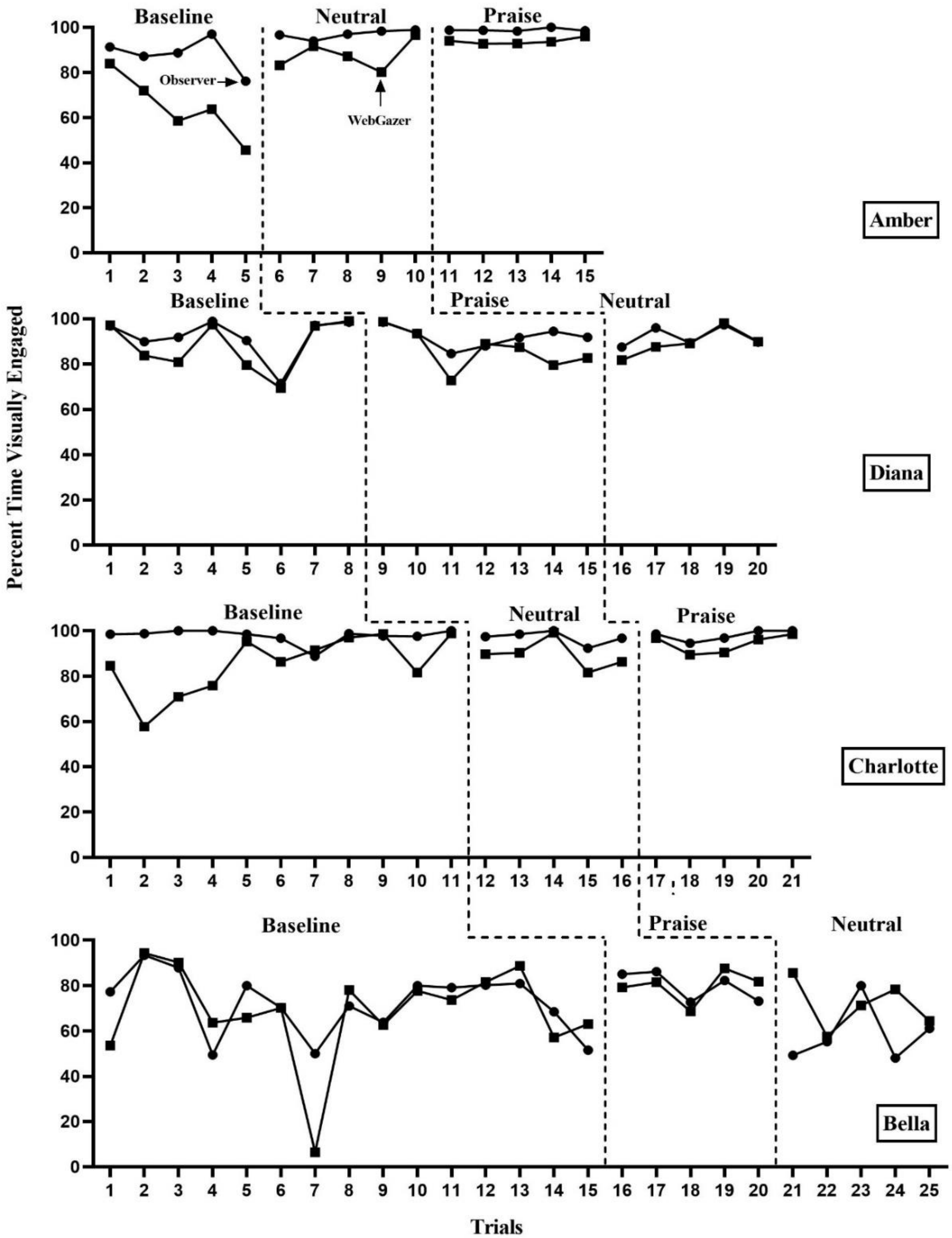


Figure 3. Percent Visually Engaged *WebGazer* and hand-scored graphs

CHAPTER IV – DISCUSSION

The purposes of this study were twofold. First, this study sought to identify if providing noncontingent praise on a fixed duration of 2 minutes affected participants' visual engagement with video lectures, and if the use of praise increases accuracy in post-lecture knowledge assessments. Second, this study sought to investigate if a readily available, free eye tracking software in combination with the user's integrated webcam could provide an alternative means of behavior observation in online learning environments.

