EFFECTS OF DISPLAYING AN INSTRUCTOR'S FACE ON LEARNING AND SUSTAINED VISUAL ATTENTION

A Thesis
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Submitted to the School of Graduate Studies
at Appalachian State University
in partial fulfillment of the requirements for the degree of
MASTER OF ARTS

August 2022
Department of Psychology

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Abstract

EFFECTS OF DISPLAYING AN INSTRUCTOR'S FACE ON LEARNING AND SUSTAINED VISUAL ATTENTION

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In online education the inclusion of a small video depicting the instructor's face superimposed over a slideshow is commonly seen. However, there is little empirical basis for this feature's effectiveness in teaching or its impact on students' visual attention during instruction. With the goal of contributing to the development of instructional resources which facilitate and support meaningful education, this study investigated the effects of continuously displaying video of an instructor's face on participants' learning outcomes and sustained visual attention as they watched a prerecorded college level lecture. No significant effect of the face's presence was observed in any of the findings on learning outcomes, while the eye tracking results revealed a sizable effect of the face on overall viewing behavior. Limitations and implications of these and other findings are discussed.

Acknowledgments

I would like to acknowledge and give heartfelt thanks to my supervisor and mentor Dr. Christopher A. Dickinson, who was instrumental in making this work a reality. His guidance helped me through every step of planning, conducting, and writing this thesis. I would also like to thank my committee members for their helpful comments and suggestions, as well as their time.

Special thanks to my family and friends for their constant support as I worked towards this goal. I never could have made it this far without you.

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Introduction

Due to recent events online-classroom based instruction continues to be a widespread part of modern students' educational experience. As a result, many educators who have not often used virtual instruction are now tasked with effectively teaching class material utilizing it as their primary instructional method. Despite remote learning’s current relevance and ubiquity in education throughout the world, there is a notable lack of conclusive evidence providing insight into the efficacy of certain elements being present within multimedia instructional displays. Furthermore, there is a wide range of virtual classroom platforms available to educators, each with unique features and distinct visual displays. In an effort to clarify the nature of a particularly common element seen in these displays, the current study utilized eye tracking to examine the influence of displaying an instructor’s face alongside class material on learners’ sustained attention, cognitive load, and learning outcomes.

The virtual classroom platforms available today are generally structured to accommodate widely used multimedia instructional methods. Broadly, multimedia learning refers to presenting instructional material to learners through the use of both verbal and pictorial information (Mayer, 2005). A common example is seen in the use of slideshow presentations, with an instructor’s voice explaining the information being displayed. Many virtual classroom platforms are also able to display a visual representation of the instructor, though at present few studies have examined this particular element’s influence on learning outcomes, attention to presented material, and cognitive load.

Some of these studies have used eye-tracking to examine how learners’ attention is distributed over time and the display during instruction. Methods which incorporate eye-tracking technology may be best equipped to further clarify the nature of attentional processes during learning. It is thought that information pertaining to gaze pattern and duration collected during eye-tracking can be used to infer how an individual allocates their attention as they view a display. This information primarily reflects two aspects of human visual processing, namely fixations and saccades. Saccades refer to automatic, ballistic movement of the eyes as they transition between different points of one's visual field. Brief moments of rest on particular points between saccades are known as fixations. The eye-mind hypothesis (Just & Carpenter, 1980) proposes that the relative locations of fixations within one's field of view inform on what information is attended to during processing. Shifts in attention precede both voluntary and involuntary saccades, suggesting that visual attention and gaze are fundamentally coupled in such a way that one is unable to shift their gaze to a location they are not attending to (Deubel & Schneider, 1996; Peterson et al., 2004). In most circumstances, it can be said that the location of one's gaze indicates where visual attention is being directed (Hoffman & Subramaniam, 1995; Kowler et al., 1995).

Literature Review

Eye tracking has been used in multimedia education research to address a range of questions. These include the efficacy of teaching materials (Molina et al., 2018; Navarro et al., 2015), color-coded presentation formats (Ozcelik et al., 2009), and the influence of a higher framerate (Gulliver & Ghinea, 2004). However, there is little convincing research available into the attentional/cognitive implications of including visuals of an instructor alongside target information in a virtual classroom setting. The limited body of existing literature suffers from inconsistencies in both theoretical foundation and methodology, as well as particularly low sample sizes. This section reviews the most relevant examples while highlighting potential shortcomings which were addressed in this study.

Colliot and Jamet (2018) represents a recent effort into examining how displaying video of an instructor alongside target material may influence multimedia learning. Of primary interest were the potential effects of a video of the instructor on learning outcomes, student viewing behavior, and subjective ratings of social presence, motivation, situational interest, and cognitive load. Participants (n = 43) completed a self-paced learning module on the topic of the Ebola virus either with or without the presence of a video which displayed the instructor from the waist up. Eye tracking was used to examine the amount of time participants spent fixating the video relative to other elements of the display. Upon completion of the module, they immediately took the subjective evaluation questionnaires and a learning test which evaluated retention and transfer of target information presented either verbally or through diagrams. No effect of the video was found on any of the four subjective measures. Regarding learning outcomes, a large effect (d = .75, p = .02) of the video was found on retention of spoken explanations, with students retaining more in the video condition (48.43%) than in the audio-only condition (35.86%). However, no significant differences were found in questions referring to diagrams, or in any of the transfer questions. Eye tracking data revealed that participants spent an average of 24.79% of their time viewing the video of the instructor.

Kizilcec et al. (2014) is also relevant to the current study. Notably, the instructor's video feed displayed only their face and shoulders in the center of the frame. This ensured that the face itself was fully visible to learners, a format which is consistent with most current virtual classroom platforms. Their primary research questions concerned whether recall scores would be influenced by the face's presence, learners' preference for the face's presence or absence, and student viewing behavior over the course of the lecture.

Specifically, they aimed to examine whether preference for display format moderated the influence of the face on recall scores. Participants (*n* = 22) watched a brief lecture, and in both experimental conditions the face was intermittently displayed for either three or four of seven total segments in a 15 minute long video which covered basic concepts in organizational sociology. Items in the recall test were coded to reflect whether the face was present or absent during the segment in which the information was presented. The post-test which evaluated participant preference was given immediately following the lecture, with a medium-term recall test sent via email five days later. Eye-tracking data revealed that participants spent an average of 41% of their time viewing the face. The majority of participants reported preference for inclusion of the face, with 15 having indicated they "extremely preferred" segments in which it was present. No effects on learning outcomes were observed.

Kizilcec et al. (2015) consisted of an observational study as well as a longitudinal attempt to examine the efficacy of a "strategic" presentation method aimed at improving learning outcomes over the course of a semester. In their observational study, students were given a choice to view lectures either with or without visuals of the instructor's face throughout an eight week course given using Coursera (https://www.coursera.org). The majority of students chose lectures with the face (57%) as compared to those who chose lectures without it (35%), while 8% watched both. In their second study, the authors compared the efficacy of constantly presenting the instructor's face to a strategic condition in which the face was displayed for anywhere between 33-67% of each lecture. In this condition, the face was hidden or displayed depending on whether the speaker was actively referring to elements present on the lecture slide. This format stemmed from an attempt to prevent the face from acting as a distractor at points where slide content was deemed most important, while also attempting to retain the potential benefits from non-verbal/social cues provided by the face when slide content was less relevant to what was being said. Primary research questions concerned learning outcomes, attrition rates, and self-reports of cognitive load and social presence. Upon enrollment in the course participants were randomly assigned to one of these two conditions, which determined the format of all subsequent lectures viewed throughout the course. Of the students who completed the course, no significant difference in final grades or attrition was observed between video presentation styles. Self-reports of cognitive load and social presence were both found to be higher in the strategic condition.

Homer et al. (2008) examined the influence of including a recording of the instructor alongside lecture slides on learning outcomes, cognitive load, and social presence. Participants ($n = 26$) watched a lecture on child development either with or without video of a speaker's full body present. A learning assessment which evaluated recall and transfer of relevant information was given immediately following its completion. While no significant difference was found for either social presence or learning outcomes, a significant and large effect was found on cognitive load, as measured by three Likert-scale questions asking participants to rate the difficulty and effort of their experience ($d = 1.02$, $p < .05$). Participants in the video condition reported greater cognitive load than those in the no video condition. In a second study ($n = 25$), learner preference for either visual or verbal presentation styles was examined, as measured by a 10-item questionnaire assessing whether participants prefer that target information be presented visually or verbally. Participants with low visual preference reported significantly more cognitive load in the video condition, while those with high visual preference reported significantly more cognitive load in the no video condition. No significant differences were found in learning outcomes.

