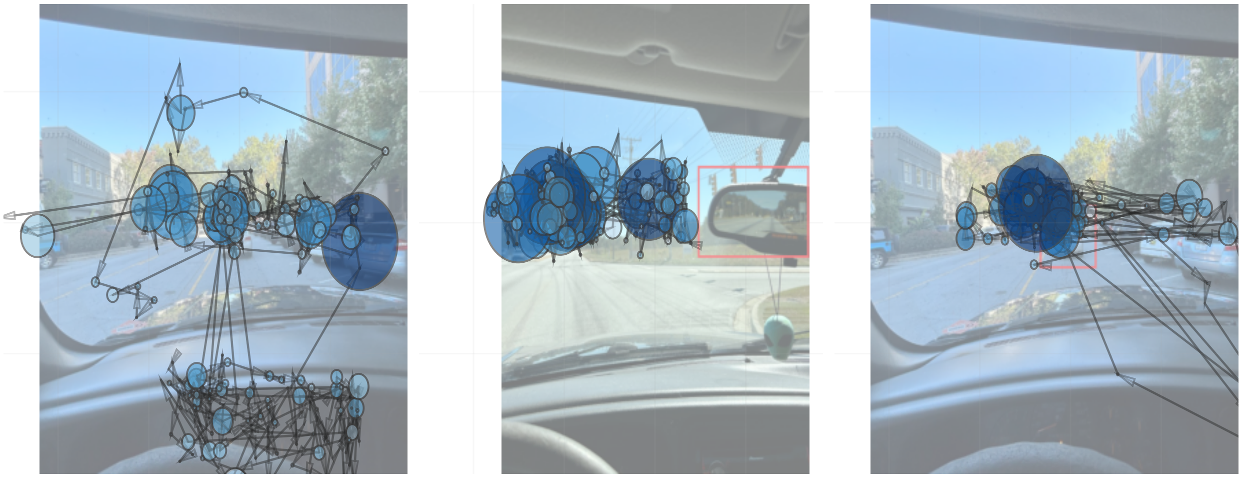
Impact of Cognitive Load on Change Blindness in Driving Scenarios

David Barnett
Clemson University
Clemson, United States
dbarne5@clemson.edu

Jordan Payne
Clemson University
Clemson, United States
jdpayne@clemson.edu



(a) Visual task (b) No task (c) Auditory task

Figure 1: Fixations for participants that were blind to changes within the scene. Areas within the red squares are where the change occurred.

ABSTRACT

Change blindness is a perceptual phenomenon in which someone does not recognize a change that should be obvious. Prior work has focused on the role of visual cues and cognitive distractions on the rate of change blindness. Though there has been some research that tracked eye movements during change blindness, these studies have not been able to determine when a change is noticed. We present a study which further evaluates the effect of cognitive load and also measures eye movements at the moment of change detection. Participants were presented with flickering sets of images depicting typical driving scenarios and tasked with reporting when they notice a change, with some participants additionally assigned a secondary cognitive task. We found that the Visual Task had higher saccade amplitudes, the Auditory Task had higher a fixation duration, and there were no differences in change blindness or perceived cognitive load.

CCS CONCEPTS

• **Human-centered computing** → *Empirical studies in HCI*.

KEYWORDS

eye-tracking, change blindness, driving simulator,

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1 INTRODUCTION

Even the most mundane of tasks requires a person to, mostly subconsciously, filter through a constant stream of perceptual information in order to retrieve relevant cues. This filtering of information leads to a series of phenomena, known as change blindness [9] and inattentional blindness [10], wherein something that should be obvious goes unnoticed by the observer. Change blindness has been found to occur everywhere: movies [13], virtual reality [15], and even in face-to-face interactions [12]. For many routine tasks, this blindness presents little-to-no harm. However, in a high-risk activity such as driving, it can be catastrophic.

Many aspects of change blindness have been studied extensively, including visual disruptions [7, 8], different methods of change [11], interest in the location of change [7], and the effect of cognitive load

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[5]. One area of research which is relatively little explored is eye movements. A majority of previous work has analyzed fixations as a way to determine if a person should have noticed the effect or not [2, 6]. One major shortcoming of this is that they did not know *when* the changes were detected. Thus, they could not determine which behaviors are indicative of detection. By better understanding what is happening when a change is noticed or overlooked, we can begin to work on ways to mitigate change blindness.

We present an experiment that looks to further measure the effect of cognitive load on change blindness in driving scenarios. Participants were asked to scan a series of images as if they were driving while also being tasked with reading a passage, listening to a passage, or nothing else. Participants reported when they detected the change, their confidence in the presence (or lack) of a change, and completed a workload assessment. By tracking their eye movements, we hope to determine behaviors that are closely related to the moment of detection.