The first research question addressed whether the use of praise affected the percent of time a participant looked at the presented video. Three of the four participants showed a higher median for the praise condition compared to either neutral or baseline conditions. Although Charlotte's baseline data had a slightly lower median than the other conditions, the upward trend in her data and similar level in her the second half of her baseline data may indicate a practice effect. Diana's praise condition data demonstrated a lower level compared to her other conditions. This may have been due to a potential ceiling since half her baseline data were nearly at 100% visual engagement and the median was already above 90% in baseline.

Relatedly, all participants except Amber demonstrated above 90% visual engagement for at least one trial, making analysis of nonoverlapping data largely irrelevant. Reduced variability and a higher level for the other three participants' praise condition data may indicate a potential treatment effect. Based on this study's results, providing praise may not have a meaningful impact on visual engagement, at least for these participants.

Based on the results of the post-lecture knowledge assessments, praise did not result in any apparent treatment effects for percent answers correct. This may have been a result of reading comprehension, the face validity of questions, insufficient number of questions, or even interest in the subject. One participant mentioned that verbal feedback occasionally obscured answers to the knowledge assessment, but because these statements occurred infrequently in comparison with the overall length of the video, this should be considered accordingly.

Lastly, the results of this study indicated that the use of a free eye tracking software and the user's webcam may indeed provide a usable alternative to manually observing and coding behavior in online settings. Although not all *WebGazer* data matched observer recorded data, this may be attributable to fewer observations made by the observer than *WebGazer* or difficulty for the observer to discern when the participant was looking at the video. When combined with the piloting data that indicated the observed data and data measured by *WebGazer* did not significantly differ, this study gives significant evidence supporting the use of eye tracking as a viable option in online learning environments.

Limitations

Multiple limitations should be considered when interpreting the data gathered through this study. One of the most significant limitations is the requirements for the eye tracker to run as designed. Participants were instructed to stay at the computer and to minimize movements during trials. This may have affected the results as participants were required to engage in behavior that may not reflect their normal behavior in an online learning environment. Two of the participants engaged in repeated repositioning during trials, but their data did not appear to be affected. The motion-activated overhead light in the room was activated on three occasions, but it did not appear to cause any issue with data collection except for one participant. While the eye tracker was typically able to estimate eye gaze accurately regardless of skin tone, when the overhead light was on, the African American participant's eyes had a darker shadow, making it difficult to differentiate the sclera from the iris. In more applied settings where lighting is not necessarily ideal, this may result in inaccurate data collection. Whereas other, more expensive eye trackers use infrared technology to identify the pupil by bouncing an infrared light off the participant's cornea, this study used a readily available integrated webcam, which relies on facial features to differentiate where the participant is looking.

It should be noted that this study did not employ one of *WebGazer's* original major strengths, which was that it continually updates as participants interact with onscreen stimuli. This limitation was anticipated by the original creators of *WebGazer*. As a result, these results should be interpreted accordingly.

Another of the limitations to this study was the type of participants chosen to be part of the study. Although participants were pursuing different majors and were not all the same ethnicity, all participants were female. Past research has indicated that praise in online learning environments may have a different impact depending on the participant's gender, with females' task performance generally decreasing when receiving praise, and males' task performance increasing when receiving praise (e.g., Zhao & Huang, 2019). It should be noted, however, that these past studies used cartoon characters that delivered praise in the form of on-screen text. How the primary investigator's praise may affect male or nonbinary students was not investigated and may have implications for effectiveness of the praise. Furthermore, because the primary investigator was also a student, the participants may have been indifferent toward the praise of a peer.

The participants' baseline percent time visually engaged may have indicated a necessary exclusion of participants who already exhibited a high level of visual engagement from the study. Because some of the participants chosen already had a high level of visual engagement, they would not necessitate intervention to increase visual attending and any potential treatment effects would be masked by the comparison condition.

The contrived nature of the experiment was also a limitation. In typical learning environments, the lecturer is also the one delivering praise. In this study, praise was being delivered while the lecturer was speaking, which may have resulted in important information being missed. Subsequently, this may have resulted in lower scores in the post lecture knowledge assessment.

Another potential limitation was that individual interest in subjects was not considered or measured. Because the topics chosen were varied, some topics may have been more interesting than others, regardless of the participant's prior knowledge.