Chen and Wu (2015) used a within-subjects design to compare the effects of three multimedia instructional display formats on learning, cognitive load, sustained attention, and emotion. In the lecture capture format, participants (n = 37) viewed a recording of an in-person lecture from the perspective of a student. Visuals of the instructor were visible alongside a physical whiteboard and projected slides. In the voice-over format, slides were of primary focus with a video of the instructor displayed by a separate media player. In the picture-in-picture format, video of the instructor was overlaid on top of lecture slides, such that their head and shoulders were visible within the frame of each slide. Perceived cognitive load was measured with participant self-reports. Heart rate variability was taken as an indication of emotional state. Sustained attention was measured on a scale of one to 100 based on raw EEG data taken through a NeuroSky MindSet headset. Learning performance was evaluated using three 10-item tests for memory, comprehension, and application, respectively. Participants rated cognitive load highest while viewing the voice-over format, with no effect observed for either of the other formats. No significant effects were observed on emotion. The voice-over format also resulted in the highest sustained attention as compared to the other two formats. Learning performance was significantly higher for the lecture capture and picture-in-picture formats as compared to the voice-over format.

Critiques

The current study investigated the influence of continuously displaying a video of the instructor's face alongside target material throughout the entire duration of a multimedia lecture. This is in contrast with examples of previous research, which have employed methods in which the face was displayed intermittently (Kizilcec et al., 2014, 2015). Although it is possible that the face's reintroduction may have served to pull attention back towards target material, as intended in the strategic condition of Kizilcec et al. (2015), it may also be the case that intermittent presentation and removal of the instructor visual prevented learners from habituating to its presence or absence. This is significant as it has been shown that although attentional capture habituates over time, it can spontaneously recover when distracting stimuli are reintroduced (Turatto & Pascucci, 2016). This may suggest that the face's regular disappearance and reintroduction exerted detrimental effects on learning which were not accounted for in these studies.

The impact of the presence of a visual representation of the instructor on cognitive load during instruction remains unclear as well. Including recorded video of a lecture may have induced higher levels of cognitive load, but this effect was reversed in students who reported a higher preference for visual learning (Homer et al, 2008). In contrast, lower levels of cognitive load were reported when "picture-in-picture" displays of the instructor over material were used as compared to a voice-over format (Chen & Wu, 2015). This was addressed by including a self-report measure of cognitive load.

Other inconsistencies include differing types of instructor visuals used between studies. Some emphasized the role of the face itself (Kizilcec et al., 2014, 2015), while others utilized video of the instructor's body and gestures (Chen & Wu, 2015; Colliot & Jamet, 2018; Homer et al., 2008). The present study utilized visuals of the instructor's face in isolation, in an effort to improve generalizability to contexts where only the face is displayed. As well, several of these studies asked participants to take the learning evaluations immediately following instruction (Chen & Wu, 2015; Colliot & Jamet, 2018; Homer et al., 2008), which may reduce their ecological validity.

The majority of these studies suffered from critically insufficient sample sizes (e.g., Chen & Wu, 2015; Colliot & Jamet, 2018; Homer et al., 2008; Kizilcec et al., 2014). While it is understood that difficulties involved with the collection of eye-tracking data may have contributed to smaller samples in this line of research, the sample sizes used in these studies cannot be said to be sufficient for detecting the majority of effects observed in psychological research. This study attempted to address this directly by aiming for a significantly larger sample size.

Rationale

As detailed previously, prior research has been largely inconsistent in determining the potential effects of concurrently displaying visuals of an instructor and class material on learning in an online setting. Based on these inconsistencies, this study used eye tracking to examine effects of displaying an instructor's face on visual attention, learning outcomes, and self-reported cognitive load. This was done in two conditions, in which the face was either continuously present without interruption, or was entirely absent. In doing so, I hoped to see whether habituation to the face's presence would occur, as the discussed studies did not examine viewing behavior over time.

Although participants tend to prefer the presence of an instructor's face and perceive it as more educational (Kizilcec et al., 2014, 2015), its influence on actual learning outcomes remains unclear. Mayer (2005) has referred to this apparent lack of effect as the image principle of multimedia learning using social cues. Specifically, the image principle states that individuals do not necessarily learn better when video of the speaker is included in multimedia instruction.

So, how might the continuous presence of an instructor's face be expected to affect learning? When considering this question, it may be helpful to first consider the cognitive processes involved with learning. In order for target information to be encoded in memory it is vital that it be selectively attended to, generally at the expense of other information (Chun & Turk-Browne, 2007). The limited nature of human memory necessitates the exclusive selection of competing elements in one's environment to be attended to at any given moment in time. A finite pool of attentional resources must be utilized for encoding to occur, requiring specific selection of what information these resources are to be spent on. Requirements of a present task (Murray & Wojciulik, 2003) and expectations derived from previous experiences in memory (Ishai et al., 2004) guide the selection process. This may suggest that if the face's presence competes for attentional selection, it may have a negative impact on learning by directing attention away from relevant information.

After being selected, meaningful learning of target information both requires and is limited by the degree of cognitive load imposed upon learners during instruction. Cognitive load theory (Sweller, 1988) refers to inherent capacity limits which determine the amount of information a given person is capable of processing at once. A minimum amount of processing is always necessary, as learning may be incomplete if a sufficient level of information is not processed. In contrast, learning may be inhibited if cognitive load is too great at the time of instruction (Mayer & Moreno, 2003). The relative amount of cognitive load a learner experiences during learning stems from three sources. These three types of cognitive load are referred to as germane, intrinsic, and extraneous. Germane load represents processing demands inherent to the process of learning itself, or the effort required to build a lasting representation of target information (Sweller et al., 1998). Intrinsic cognitive load refers to processing demands related to aspects of the target information itself, namely the degree to which concepts are interconnected (Sweller, 1994). While the intrinsic cognitive load of target material remains constant over different methods of instruction, external elements concerning how information is presented to students can be manipulated to reduce or increase difficulty in understanding and thus impact students' learning outcomes. This is referred to as extraneous cognitive load, or processing demands contributed by something irrelevant to target information (Sweller, 1994). It has been shown that the inclusion of extraneous information during instruction may negatively affect learning in this way (Mayer & Fiorella, 2014; Mayer & Moreno, 2010), suggesting that the face's absence may improve learning compared to its presence by reducing overall processing demands.

Selective and sustained attention operate in conjunction with working memory to store and integrate attended information. The working memory model itself (Baddeley & Hitch, 1974) highlights the limitations of human processing dependent in part upon the perceptual modality in which information is presented. In order to be effectively processed, different types of information are temporarily held in working memory by specialized systems. Visually presented information is maintained by the visuo-spatial sketchpad, and verbal information is held within the phonological loop. Both of these systems are thought to have concrete limitations on the amount of information that can be held within them at one time. This may have implications for the influence of the face's presence, as it is possible that the face may ultimately compete with image-based information for visual attentional resources. In contrast, information presented only through text would not be expected to compete with the face as it would be held separately within the phonological loop.

From a behavioral perspective, the inclusion of an instructor's face can be expected to shift learners' viewing behavior. When included, the face tends to become a dominant visual focus of the display. Eye-tracking research has demonstrated that participants spend a significant amount of time fixating it relative to other areas of a display (Colliot & Jamet, 2018; Kizilcec et al., 2014). This is consistent with previous literature detailing an inherent human tendency to prioritize attending to facial information, which has been found to be present from infancy (Farroni et al., 2005; Johnson et al., 1991). However, the potential effects of habituation to the face being present or absent on viewing behavior have not been effectively accounted for in prior research. As discussed in the literature review, both Kizilcec et al. (2014) and Kizilcec et al. (2015) utilized methods which involved video of the instructor being displayed inconsistently. This would have prevented participants from habituating to the face's presence or absence over time, as the reintroduction of distracting stimuli has been shown to cause spontaneous recovery of attentional capture (Turatto & Pascucci, 2016). In this study eye tracking was used to record eye movements for the duration of the lecture, allowing us to determine whether the amount of time participants spent viewing the instructor's face changed over the course of the lecture.

Several hypotheses were proposed concerning the influence of the face on learning outcomes, perceived cognitive load, and viewing behavior. Firstly, I expected the presence of the face to negatively impact learning of information presented through images based on its potential to compete for visuo-spatial attentional resources. No effect was anticipated for information presented through text, as the face would not have been thought to compete for phonological attentional resources. Secondly, I anticipated ratings of cognitive load to be higher in face-present condition due to its presence contributing extraneous cognitive load. Concerning viewing behavior, I expected participants to habituate to the face's presence over time, resulting in fewer fixations on it towards the end of the lecture.

Method

Participants

A preliminary power analysis for independent samples *t*-test revealed that a minimum of 108 participants in each condition would be required to reveal an effect of $d = .4$ at 90% power. This results in a total minimum sample size of 216 participants. A total of 51 participants completed Part 1 of the experiment, while 34 participants completed Parts 1 and 2. Undergraduate psychology students were recruited for participation using the Appalachian State University Psychology Subject Pool. As compensation for participating, they received Experiential Learning Credits required for students enrolled in intermediate level psychology courses. All procedures were approved by the University's Institutional Review Board (see Appendix A).

Apparatus

Eye tracking data was collected using an SR Research Eyelink 1000 video-based remote eye tracker running on a Dell PC with Windows 10. Eye position was sampled at a constant rate of 500 Hz. A nine-point calibration method was used: first both eyes are calibrated to determine which is more accurate, then data is recorded solely from the more accurate one. Exact spatial resolution is dependent on the accuracy of calibration between participants, but is generally about 0.2 degrees. Stimuli were displayed on a 24 in. ASUS

LCD monitor at a 1920 x 1080 resolution with a refresh rate of 70 Hz. Participants' eye position was consistently fixed at 70 cm from the screen using an adjustable chin rest.

Stimuli/Materials

Instruction consisted of a 31 min 6 s long video of a lecture on basic concepts relevant to visual attention and visual search. A minimum length of 15 min was necessary to ensure enough information was available for the memory tests, as well as to examine changes in attention over time. This is because it has been shown that after 15 min individuals tend to have trouble sustaining attention (Warm et al., 2008). A maximum length of 30 min facilitated efficient data collection. The presentation itself was created using Microsoft PowerPoint, and the video was recorded using Zoom Meetings (Yuan, 2021). One recording of this lecture was used, with the slideshow being controlled by the instructor at the time of recording. Slides were designed such that certain concepts were presented purely as text, while others were presented as images with minimal text. Figure 1 shows an example of information presented as purely text. Figure 2 shows an example of information presented as images with minimal text.

Figure 1

Example of Material Presented as Pure Text

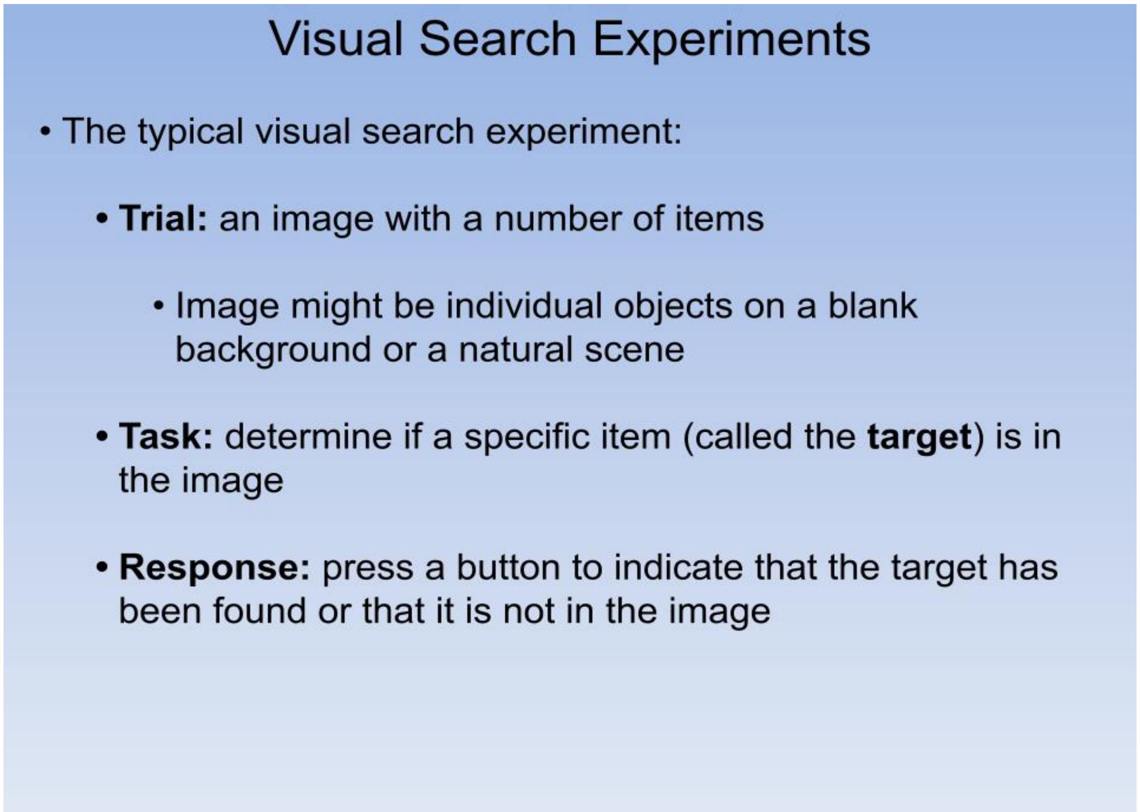
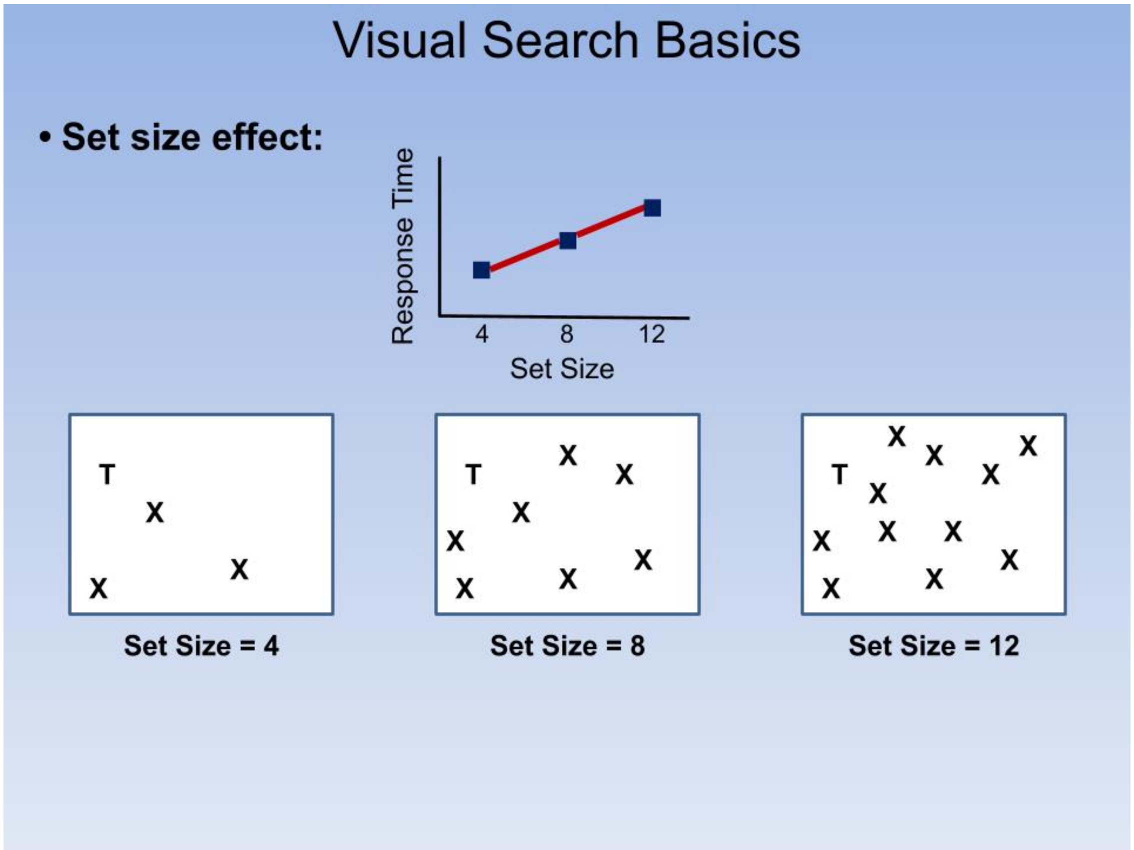


Figure 2

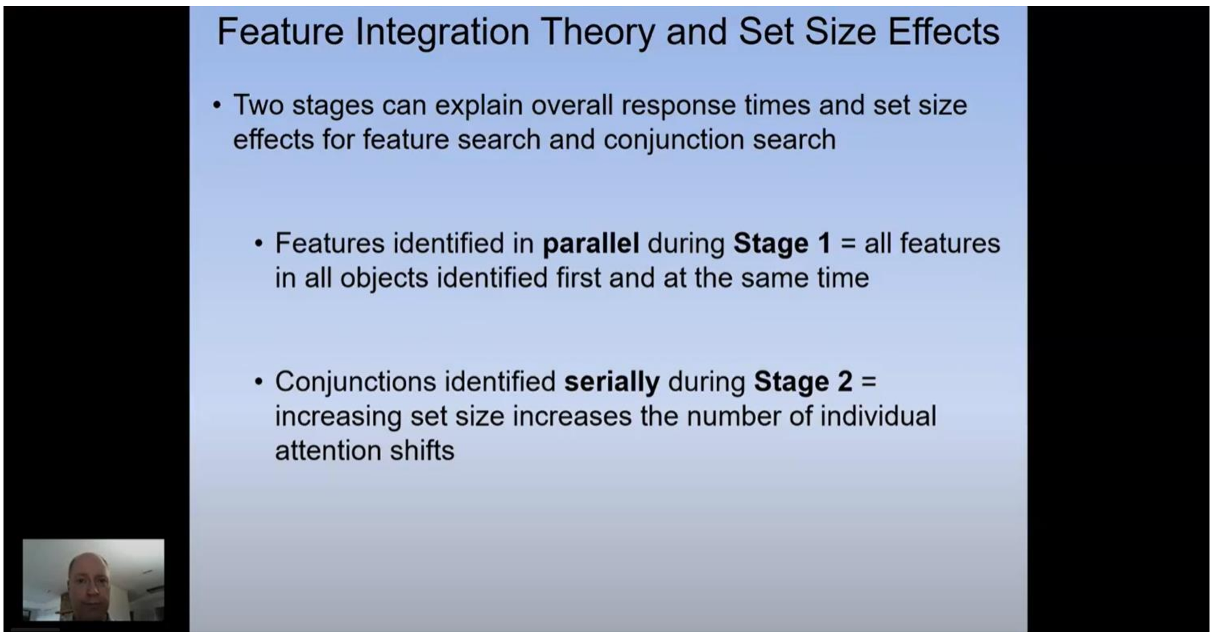
Example of Material Presented as Images with Minimal Text