Another limitation to be considered was the rate of praise chosen in the study. This study utilized a 2-minute noncontingent reinforcement schedule based on recent research (Blaze et al., 2014; Williamson, 2017) indicating that 2 minutes may be sufficient for reducing disruptive behavior and increasing appropriate behavior for students in classrooms. One praise per two minutes has typically resulted in a significant effect on target behavior for the overall classroom, but it does not always result in an effect for every student. However, there is still limited evidence for an ideal rate of praise, and these studies studied students in primary and secondary education settings (e.g., Allday et al., 2012; Dufrene, Lestremau, & Zoder-Martell, 2014; Sutherland, Wehby, & Copeland, 2000). Furthermore, these studies are commonly class-wide, rather than individualized.

Another limitation was the length of the videos. Some studies have indicated that videos under 9 minutes may be most likely to maintain attention the longest, and videos over 12 minutes may be more likely to lose attention sooner (e.g., Guo, Kim, & Rubin, 2014). Others have claimed that after 10-15 minutes, student attention begins to decrease (Davis, 1993; McKeachie, 1986; Wankat, 2002). These studies commonly reference the Hartley and Davies (1978) as the original source for the 10-15 minutes rule. The primary dependent variable of the Hartley and Davies study was student notetaking, but even the authors have agreed that notetaking is not necessarily a good indicator of attention. The authors stated that that student notetaking was greatest during the first 10-15 minutes of class, and at its lowest during the final 10 minutes, but subsequent analyses have determined that notetaking generally appeared to be consistent throughout the lecture, only declining as course content normally declined in the final 10 minutes of class. Few studies have explored how attention changes over the course of a lecture. The Johnstone and Percival (1976) study is among the more well-known which found that attention began to decrease after 5 minutes, then a further decrease in attention 10-18 minutes into class. However, several methodological issues are raised with this study, such as what constituted a lapse in attention and what constituted attending (Bradbury, 2016; Wilson & Korn, 2007).

Another limitation of the current study was that attending was defined in a narrower sense than would necessarily be expected in more applied settings. Because the eye tracker was the source for determining attending, other behaviors that are typically considered as being on-task, such as taking notes, looking up information in a book, or even looking away while considering new information would all have been considered off-task in this study.

Furthermore, even the visual engagement components of the study was potentially flawed. Sustained eye contact may indicate increased effort in problem solving (Raynor et al., 2006) or mind wandering in the form of staring (Faber, Bixler, & D'Mello, 2018). When attending to material, individuals typically also engage in slight movements of the eye, called saccades. As the eyes move, the individual perceives surrounding pertinent information and can interpret the information contextually, such as when reading.

This study also operated under the assumption that praise was acting as a reinforcer for visual engagement. Past research has indicated that different forms of social presence, such as a video of the lecturer or a cursor controlled by the lecturer may result in increased visual attending during lectures (Wang & Antonenko, 2017; Wang, Pi, & Hu, 2018). However, an increase in visual engagement also occurred in the neutral verbalizations condition for some participants. Thus, the addition of any stimulus may have been enough to evoke increased visual engagement.

The type of information being presented also may have been a limitation of the current study. Much of the information presented did not necessarily require the individual to look at the screen to comprehend it. If presented information regarding the movements of armies with a visual aid, this may require more visual engagement than just being read information from a list of dates.

Lastly, motivation to get answers correct may have been a limitation. This study assumed that praise would increase visual engagement, but increased engagement did not necessarily mean the individual would recall information better. Although three of the four participants consistently answered questions with about 50% accuracy, one participant answered at nearly chance percent accuracy (i.e., 25%). This may have been a result of motivation or perhaps even the individual's reading comprehension ability.

Future Directions

Future studies should investigate how to increase the increase the sensitivity of these new, free eye tracking software options in more naturalistic settings, such as with diminished light or with unintrusive, but continual calibrations for more passive tasks. Relatedly, future studies may also wish to investigate how to incorporate other appropriate, academically engaged behaviors such as note taking and how to measure.

This study examined how praise may reinforce visual engagement. Future research may extend upon this by comparing different types of consequences. For example, while praise may act as positive reinforcement, negative reinforcement is arguably the most potent reinforcer, in which an aversive stimulus is removed. Perhaps discontinuing visual engagement for an extended period of time may result in the video pausing, requiring the user to resume visual engagement to finish the lecture.