As only one version of the slides and audio were used, written text and images on each slide as well as the instructor's spoken explanations were identical in both the face-present and face-absent conditions. The only difference between groups was the presence or absence of the instructor's face. In the face-present condition, the speaker's displayed face was included in the lower left hand corner of the display such that it did not occlude target information being presented on the slides. The video of the face was 265 pixels by 170 pixels in size. In the same location, the no-face condition included a continuously visible gray rectangle of the same size displaying the text 'the instructor is speaking' in white. The timing of slide transitions, and thus the rate at which information is presented to participants, was identical between conditions. Figure 3 shows an example of the face as taken from the recording of the lecture.

Figure 3

Example of Video of the Instructor's Face in Face Present Condition



Learning outcomes were evaluated using an assessment derived from a knowledge test utilized by Cierniak et al. (2009), (see Appendices B & C). Recall of basic knowledge was measured with 13 multiple choice questions, each with four answer choices, pertaining to foundational information used in the lecture. In addition to simple fact-based questions, definitions of basic terminology were presented with the corresponding term available to be chosen from a set of alternatives. Seven of the multiple choice questions were drawn from information presented only as text, and six from information presented as images with minimal text. Comprehension of target material was assessed with 13 true or false questions, which evaluated the accuracy of statements describing concepts detailed during instruction. Six of the true or false questions were drawn from information presented only as text, and seven from information presented as images with minimal text.

Perceived extraneous cognitive load was assessed using self-reported ratings collected using three questions on an 11-point scale adapted from Leppink et al. (2014), which asked participants to rate the degree to which they thought the lecture was unclear or ineffective (see Appendix D). For each item, a response of ‘0’ indicated not at all the case and ‘10’ indicated completely the case. Higher ratings indicated higher perceived cognitive load. It is worth noting that participant self-reports of cognitive load are reliant upon an individuals’ capability to accurately introspect upon their own cognition. Using multiple item ratings may aid in addressing the potential effects of individual differences in introspection (Joseph, 2013).

Procedure

In order to assign the same number of participants to each group, experimental condition was alternated with every participant. Upon arrival, participants were given a description of the procedure and asked to read an informed consent form. To avoid distractions, instruction took place in a quiet room in the Appalachian State Psychology lab with only the experimenter and participant present. The experimenter was seated behind and to the side of participants while monitoring the eye tracker to avoid drawing attention away from the stimuli.

Participants were seated at a distance of 70 cm from the display in a stationary position, held constant for the duration of instruction by a chin rest. Note taking was not permitted during instruction. After the eye tracker had been calibrated and accurate tracking was established, participants were instructed that they would be viewing a video lecture and would have their memory on it tested at a later time. The recording was then played continuously for its entire duration without pause.

Self-reports assessing cognitive load were taken on the same computer following the lecture's completion. At this point, participants were also given the chance to sign up for the second part of the study for one additional ELC, which was the follow-up measure of learning outcomes. They were instructed to take the test 48 hours after the session through Qualtrics.

Results

Due to various difficulties, my total sample was 30 participants for whom I still had both eye tracking and memory test data. The final count consisted of 17 in the face present condition and 13 in the face absent condition. First, I encountered some technical difficulties leading to 16 of the initial 51 participants' eye tracking data being corrupted. Further contributing to this data loss, five of the remaining participants for whom I had eye data had not taken the memory test. Results are further limited by inconsistency in the retention interval between participants viewing the lecture and taking the memory test. I was able to find these data by comparing the date and time they signed up for the memory test with the record of when the test was taken. Although the original design requested participants wait 48 hours, the average retention interval was about four days. Four participants took the memory test the same day they viewed the lecture, two the next day, 10 after the instructed interval of two days, and 14 after three or more days. Despite this I have decided to look at all of the data available to us given the already low sample size. All interpretations of the following results should be considered tentative because of these factors.

Memory Test

Figure 4 shows the overall proportion of correct responses for each question in the basic knowledge evaluation. Figure 5 shows the overall proportion of correct responses for each question in the comprehension evaluation.

Figure 4

Proportion of Correct Responses in Basic Knowledge Evaluation

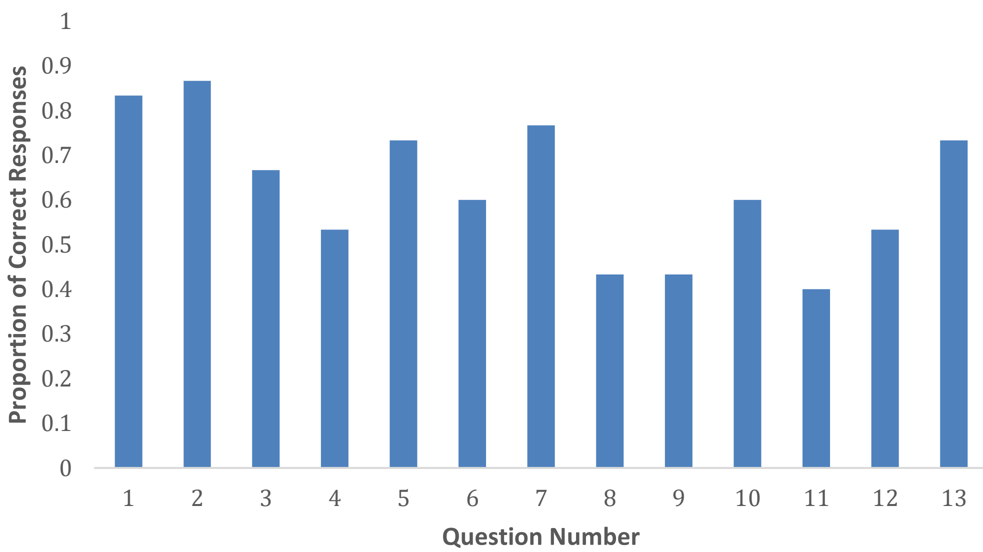
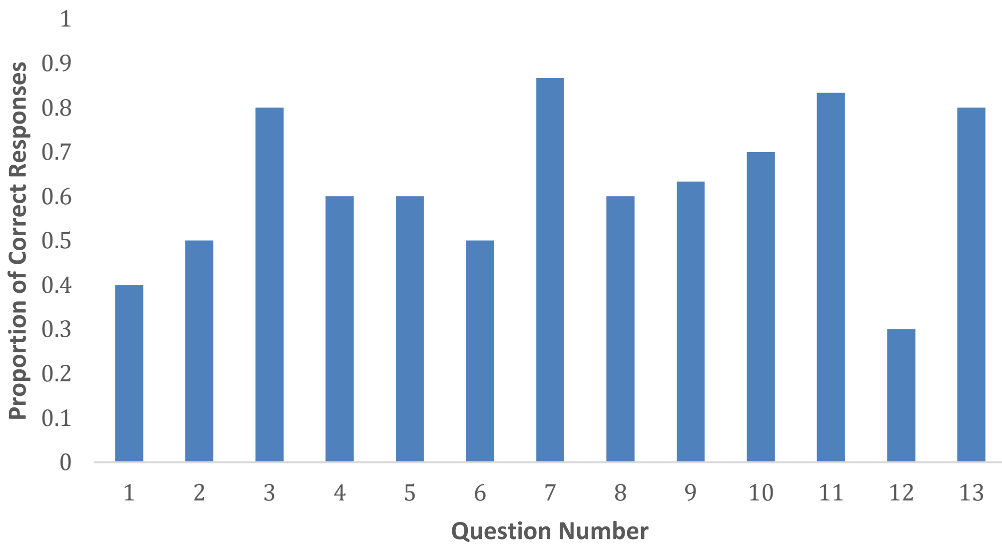


Figure 5

Proportion of Correct Responses in Comprehension Evaluation



To address the general question of whether the presence of the face would impair participants' learning of basic facts or comprehension, two independent samples *t*-tests were conducted to compare memory test scores for both types of learning between each condition. No significant difference was observed between the present ($M = 7.82$, $SD = 2.17$) and absent ($M = 8.54$, $SD = 2.79$) conditions for multiple choice scores ($t(28) = 0.79$, $p = 0.437$, $d = 0.29$). As well, no significant difference was observed between the present ($M = 8.06$, $SD = 1.35$) and absent ($M = 8.23$, $SD = 1.59$) conditions for true/false scores ($t(28) = 0.32$, $p = 0.751$, $d = 0.12$). This suggests that the face's presence did not impair participants' recall of either basic facts or comprehension of target material.

To test the hypothesis that memory for information presented using images would be significantly lower for participants in the face present condition, two within-subjects ANOVA were conducted comparing memory test scores for material from each information format between participants in both conditions. Results were converted to proportions, as there were an unequal number of questions based on information from each presentation format. Table 1 shows the proportion of correct responses in both learning evaluations based on material presented in each format for both the face absent and face present conditions.

Table 1

Mean Memory Test Scores for Text and Image Presentation Formats

	Basic Knowledge		Comprehension	
	M	*SD*	*M*	*SD*
Text				
Absent	0.593	0.246	0.731	0.231
Present	0.613	0.187	0.676	0.191
Images				
Absent	0.731	0.285	0.549	0.128
Present	0.588	0.244	0.571	0.124

Note. Means represent proportion of correct responses; *N* = 30 (*n* = 13 for Absent; *n* = 17 for Present).

To test the hypothesis that recall of basic knowledge for information presented using images would be significantly lower for participants in the face present group, a two-way within subjects ANOVA was conducted comparing the proportion of multiple choice scores for material from each presentation format between conditions. No statistically significant difference was found between the face present (*M* = 0.60, *SD* = 0.22) and absent (*M* = 0.66, *SD* = 0.53) conditions ($F(1, 28) = 0.76$, $p = 0.392$), or between information presented as text (*M* = 0.60, *SD* = 0.22) or images (*M* = 0.66, *SD* = 0.26), ($F(1, 28) = 1.11$, $p = 0.300$). The interaction was also not found to be significant ($F(1, 28) = 2.34$, $p = 0.137$). This fails to support the hypothesis that memory for basic knowledge of target information presented as images would be worse for participants in the face present condition.

To test the hypothesis that comprehension of information presented using images would be significantly lower for participants in the face present group, a two-way within subjects ANOVA was conducted comparing the proportion of true/false scores for material from each presentation format between conditions. No statistically significant difference was found between the face present ($M = 0.62$, $SD = 0.16$) and absent ($M = 0.64$, $SD = 0.18$) conditions ($F(1, 28) = 0.14$, $p = 0.709$), though a small but significant difference was observed between information presented as text ($M = 0.70$, $SD = 0.21$) or images ($M = 0.56$, $SD = 0.13$), ($F(1, 28) = 9.30$, $p = 0.005$). The interaction was not found to be significant ($F(1, 28) = 0.66$, $p = 0.424$). This fails to support the hypothesis that memory for comprehension of target information presented as images would be worse for participants in the face present condition.

Cognitive Load

An independent samples *t*-test was conducted to examine the hypothesis that cognitive load ratings would be higher in the face present condition. A small but significant difference was found between groups, suggesting that ratings were higher in the face absent group ($M = 2.69$, $SD = 3.71$) than face present group ($M = 1.24$, $SD = 1.35$), ($t(28) = 2.54$, $p = 0.017$, $d = 0.934$). This does not support the hypothesis that the face present group would show higher perceived cognitive load.

Viewing Behavior

Before analysis, eye-tracking data concerning the number and duration of fixations were converted to proportions. Fixation counts were converted into proportions by dividing the number of fixations which fell on the face region by participants' total number of fixations over the course of the lecture. Proportions of fixation durations were found by dividing the total fixation duration on the face region by the total duration of the lecture.

For both fixations and durations, independent samples *t*-tests were conducted to determine whether their proportion was significantly greater for the video of the face itself as compared to its placeholder in the face absent condition. A significant difference was found in number of fixations, in which the face present condition ($M = 0.13$, $SD = 0.06$) showed more fixations on the target area than the face absent condition ($M = 0.01$, $SD = 0.02$), ($t(28) = 6.50$, $p < .001$, $d = 2.40$). A significant difference was also found in the durations, with the face present condition ($M = 0.17$, $SD = 0.09$) showing longer durations than the face absent condition ($M = 0.01$, $SD = 0.01$), ($t(28) = 6.03$, $p < .001$, $d = 2.22$).

Two within subjects ANOVA were used to examine the hypothesis that the proportions of fixations falling on the face would be lower towards the end of the lecture. For each set of proportions, an ANOVA was run with the data separated into sixteen 1-min 56 s long bins. Proportions of fixation counts were found by dividing the number of fixations on the face by the number of fixations made for each bin. Proportions of time spent fixating the face were found by dividing fixation duration on the face region by the duration of each bin. If a fixation on the face started and ended in different bins, half of a fixation was counted for each bin, and its duration was divided proportionally between them. Figure 6 shows how the proportion of fixations which fell on the face region changed over time in each condition.

Figure 7 shows how the proportion of time spent fixating the face changed over time in each condition.

Figure 6

Proportion of Fixations Falling on Face Region Over Time

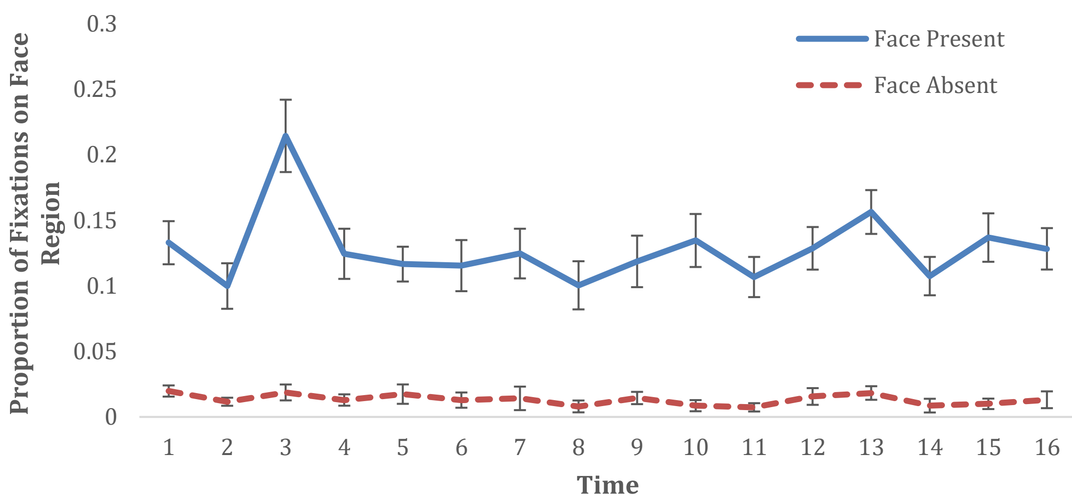
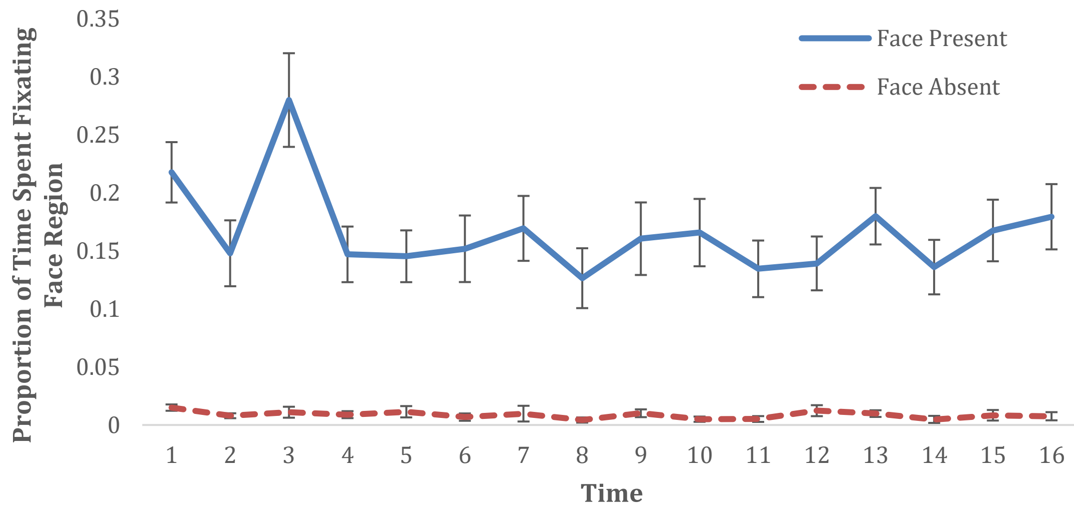


Figure 7

Proportion of Time Spent Fixating Face Region Over Time



For fixations, significant main effects were observed for time ($F(15, 420) = 5.23$, $p < .001$) and group ($F(1, 28) = 43.53$, $p < .001$), with a significant interaction ($F(15, 420) = 3.76$, $p < .001$). In the face present condition, post hoc comparisons revealed that the third bin contained significantly more fixations than the first, second, fourth, fifth, sixth, seventh, eighth, ninth, 10th, 11th, 12th, 13th, 14th, 15th, and 16th bins (all $p < .001$). These results may suggest that participants paid more attention to the face earlier in the lecture.