Future research may also wish to investigate how different types of information presented may be affected by praise. Previous research has indicated, for example, that how one attends when watching lectures on declarative knowledge and procedural knowledge differ (Hong, Pi, & Yang, 2018). In one research study by Wang, Pi, and Hu (2018), the authors used eye tracking to measure how gaze guidance influenced visual attending to videos covering either a procedure being taught or declarative knowledge. Gaze guidance took the form of a video representation of the lecturer looking at relevant parts of a video. The results demonstrated increased attending across both types of videos as well as higher accuracy in post-lecture questions. As a result, replicating this study with praise versus other stimuli (e.g., gaze guidance) may prove fruitful.

Future research into more individualized rates of noncontingent reinforcement may also prove beneficial. As was previous stated, one praise statement per 2 minutes has been found to be effective in increasing classroom-wide behavior in K-12 settings. Part of the rationale was that it was easier for teachers to provide praise at this rate (Blaze et al., 2014). By determining the amount of time before the individual's visual engagement decreases, an ideal rate may be more easily calculated. Furthermore, an automatic form of reinforcement independent of the teacher may enable teachers to allocate their time to other tasks such as lecturing or answering questions.

Lastly, future research may also investigate how praise for correct answers during more interactive tasks in an online learning environment may influence visual engagement during these tasks. Past research has indicated that praising correctly answering questions increased on-task behavior in elementary students, but praising on-task behavior did not necessarily increase the percent answers correct in a classroom setting (e.g., Hay, Hay, & Nelson, 1977). With the use of eye tracking technology, this may be even easier to measure than in the past.

Conclusion

The results of this study have promising implications for practice. As more schools and universities offer increased access to online learning options, the field of School Psychology must also evolve. Since its introduction in the mid-1900s, applied behavior analysis has played an important role in much of the research in school psychology. The principles of operant conditioning, function-based assessments, and behavior interventions rely squarely on the ability to measure socially significant human behavior in an accurate manner. For all the advancements we have made, we are still our own greatest obstacle in behavior analysis. This may be due to observer drift, which is an unintended change in the way an observer measures a behavior either due to ambiguity in how it is operationally defined or insufficient examples to cover different topographical presentations of behavior. It may also be due to a lack of resources, such as attention or even personnel. Data collection itself can become harder as the environment in which observations are occurring become more complex. While continuous data collection would be ideal, it is impossible to maintain accurate data collection while also recording all pertinent environmental changes. We decide which form of data collection to use based on if we are willing to overestimate or underestimate a particular behavior. This again is due to our limits as humans.

With the introduction of computers in the latter half of the 20th century, we also have gained access to new technologies that may offset some of these weaknesses in current data collection methodologies. Computers are not susceptible to observer drift beyond how they are programmed. Once the topographical behavior is identifiable to the program, it will remain identifiable. Computers are also not susceptible to the same limitations humans are. Computers are capable of recording data thousands of times a second, essentially resulting in continuous data collection.

Once only seen in universities and research labs, computers and other technologies such as eye tracking are steadily becoming more widely available to the public. With the introduction of *WebGazer* and other free eye tracking software, the necessary resources to implement these technologies have become more a matter of access knowledgeable staff. As more programs are developed and made easier to use, this will only become simpler for researchers and teachers alike. While researchers may experimentally manipulate conditions and use eye tracking to measure the behavior, teachers can use software programmed to identify when an academically relevant behavior such as attending is occurring without the teacher constantly having to assess all students' behaviors. This may result in more fluid instruction, accurate feedback, and less effort on the teachers' part.

This study was just one example of how eye tracking may be combined with an academically relevant research question. While some limitations exist in the methodology, the overall findings of this study are promising in that they indicate some typical classroom-based strategies to maintain attention such as praise may have utility in online learning environments. As our technology advancements continue to grow, so too will our ability to answer more research questions and continue to improve our work as school psychologists.

APPENDIX A – IRB Approval Letter

Office *of*
Research Integrity

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

118 COLLEGE DRIVE #5125 • HATTIESBURG, MS | 601.266.6576 | USM.EDU/ORI

NOTICE OF INSTITUTIONAL REVIEW BOARD ACTION

The project below has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services regulations (45 CFR Part 46), and University Policy to ensure:

- The risks to subjects are minimized and reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered involving risks to subjects must be reported immediately. Problems should be reported to ORI via the Incident template on Cayuse IRB.
- The period of approval is twelve months. An application for renewal must be submitted for projects exceeding twelve months.

PROTOCOL NUMBER: IRB-21-292
PROJECT TITLE: Using Verbal Reinforcement to Increase Visual Attending in an Asynchronous Online Learning Environment: An Eye Tracking Study
SCHOOL/PROGRAM: School of Psychology, Psychology
RESEARCHER(S): Andrew Rozsa, D Olmi

IRB COMMITTEE ACTION: Approved
CATEGORY: Expedited
7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

PERIOD OF APPROVAL: July 16, 2021

Donald Sacco, Ph.D.

Donald Sacco, Ph.D.
Institutional Review Board Chairperson

APPENDIX B– Recruitment Flyer

Undergraduate Students Needed for Eye Tracking Study

What?

The purpose of this study is to identify how different forms of researcher's verbal feedback may alter participant's task performance.

Who?

- Must be a USM undergraduate student
- Must be able to work at a computer for an hour without the aid of eyeglasses

Why?

You will be compensated **$15 per hour** upon completion of participation or on September 9th, whichever comes first.

Please note! No SONA credit will be available for this study nor will instructors be informed of your participation.

When?

Sessions will occur during August and September. Each session will last about **one hour**, during which you'll watch 2-3 lectures about world history and answer questions. You should expect to commit **a total of 5 to 8 hours** spread across **2 to 4 weeks**. To finish in a timely manner, we will meet at least twice a week, depending on availability.

How?

Confirm you meet the above criteria by scanning this QR code with your camera and filling out the required information on the qualtrics page that appears:

Alternatively, you may go directly to the site at

https://tinyurl.com/yvfx266j

After submission, you will receive a survey by email. Please fill this out as soon as possible. Participants who meet criteria will be contacted within one to two days of submission.

This study is being conducted under the supervision of Dr. Joe Olmi and

has been approved by USM's Institutional Review Board (Protocol #: IRB-21-292)

APPENDIX C – Pre-Study Questionnaire

Please indicate how familiar you consider yourself with each of the following topics on a scale from "Not at all familiar" to "Incredibly familiar."

	Not at all familiar	Little familiarity	Some familiarity	Very familiar
Golden Age of Athens, Pericles and Greek Culture	○	○	○	○
Paris Peace Conference and Treaty of Versailles	○	○	○	○
International Human Rights	○	○	○	○
Hinduism: Brahman, Atman, Samsara, and Moksha	○	○	○	○
Augustus of Rome	○	○	○	○
Feudal System during the Middle Ages	○	○	○	○
Ottoman, Safavid and Mughal Empires	○	○	○	○
Indus River Valley Civilizations	○	○	○	○
Golden age of Islam	○	○	○	○
Ides of March and civil war	○	○	○	○
Socrates, Plato, and Aristotle	○	○	○	○
Punic Wars between Rome and Carthage	○	○	○	○
Initial Rise of Hitler and the Nazis	○	○	○	○
Theodor Herzl and the birth of political Zionism	○	○	○	○
Alexander the Great	○	○	○	○
Protestant Reformation: Martin Luther	○	○	○	○
Arian Controversy and the Council of Nicaea	○	○	○	○
Fall of the Roman Empire	○	○	○	○
Closing Stages in World War I	○	○	○	○
Hitler and the Nazis come to power	○	○	○	○
Blockades, U-boats, Lusitania	○	○	○	○
Continuity-Sikhism connections to Hinduism and Islam	○	○	○	○
Spread of Islam	○	○	○	○
Hittite Empire and Battle of Kadesh	○	○	○	○
Napoleon and the Wars of the First and Second Coalitions	○	○	○	○
Bay of Pigs Invasion	○	○	○	○
Cyrus the Great and the Achaemenid Empire	○	○	○	○
Ancient Egypt	○	○	○	○
French Revolution	○	○	○	○
Allende and Pinochet in Chile	○	○	○	○
Confucius and the Hundred Schools of Thought	○	○	○	○
Axis in World War II	○	○	○	○

APPENDIX D – Consent Form

ORI | Office *of* Research Integrity

INSTITUTIONAL REVIEW BOARD

STANDARD (SIGNED) INFORMED CONSENT

STANDARD (SIGNED) INFORMED CONSENT PROCEDURES

This completed document must be signed by each consenting research participant.

- The Project Information and Research Description sections of this form should be completed by the Principal Investigator before submitting this form for IRB approval.
- Signed copies of the consent form should be provided to all participants.