For durations, significant main effects were observed for time ($F(15, 420) = 4.52$, $p < .001$) and group ($F(1, 28) = 36.25$, $p < .001$), with a significant interaction ($F(15, 420) = 3.85$, $p < .001$). In the face present condition, post hoc comparisons revealed that the third bin contained significantly longer durations than the first, second, fourth, fifth, sixth, seventh, eighth, ninth, 10th, 11th, 12th, 13th, 14th, 15th, and 16th bins (all $p < .001$). This may also suggest that more attention was paid to the face earlier in the lecture.

Discussion

This study's primary goal was to identify the potential effects of continuous video of an instructor's face, a commonly observed element in multimedia instructional displays, on students' learning outcomes and their allocation of visual attention. Participants watched one of two versions of a recorded lecture, either with or without the face present on the display, while their eye movements were recorded. After this, they completed a cognitive load measure before taking a memory test on the lecture's content online. Primary research questions concerned whether the face would negatively influence two types of learning, which were examined using evaluations for recall of basic facts and comprehension of target material. I also examined a participant rating of cognitive load, as well as the presentation format of target information in the lecture. Further research questions concerning the face's influence on visual attention were examined using measurements of how often and for how long participants spent looking at the face's area. In an effort to address the potential effects of attentional habituation on viewing behavior, eye tracking data were analyzed to examine how visual attention to the face region may have changed over the course of the lecture.

Ultimately, the memory test results did not reveal a significant effect of the face's presence on either basic knowledge or comprehension of target material. This may suggest that the face's presence alone has no significant influence on learning outcomes in these particular types of evaluations. While a small difference in comprehension scores was observed as a result of material presentation format, no difference was found in basic knowledge scores or for format's interaction with the face's presence in either evaluation. These results did not support the hypothesis that video of the instructor's face would hinder recall for basic knowledge and comprehension of material presented as images. Rather, these results may suggest that the face does not compete with this material for visuo-spatial attentional resources, and as such can be freely included in multimedia instructional displays for class material utilizing both text and images to convey target information.

The cognitive load measure revealed a small effect due to the face’s presence, but in the opposite direction as had been hypothesized. Interestingly, it appears that participants in the face absent condition experienced higher levels of cognitive load compared to the face present condition. At a minimum, this suggests that the face’s presence did not significantly contribute extraneous cognitive load, and that it may rather have served to facilitate participants' learning of the target material in some way. Perhaps the face’s presence maintained/improved overall engagement merely by adding a non-static visual element to the slides. Or perhaps it somehow aided in learners’ processing of target material by providing some form of information or instructional cue which was not present in the face absent condition. It may also be the case that the mere absence of a salient display element in that position independently hindered learning, and that some other form of irrelevant yet dynamic element being in the display may alleviate this effect.

Through comparisons of participant viewing behavior between conditions, I observed a significant difference in both the proportion of individual fixations falling on the face’s area as well as the proportion of their durations. On average participants in the face present condition exhibited significantly more fixations on the target area, and spent more time fixating it, than the face absent group. This suggests that despite its apparent lack of influence on learning outcomes, the face’s presence did manage to influence participants’ viewing behavior while they watched an otherwise identical lecture.

Beyond simply expecting the face to influence overall proportions of fixations and durations for the video's total runtime, I also expected to observe an effect over time as well. It was initially predicted that, for the face present condition, the number and duration of fixations on the face's area would decrease towards the end of the lecture. This was because participants were expected to habituate to the face's presence over time (Turatto & Pascucci, 2016), resulting in less attention being paid to it as the lecture went on. Although the results do seem to suggest that more attention was allocated to the face earlier in the lecture, visual inspection did not suggest a linear trend over time.

Limitations and Future Directions

Primarily, an unexpectedly low sample size weakened the strength of any potential conclusions considerably. Keeping this small sample in mind, the previous interpretations of all analyses should be considered tentative at best. Technical difficulties with eye-tracking data, in addition to a lack of participants following instructions regarding the memory test's retention period, further limits potential conclusions. As mentioned earlier, participants had been instructed to wait 48 hours before completing the memory test. Unfortunately, average retention was about four days. Though I chose to examine all of the available data, I may consider a follow up only using participants with a two-day retention interval. To avoid confusion and lower attrition rates, any follow up studies should consider giving participants the memory test in the same session they view the lecture. Although, as mentioned earlier, this may reduce ecological validity, it would be consistent with previous research and may help with data collection.

Another primary factor limiting interpretation of this study's results is the lack of interaction between the learner and material. This poses a significant departure from actual learning contexts, as even when online, real class environments provide students with chances to ask questions, take notes, make unique contributions, or otherwise engage with material in real time. Such interactions provide opportunities for repetition and reinforcement of target information and allow for flexibility in addressing differences in individual learning styles. Although it would be challenging to account for these differences in a study with eye tracking, methods that could allow for such actions as note-taking during instruction might begin to address this gap.

In reality, formal education takes place over the course of many class sessions with various methods for evaluating learning performance. In this study learning occurred at only one particular point of time in a single session, with one assessment of outcomes. To increase ecological validity, future research would do well to incorporate methods which examine the presentation of class material across an extended period of time with multiple instances of instruction and learning evaluations.

The lecture was also limited to audio and video of only one instructor. Variability in a wide range of instructor behaviors (e.g. rate of speech, tone, volume, use of gestures, facial expressions) may impact students' attention and perceptions of cognitive load. A similar range of complications may also arise from using only one recording of one version of a presentation on one specific topic. As such, the results of this study are unable to account for differences due to varying subjects, instructors, fields, or the educational level of learners. Given that this study was limited to undergraduate psychology students, potential effects resulting from learners' age were also unaccounted for. Conducting similar studies with students and instructors of various ages, using a variety of academic subjects, would greatly expand upon the potential applications of this research.

Although variability in participants' retention intervals and a low sample size likely contributed to an observed lack of effect of the face on both memory tests, I propose that the questions themselves may have played a role as well. Item analyses of the memory tests, shown in Figures 4 and 5, suggest that their overall difficulty may have masked potential effects due to the face's presence.

Regardless, any conclusions are still limited by many of the factors stated above, particularly the use of a single instructional session with one evaluation. Another limiting factor would be the laboratory context in which instruction took place. When in an actual online or otherwise multimedia based learning scenario, students have a varying degree of flexibility in their individual environments that was not reflected in the design. It is possible that participants' unfamiliarity with the space, the restrictions of the eye-tracking apparatus, or some other aspect of the environment was in some way harmful to learning.

Besides the actual difference of format itself, a few other factors serve to limit conclusions on presentation format's effects on learning. I would like to emphasize that this variable was not manipulated in this study. As such, each participant was exposed to the same proportion of information in each format which, as discussed earlier, was not entirely equal. It also appears that the slides which contained material presented purely as text tended to be denser than slides using mostly images with minimal text. The relative density of the text-based slides may have prompted more engagement with target information than the comparatively sparse image-based slides, resulting in the significant main effect of format which was observed.

While the measure of extraneous cognitive load revealed a significant effect, the conclusions which can be drawn about the face's influence on perceived cognitive load are limited. This is partly due to this measure relying on participant self-reports, which ultimately depend on each individual's capacity to accurately assess their own cognitive activity. Furthermore, the evaluation only consisted of three items, specifically tailored to extraneous cognitive load. Future research might consider utilizing a more comprehensive measure of cognitive load.

A sizable and significant effect of the face's presence on overall proportions of fixations and fixation durations may have been found, but the conclusions to be made based on these findings are still somewhat limited. It may be worth asking whether these effects are limited to faces in particular, or whether other dynamic elements of multimedia displays exert a similar influence on viewing behavior. Future research has the potential to expand on this with other forms of distractors that may compete for visual attention, especially considering that the placeholder in this study was entirely static.

The observed significant effect of the face on visual attention over time was not as clear as it may have initially appeared. While the results do seem to indicate that a greater amount of attention was allotted to the face earlier in the lecture, as stated earlier, visual inspection of the data does not suggest a linear trend over time. Furthermore, post hoc analyses revealed that the observed difference primarily resulted from the third bin, which fell early in the video's runtime and exhibited far more fixations on the face than any other point in the lecture. It is entirely possible that a particularly salient and isolated event may have occurred within this section of the video, causing momentary capture of participants' attention. However, further examination of the lecture video did not reveal any event that may have caused the observed increase in attention allotted to the face during bin three. In any case, a series of follow up studies could help clarify the extent to which this pattern may or may not generalize, in addition to determining whether an effect of habituation really exists in this case.

Conclusions

In conclusion, this study was ultimately unable to support or refute any effect of including video of an instructor’s face on recall for basic knowledge or comprehension in multimedia focused educational settings. It was also unable to determine whether the presentation format of target information may play a role in these potential effects as well. However, despite a number of limitations I was able to highlight a few potential effects on learners stemming from this element’s presence in multimedia instructional displays. Contrary to expectations, the face’s presence seemed to result in lower participant ratings of cognitive load. As well, a clear effect was observed on viewing behavior as a result of the face’s presence. However, several existing issues, notably low sample size, ultimately limit any interpretations of these effects, pending sufficient support from follow up studies. Follow up research with notably higher statistical power would be best suited to address the as of still unclear influence of the face in addition to other potentially attention-grabbing elements of multimedia displays on a range of learning outcomes.

References

Baddeley, A. D., & Hitch, G. (1974). Working memory. In *Psychology of learning and motivation* (Vol. 8, pp. 47-89). Academic Press. https://doi.org/10.1016/S0079-7421(08)60452-1

Cierniak, G., Scheiter, K., & Gerjets, P. (2009). Explaining the split-attention effect: Is the reduction of extraneous cognitive load accompanied by an increase in germane cognitive load? *Computers in Human Behavior*, *25*(2), 315-324. https://doi.org/10.1016/j.chb.2008.12.020

Chen, C.-M., & Wu, C.-H. (2015). Effects of different video lecture types on sustained attention, emotion, cognitive load, and learning performance. *Computers & Education, 80,* 108-121. https://doi.org/10.1016/j.compedu.2014.08.015

Chun, M. M., & Turk-Browne, N. B. (2007). Interactions between attention and memory. *Current Opinion in Neurobiology*, *17*(2), 177-184. https://doi.org/10.1016/j.conb.2007.03.005

Colliot, T., & Jamet, E. (2018). Understanding the effects of a teacher video on learning from a multimedia document: an eye-tracking study. *Educational Technology Research and Development*, *66*(6), 1415-1433. https://doi.org/10.1007/s11423-018-9594-x

Deubel, H., & Schneider, W. X. (1996). Saccade target selection and object recognition: Evidence for a common attentional mechanism. *Vision research*, *36*(12), 1827-1837.

Farroni, T., Johnson, M. H., Menon, E., Zulian, L., Faraguna, D., & Csibra, G. (2005). Newborns' preference for face-relevant stimuli: Effects of contrast polarity. *Proceedings of the National Academy of Sciences of the United States of America*, *102*(47), 17245-17250. https://doi.org/10.1073/pnas.0502205102

Gulliver, S. R., & Ghinea, G. (2004). Stars in their eyes: What eye-tracking reveals about multimedia perceptual quality. *IEEE Transactions on Systems, Man, and Cybernetics-Part A: Systems and Humans*, *34*(4), 472-482. 10.1109/TSMCA.2004.826309

Hoffman, J. E., & Subramaniam, B. (1995). The role of visual attention in saccadic eye movements. *Perception & psychophysics*, *57*(6), 787-795. https://doi.org/10.3758/BF03206794

Homer, B. D., Plass, J. L., & Blake, L. (2008). The effects of video on cognitive load and social presence in multimedia-learning. *Computers in Human Behavior*, *24*(3), 786-797. https://doi.org/10.1016/j.chb.2007.02.009

Ishai, A., Pessoa, L., Bikle, P. C., & Ungerleider, L. G. (2004). Repetition suppression of faces is modulated by emotion. *Proceedings of the National Academy of Sciences of the United States of America*, *101*(26), 9827-9832. https://doi.org/10.1073/pnas.0403559101

Johnson, M. H., Dziurawiec, S., Ellis, H., & Morton, J. (1991). Newborns' preferential tracking of face-like stimuli and its subsequent decline. *Cognition*, *40*(1-2), 1-19. https://doi.org/10.1016/0010-0277(91)90045-6

Joseph, S. (2013). *Measuring cognitive load: A comparison of self-report and physiological methods* [Doctoral dissertation, Arizona State University]. Arizona State University Library Digital Repository. https://repository.asu.edu/attachments/110550/content/SchinkJoseph_asu_0010E_12971.pdf

Just, M. A., & Carpenter, P. A. (1980). A theory of reading: From eye fixations to comprehension. *Psychological Review*, *87*(4), 329-354. https://doi.org/10.1037/0033-295X.87.4.329

Kizilcec, R. F., Papadopoulos, K., & Sritanyaratana, L. (2014, April 26-May 1). *Showing face in video instruction: Effects on information retention, visual attention, and affect* [Conference proceeding]. SIGCHI Conference on Human Factors in Computing Systems, Toronto, ON, Canada. https://doi.org/10.1145/2556288.2557207

Kizilcec, R. F., Bailenson, J. N., & Gomez, C. J. (2015). The instructor's face in video instruction: Evidence from two large-scale field studies. *Journal of Educational Psychology*, *107*(3), 724-739. https://doi.org/10.1037/edu0000013

Kowler, E., Anderson, E., Dosher, B., & Blaser, E. (1995). The role of attention in the programming of saccades. *Vision Research*, *35*(13), 1897-1916.

Leppink, J., Paas, F., Van Gog, T., van Der Vleuten, C. P., & Van Merrienboer, J. J. (2014). Effects of pairs of problems and examples on task performance and different types of cognitive load. *Learning and Instruction*, *30*, 32-42. https://doi.org/10.1016/j.learninstruc.2013.12.001

Mayer, R. E. (Ed.). (2005). *The Cambridge handbook of multimedia learning*. Cambridge University Press. https://doi.org/10.1017/CBO9780511816819

Mayer, R. E., & Fiorella, L. (2014). 12 principles for reducing extraneous processing in multimedia learning: Coherence, signaling, redundancy, spatial contiguity, and temporal contiguity principles. In *The Cambridge handbook of multimedia learning* (Vol. 279). Cambridge University Press.

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist*, *38*(1), 43-52. https://doi.org/10.1207/S15326985EP3801_6

Mayer, R. E., & Moreno, R. E. (2010). Techniques that reduce extraneous cognitive load and manage intrinsic cognitive load during multimedia learning. In *Cognitive load theory* (pp. 131-152). Cambridge University Press.

Molina, A. I., Navarro, Ó., Ortega, M., & Lacruz, M. (2018). Evaluating multimedia learning materials in primary education using eye tracking. *Computer Standards & Interfaces*, *59*, 45-60. https://doi.org/10.1016/j.csi.2018.02.004

Murray, S. O., & Wojciulik, E. (2003). Attention increases neural selectivity in the human lateral occipital complex. *Nature Neuroscience*, *7*(1), 70-74. https://doi.org/10.1038/nn1161

Navarro, O., Molina, A. I., Lacruz, M., & Ortega, M. (2015). Evaluation of multimedia educational materials using eye tracking. *Procedia-Social and Behavioral Sciences*, *197*, 2236-2243. https://doi.org/10.1016/j.sbspro.2015.07.366

Ozcelik, E., Karakus, T., Kursun, E., & Cagiltay, K. (2009). An eye-tracking study of how color coding affects multimedia learning. *Computers & Education*, *53*(2), 445-453. https://doi.org/10.1016/j.compedu.2009.03.002

Peterson, M. S., Kramer, A. F., & Irwin, D. E. (2004). Covert shifts of attention precede involuntary eye movements. *Perception & psychophysics*, *66*(3), 398-405. https://doi.org/10.3758/BF03194888

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, *12*(2), 257-285. https://doi.org/10.1016/0364-0213(88)90023-7

Sweller, J., Van Merrienboer, J. J., & Paas, F. G. (1998). Cognitive architecture and instructional design. *Educational psychology review*, *10*(3), 251-296. https://doi.org/10.1023/A:1022193728205

Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. *Learning and Instruction*, *4*(4), 295-312. https://doi.org/10.1016/0959-4752(94)90003-5

Turatto, M., & Pascucci, D. (2016). Short-term and long-term plasticity in the visual-attention system: Evidence from habituation of attentional capture. *Neurobiology of Learning and Memory*, *130*, 159-169. https://doi.org/10.1016/j.nlm.2016.02.010

Warm, J. S., Parasuraman, R., & Matthews, G. (2008). Vigilance requires hard mental work and is stressful. *Human factors*, *50*(3), 433-441. https://doi.org/10.1518/001872008X312152

Yuan, E. (2021). *Zoom Meetings* (Version 5.8.4) [Computer Software]. Zoom Video Communications. https://zoom.us/

Appendix A

IRB Approval

6/23/22, 12:26 PM Appalachian State University Mail - [External] IRB Notice - 22-0059

Lane Shoffner <shoffnerld@appstate.edu>

[External] IRB Notice - 22-0059

IRB <irb@appstate.edu> Wed, Feb 23, 2022 at 3:06 PM
To: dickinsonca@appstate.edu, shoffnerld@appstate.edu

To: Lane Shoffner
Psychology
CAMPUS EMAIL

From: Dr. Andrew Shanely, IRB Chairperson
Date:
RE: Notice of IRB Approval by Expedited Review (under 45 CFR 46.110)
Agrants #:
Grant Title:

STUDY #: 22-0059
STUDY TITLE: The impact of the presence of an instructor's face in online learning
Submission Type: Initial
Expedited Category: (4) Collection of Data through Noninvasive Procedures Routinely Employed in Clinical Practice,(7) Research on Group Characteristics or Behavior, or Surveys, Interviews, etc.
Approval Date: 2/23/2022

NOTE: All in-person research with human subjects at Appalachian State University is subject to other requirements, laws, regulations, policies, and guidelines of the University and the state of North Carolina. As of August 26, 2021 and until further notice, this includes additional requirements for protections against COVID-19. Please go here for the additional requirements that you must fulfill.