Last Edited Feb. 3rd, 2021

Today's date:		
PROJECT INFORMATION		
Project Title: Visual Engagement during Online Lectures		
Principal Investigator: Andrew Rozsa	Phone: 2056168787	Email: andrew.rozsa@usm.edu
College: Education and Human Sciences	School and Program: School Psychology Doctoral Program at the Department of Psychology	
RESEARCH DESCRIPTION		

1. **Purpose**:

The purpose of this study will be to identify how different forms of verbal feedback may alter attention during online lectures.

2. **Description of Study:**

Participants will be comprised of undergraduate students recruited from The University of Southern Mississippi through enrollment in a Careers in Psychology course (PSY 251). The professor of the course will be contacted and informed of the goal of the study and expectations. Upon the professor's agreement, the professor and/or researcher will distribute information related to the study to students in those respective classes. Four students will be selected from the class based on their expressed interest in participating and meeting exclusionary criteria, including being able to engage with a computer screen for up to an hour without the aid of eye-glasses. Participants who meet this criteria will be seated in a room on-campus with a laptop equipped with a webcam, which will be provided by the researcher. The participant will click on multiple squares on-screen to calibrate the eye tracking software. They will be informed that they should minimize movements as much as possible during trials. During the trials, a video will be presented on a topic in history of which the participant has indicated little to some knowledge. The researcher will use different types of verbal feedback in successive trials to identify how this affects participants' attending to the video lecture. Following each video, the participant will then answer questions related to the video's content to assess how well they retained the information presented. Four participants will be chosen based on take part in the study Sessions will last about one hour, with each trial lasting about twenty minutes. The entire study will last between two weeks and a month, depending on participant availability.

3. **Benefits:**

Participants will be compensated for their time at a rate of $15/hour.

4. **Risks:**

Because the individual will be required to look at a screen for prolonged periods of time, sessions will not last beyond one hour to minimize eye strain. Participants will also be asked to minimize head and body movements during trials, which may result discomfort due to posture. As a result, an office chair with adjustable lumbar support will be provided and the individual will be allowed to stretch and change positions between trials.

5. **Confidentiality:**

The eye tracking software can only be implemented through the use of a webpage. Pavlovia (https://pavlovia.org/docs/home/about) is an experiment hosting web server that is Health Insurance Portability and Accountability Act (HIPAA)-compliant and does not store any personally identifiable information. All data will be copied from the Pavlovia server following each session, and removed from the site. The server is backed up and updated up to every three months, resulting in any stored data being permanently removed from the server within three months of any given trial. Videos will also be recorded for interobserver agreement and assessment of procedural integrity. These will be recorded locally and stored on two encrypted thumb drives which will be stored on-campus. These thumb drives will be accessible only to volunteer observers and the primary researcher. At the conclusion of the study, all data will be stored up to a year on-campus in a locked room accessible only to faculty.

6. **Alternative Procedures:**

Due to the exploratory nature of this study, alternatives are not being offered.

7. **Participant's Assurance:**

This project and this consent form have been reviewed by USM's Institutional Review Board, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5125, Hattiesburg, MS 39406-0001, 601-266-5997.

Any questions about this research project should be directed to the Principal Investigator using the contact information provided above.

CONSENT TO PARTICIPATE IN RESEARCH

Participant's Name: ________________________

I hereby consent to participate in this research project. All research procedures and their purpose were explained to me, and I had the opportunity to ask questions about both the procedures and their purpose. I received information about all expected benefits, risks, inconveniences, or discomforts, and I had the opportunity to ask questions about them. I understand my participation in the project is completely voluntary and that I may withdraw from the project at any time without penalty, prejudice, or loss of benefits. I understand the extent to which my personal information will be kept confidential. As the research proceeds, I understand that any new information that emerges and that might be relevant to my willingness to continue my participation will be provided to me.

Include the following information only if applicable. Otherwise delete this entire paragraph before submitting for IRB approval: The University of Southern Mississippi has no mechanism to provide compensation for participants who may incur injuries as a result of participation in research projects. However, efforts will be made to make available the facilities and professional skills at the University. Participants may incur charges as a result of treatment related to research injuries. Information regarding treatment or the absence of treatment has been given above.