The Institutional Review Board (IRB) approved this study. The IRB found that the research procedures carry no more than minimal risk and meet the expedited category or categories cited above. This approval applies to the life of the study, and you do not need to submit an annual request for renewal. You are required to request approval for any changes you may make to the study in the future, as described below in the section on Modifications and Addendums.

IRB approval is limited to the activities described in the IRB approved materials, and extends to the performance of the described activities in the sites identified in the IRB application. In accordance with this approval, additional IRB findings and approval conditions for the conduct of this research may be listed below.

Study Regulatory and other findings:

This study was reviewed by expedited review at the Chair meeting on 02/23/2022, and was approved with stipulations under expedited categories 4 and 7. The IRB determined that this study involves minimal risk to participants.

All approved documents for this study, including consent forms, can be accessed by logging into IRBIS. Use the following directions to access approved study documents.

1. Log into IRBIS
2. Click "Home" on the top toolbar
3. Click "My Studies" under the heading "All My Studies"
4. Click on the IRB number for the study you wish to access
5. Click on the reference ID for your submission
6. Click "Attachments" on the left-hand side toolbar
7. Click on the appropriate documents you wish to download

Approval Conditions:

Appalachian State University Policies: All individuals engaged in research with human participants are responsible for compliance with the University policies and procedures, and IRB determinations.

https://mail.google.com/mail/u/0/?ik=cde89c9922&view=pt&search=all&permmsgid=msg-f%3A1725585739171983297&simpl=msg-f%3A1725585739… 1/2

Principal Investigator Responsibilities: The PI should review the IRB's list of PI responsibilities. The Principal Investigator (PI), or Faculty Advisor if the PI is a student, is ultimately responsible for ensuring the protection of research participants; conducting sound ethical research that complies with federal regulations, University policy and procedures; and maintaining study records.

Modifications and Addendums: IRB approval must be sought and obtained for any proposed modification or addendum (e.g., a change in procedure, personnel, study location, study instruments) to the IRB approved protocol, and informed consent form before changes may be implemented, unless changes are necessary to eliminate apparent immediate hazards to participants. Changes to eliminate apparent immediate hazards must be reported promptly to the IRB.

Post-Approval Monitoring (PAM): The PI is responsible for providing requested documentation and/or in-person review time of the study by the Office of Research Protections if this study is selected for a Post-Approval Monitoring Review.

Prompt Reporting of Events: Unanticipated Problems involving risks to participants or others; serious or continuing noncompliance with IRB requirements and determinations; and suspension or termination of IRB approval by an external entity, must be promptly reported to the IRB.

Closing a study: When research procedures with human subjects are completed, please log into our system at https://appstate.myresearchonline.org/irb/index_auth.cfm and complete the Request for Closure of IRB review form.

Websites:

1. PI responsibilities: http://researchprotections.appstate.edu/sites/researchprotections.appstate.edu/files/PI%20Responsibilities.pdf

2. IRB forms: http://researchprotections.appstate.edu/human-subjects/irb-forms

required

Appendix B

Basic Knowledge Items

1. Which of the following would be an example of a visual search task?
   a. Trying to find your friend in a crowd based on what their voice sounds like.
   b. Seeing a car in the corner of your vision.
   c. Looking at a picture you haven't seen in a while.
   d. Looking in an office for a computer.
2. If you were searching an image for a shoe, the shoe would be in the image on (a)
   a. target-present trial.
   b. target-absent trial.
   c. both a and b
   d. neither a nor b
3. A set size effect occurs when
   a. someone finds a target on a visual-search trial.
   b. someone does not find a target on a visual-search trial.
   c. increasing the number of display items makes it take longer to find the target on a visual-search trial.
   d. making the target look more like the distractors makes it longer to find the target on a visual-search trial.
4. In a visual search task, response time refers to
   a. How long it takes someone to find the target on a visual-search trial.
   b. How long it takes someone to decide that there is no target in the display on a visual-search trial.
   c. Both a and b
   d. Neither a nor b
5. In a visual search task, a search slope is a measure of
   a. how the response time is affected by the number of trials.
   b. how the number of errors made on a visual-search trial is affected by the number of display items.
   c. how the response time is affected by adding display items on a visual-search trial.
   d. the difference between response times on target-present trials and target-absent trials.
6. Which of these would be an example of searching for a target defined by a feature?
   a. Searching for a T among Ls.
   b. Searching for a green circle among red circles.
   c. Searching for a large red car among large green cars and small red cars.
   d. Searching for a blue X among green Xs and blue Os.
7. Which of these would be an example of searching for a target defined by a conjunction?
   a. Searching for a tall person among short people.
   b. Searching for a square box among round boxes.
   c. Searching for a red "+" sign among green "+" signs and red Xs.
   d. Searching for a vertical line among horizontal lines.

8. According to Feature Integration Theory, features are identified during
    a. Stage 1.
    b. Stage 2.
    c. both stages.
    d. neither stage.
9. According to Feature Integration Theory, conjunctions are identified during
    a. Stage 1.
    b. Stage 2.
    c. both stages.
    d. neither stage.
10. According to Feature Integration Theory, features are identified
    a. in parallel across an entire image.
    b. serially at individual locations.
    c. both.
    d. neither.
11. According to Feature Integration Theory, attention is used at individual object locations during
    a. Stage 1.
    b. Stage 2.
    c. both stages.
    d. neither stage.
12. According to Feature Integration Theory, an illusory conjunction
    a. does not occur as long as all of the features in an image have been identified.
    b. occurs during Stage 1 search.
    c. occurs when there is <u>not</u> enough time for attention to combine all of the features of a given object together.
    d. causes people to perceive combinations of features in the same object correctly.
13. Which theory states that information from Stage 1 of visual search can be used during Stage 2 to allow someone to search among only a subset of items based on those items having a specific feature?
    a. Feature Integration Theory
    b. Guided Search Theory
    c. both theories
    d. neither theory

Appendix C

Comprehension Items

1. Based on typical findings in visual search experiments, searching for a red circle among green circles and blue squares should take less time than searching for a blue square among red circles and blue circles.
2. Based on typical findings in visual search experiments, if you were searching for a large circle among small circles, adding more distractors to the display should not make it take longer to find the target.
3. Based on typical findings in visual search experiments, if you were searching for a red vertical line among red horizontal lines and green vertical lines, adding more distractors to the display should make it take longer to find the target.
4. According to Feature Integration Theory, as long as the set sizes were the same, a search for a green vertical line among green horizontal lines and blue vertical lines should take longer that a search for a blue circle among yellow circles.
5. If someone was given only enough time to complete Stage 1 of a visual search, they should not be able to identify the target if it was a long vertical line among long horizontal lines and short vertical lines.
6. According to Feature Integration Theory, if you were searching for a woman with a blue hat and a green coat among other women wearing hats and coats, you should be able to avoid looking at women wearing red hats and green coats.
7. According to Feature Integration Theory, if you saw a picture very briefly, and in the picture, a man with a red coat was standing next to a woman with a blue coat, you might remember the man having the blue coat and the woman having the red coat.
8. According to Feature Integration Theory, if you were searching for a tall man with a red hat among short men with red hats, adding more short men wearing red hats to the image should make the search take longer.
9. According to Guided Search Theory, if you were searching for a man with a red hat and a blue coat among other men wearing hats and coats, you should be able to avoid looking at men wearing green hats and blue coats.
10. Based on experiments that examined whether context affects where people search for things, you should expect that someone would spend just as much time searching the front of a classroom for the teacher as they would spend searching in any other part of the room.
11. Someone witnesses an accident and later reported that they saw something red, but that they were not sure if it was a red car, a red truck, or a red stop sign. This would suggest that they completed Stage 1 of a visual search of the scene, but not Stage 2.
12. If you were trying to find a toaster on a shelf that contained other kitchen appliances, the shelf would be a source of context for your search.
13. You are shown a picture, and a short time after you see it, someone asks you if you noticed if there was a large green box in the picture. If you said "Yes," this would suggest that you were able to complete both Stage 1 and Stage 2 of a visual search of the picture.

Appendix D

Cognitive Load Measure

1. The instructions and explanations during the lecture were very unclear.

2. The instructions and explanations during the lecture were full of unclear language.

3. The instructions and explanations during the lecture were, in terms of learning, very ineffective.

Vita

Lane Davis Shoffner was born in Jacksonville, North Carolina, to Katherine and David Shoffner. He graduated from Apex High School in June 2015. Soon after, he began studying Psychology at North Carolina State University and was awarded a Bachelor of Arts degree in June 2020. In the fall of 2020, he began working towards a Master of Arts degree in Psychology at Appalachian State University.