____________________________ **Research Participant**	____________________________ **Person Explaining the Study**
____________________________ **Date**	____________________________ **Date**

APPENDIX E – Video Links

Https://youtu.be/UZ3oEn5Q7U4	Fall of the Roman Empire
Https://youtu.be/9ahqfkc3mky	Golden Age of Athens, Pericles and Greek Culture
Https://youtu.be/ojskgvxfi4m	Spread of Islam
Https://youtu.be/sgslyp8mmmc	Ancient Egypt
Https://youtu.be/0t4mf9zoppm	French Revolution Part 2
Https://youtu.be/Um92GZLCQ_Q	Allende and Pinochet on Chile
Https://youtu.be/t8o4actyjhc	Arian Controversy and the Council of Nicaea
Https://youtu.be/y33lnxg2l80	Augustus Becomes First Emperor of Rome
Https://youtu.be/whtpjxlji2i	Hinduism, Brahman, Atman, Samsara, and Moksha
Https://youtu.be/ozyh-1p9nag	Napoleonic Wars of First and Second Coalitions
Https://youtu.be/qckn5bu8ggm	Initial Rise of Hitler and the Nazis
Https://youtu.be/p3pyuy4buik	Feudal System During the Middle Ages
Https://youtu.be/hnpcqegw3s4	Ottoman, Safavid and Mughal Empires
Https://youtu.be/ipq6gb822x4	Confucius and the Hundred Schools of Thought
Https://youtu.be/-j7n-xpi5z0	Hittite Empire and Battle of Kadesh
Https://youtu.be/mi9smaznpxm	Indus River Valley Civilizations
Https://youtu.be/k5xkjk0-hco	Golden Age of Islam
Https://youtu.be/zc_p7Mw1A7U	Ides of March and Civil War
Https://youtu.be/pjqr77vzwyk	Socrates, Plato, and Aristotle
Https://youtu.be/xhvty6_XTJY	Punic Wars between Rome and Carthage
Https://youtu.be/g8sxna-E-H0	Theodor Herzl and the Birth of Political Zionism
Https://youtu.be/Sa5eqaYwQ2Q	Alexander the Great Takes Power
Https://youtu.be/xfbk9534ni8	Closing Stages in World War I
Https://youtu.be/B_p48taky3y	Blockades, U-Boats, and the Lusitania
Https://youtu.be/xmkbadumd_E	Bay of Pigs Invasion
Https://youtu.be/eqeendy0st8	Cyrus the Great Establishes Achaemenid Empire
Https://youtu.be/x3bqqi7-scg	Axis Momentum Accelerates in WW2
Https://youtu.be/a9qtifpiql4	Overview of Chinese History 1911 - 1949
Https://youtu.be/eifq4gfsz3u	Sykes-Picot Agreement and Balfour Declaration

APPENDIX F – Post Lecture Knowledge Assessment Example

Who was the son of Marcus Aurelius?
A. Commodus
B. Diocletian
C. Constantine
D. Theodosius

What led to the Third Century Crisis?
A. The Huns attacking
B. The ascension of Diocletian
C. The assassination of Serverus Alexander
D. The assassination of Marcus Aurelius

How was the empire split by Diocletian?
A. North and South
B. By Tribes
C. East and West
D. By Provinces

Which emperor embraced Christianity?
A. Diocletian
B. Constantine
C. Marcus Aurelius
D. Theodosius

To which city was the Western Capital of the Roman Empire moved?
A. Ravenna
B. Constantinople
C. Adrianople
D. Rome

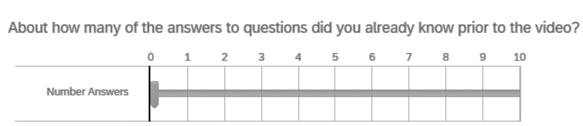
Which city was previously named Byzantium?
A. Constantinople
B. Ravenna
C. Rome
D. Adrianople

Which tribe attacked Rome navally?
A. Visigoths
B. Hans
C. Ostrogoths
D. Huns

Which marked the end of the Western Roman Empire?
A. Odoacer's army attacking Ravenna
B. The Vandals attacking Rome
C. The Visiogoths attack Rome
D. The movement of the capital from Rome to Ravenna

Which of the following was the last of "The Five Good Emperors?"
A. Commodus
B. Marcus Aurelius
C. Adrian
D. Theodosius

Where did the visiogoths eventually settle?
A. Gaul
B. Ravenna
C. Spain
D. Britain



APPENDIX G – Procedural Integrity Data Sheet

Date

Participant

Session

Condition B NV P

	1.1	1.2	1.3	1.4	1.5	1.6	2.1	2.2	2.3	2.4	2.5	2.6
Engage												
Pos Verb												
Neut Verb												
	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5	4.6
Engage												
Pos Verb												
Neut Verb												
	5.1	5.2	5.3	5.4	5.5	5.6	6.1	6.2	6.3	6.4	6.5	6.6
Engage												
Pos Verb												
Neut Verb												
	7.1	7.2	7.3	7.4	7.5	7.6	8.1	8.2	8.3	8.4	8.5	8.6
Engage												
Pos Verb												
Neut Verb												
	9.1	9.2	9.3	9.4	9.5	9.6	10.1	10.2	10.3	10.4	10.5	10.6
Engage												
Pos Verb												
Neut Verb												
	11.1	11.2	11.3	11.4	11.5	11.6	12.1	12.2	12.3	12.4	12.5	12.6
Engage												
Pos Verb												
Neut Verb												
	13.1	13.2	13.3	13.4	13.5	13.6	14.1	14.2	14.3	14.4	14.5	14.6
Engage												
Pos Verb												
Neut Verb												
	15.1	15.2	15.3	15.4	15.5	15.6						
Engage												
Pos Verb												
Neut Verb												

APPENDIX H – Baseline Procedural integrity

Baseline	
Date: _____ Participant: ____ Trial: _____ Obs: ________	
Circle "Y" for each step each time the implementer(s) completed the step correctly. Circle "N" for each time an implementer missed or incorrectly completed a step Circle "N/A" if the step was unnecessary for a trial (e.g., if no proximity prompt was issued, then therapist does not need to record occurrence on data sheet) Integrity = Yes/(Yes+No) * 100	
1. The researcher told participant to keep their speakers on, unmute themselves, to take no notes, stay at the computer, and to read all directions on the screen	Y N
2. Researcher confirmed that their video is disabled	Y N
3. The participant read all instructions out loud	Y N
4. Researcher acknowledged when participant said "Ready," and told participant to "press y"	Y N
5. Researcher engaged in no verbal communication during the session	Y N
Total Percent Correct Implementation	%

APPENDIX I – Neutral Verbalizations Procedural integrity

Baseline	
Date: ______ Participant: _____ Trial: ______ Obs: ________	
Circle "Y" for each step each time the implementer(s) completed the step correctly. Circle "N" for each time an implementer missed or incorrectly completed a step Circle "N/A" if the step was unnecessary for a trial (e.g., if no proximity prompt was issued, then therapist does not need to record occurrence on data sheet) Integrity = Yes/(Yes+No) * 100	
1. The researcher told participant to keep their speakers on, unmute themselves, to take no notes, stay at the computer, and to read all directions on the screen	Y N
2. Researcher confirmed that their video is disabled	Y N
3. The participant read all instructions out loud	Y N
4. Researcher acknowledged when participant said "Ready," and told participant to "press y"	Y N
5. After the participant presses y, the researcher delivers the first neutral verbalization	Y N
6. Researcher only engaged in verbal communication during trials at the designated intervals (every 2 minutes)	Y N
7. All verbalizations were neutral and were related to the video (e.g., "You're watching a history video," "This video is about Europe.")	Y N
Total Percent Correct Implementation	%

APPENDIX J – Praise Procedural integrity

Praise	
Date: ______ Participant: _____ Trial: ______ Obs: ________	
Circle “Y” for each step each time the implementer(s) completed the step correctly. Circle “N” for each time an implementer missed or incorrectly completed a step Circle “N/A” if the step was unnecessary for a trial (e.g., if no proximity prompt was issued, then therapist does not need to record occurrence on data sheet) Integrity = Yes/(Yes+No) * 100	
1. The researcher told participant to keep their speakers on, unmute themselves, to take no notes, stay at the computer, and to read all directions on the screen	Y N
2. Researcher confirmed that their video is disabled	Y N
3. The participant read all instructions out loud	Y N
4. Researcher acknowledged when participant said “Ready,” and told participant to “press y”	Y N
5. After the participant presses y, the researcher delivers the first positive verbalization	Y N
6. All verbalizations consisted of a verbal statement that signified approval (e.g., “Nice job watching the video,” “Awesome attending.”)	Y N
7. Researcher only engaged in verbal communication during trials at the designated intervals (every 2 minutes)	Y N
Total Percent Correct Implementation	%

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