1.1 Hypotheses

We hypothesized the following:

(1) *H1*: Participants will have higher cognitive load in the visual task condition than the auditory task or no task conditions.
(2) *H2*: Participants will experience higher levels of change blindness in the visual task condition than the auditory task or no task conditions.
(3) *H3*: Participants who notice a change will have more fixations around the change than participants who do not notice the change.

2 RELATED WORKS

Change blindness is a phenomenon in which a person does not recognize a change in the visual details of a scene, even if the change is obvious [9]. Another "blindness" phenomenon is inattentional blindness, which is one's inability to recognize new objects when their attention is focused elsewhere. The most famous example is a study conducted by Simons and Chabris in which participants tasked with counting the number of passes between players in a ball game were unlikely to notice someone in a gorilla costume walk through the scene [10]. Going forward, we are going to use change blindness to refer to both phenomena. Visual disruption is an obvious aspect of change blindness, as any change that occurs instantly while being focused on is consistently detected [11]. Given that, one of the most common methods to study change blindness, devised by Rensink et al, is the "flicker" paradigm: a sequence of images (an original and a modified) are periodically swapped back and forth with a blank image interspersed between them. In their initial studies they found that participants rarely detected a change on the first cycle and that details of "marginal interest" (i.e. not included in any verbal descriptions of the image) are much less likely to be detected [7]. This flashing disruption does not need to cover the entire view or even the object that is changing. Rensink et al. compared different variations of the disruption image such as different times, colors, and amount of coverage. They found that changes introduced with a reduced disruption (which did not cover the changed area) were detected sooner than those introduced during a full coverage disruption, yet still significantly later than when there was no disruption [8]. Surprisingly, a visual disruption is not entirely necessary. Simons et al. compared a gradual change with no disruption to an instant change with disruption. They found that gradual changes were just as susceptible to change blindness, and even more so for color changes [11]. These findings suggest that visual cues are important for change detection.

There is work that suggests that visual cues are not the only source of change blindness. Simons and Chabris' observed that participants tasked with counting the passes for the team wearing white jerseys or keeping a count for both teams were less likely to notice the unexpected event than participants tasked with counting the team in black jerseys. This suggests that event similarity (such as between a black jersey and black gorilla) and task complexity (such as the increased demand of counting both teams) impacted detection [10]. Perhaps unsurprisingly, people are especially prone to change blindness in situations which are novel, complex, or difficult [4]. One possible reason for this is an increase in cognitive load which takes away from perception and attention. Strayer and Drews measured change blindness in a distracted driving scenario through object recall. They had a few interesting findings: 1) drivers who were talking on a hands-free phone were less likely to recognize objects that appeared during the drive; 2) listening to the radio or an audiobook did not impair object recall; and 3) there was no significant difference between recall accuracy for objects related to the primary task (driving) and unrelated objects [14]. Unsurprisingly, this trend was also found in flight simulations [1, 16]. These findings support that an increase in cognitive load leads to an increase in change blindness.

One possible explanation is that an increase in cognitive load leads to a difference in the scanning of a scene and the fixations on areas of interest. Luckily, there is plenty of work that measured eye movements during change blindness. Li et al. ran a version of Simons and Chabris' gorilla study where they tracked the participants' eye movements. They found that participants who experienced change blindness had a shorter fixation duration, fewer fixation times, shorter first view time, smaller saccades, and a higher blink frequency. They also found that participants with the increased task load shared similar trends: shorter fixation duration, fewer number of fixations, and a shorter first view time [5]. Logically, fixations would seem to be the clearest metric of whether or not a change is detected, but that does not appear to be the case. Two studies which revisited the gorilla study observed multiple participants had fixated on the gorilla, yet did not notice it [2, 6]. Pappas et al. even had two participants who *did* notice the gorilla despite having *zero* fixations on it [6]. Strayer and Drews found in their distracted driving study that the participants talking on a phone were less likely to recall an object, even if they had fixated on it for a similar duration to the non-distracted participants [14].

3 METHODS

3.1 Apparatus

For this study, we used a Gaze Point 3 (GP3) desktop-mounted eye tracker to record eye movement behaviors. The GP3 has a sampling rate of 60 Hz and accuracy of 0.5-1 degrees. Participants were seated 60 cm away from a 23.8" desktop monitor with a resolution of 1920

Figure 2: Top: Original image depicting the driver's point of view while waiting at a busy city intersection. Bottom: Version altered to remove pedestrians from the roadway.

x 1080. A wired keyboard and mouse were used to record detection and responses.

3.2 Stimulus

We selected a range of still image stimuli to represent common scenarios encountered in the driving task from the first-person point of view of the driver. Scenarios captured included waiting at a busy city intersection, waiting at a rural intersection, driving along a city street, and driving along a rural highway. Within these scenarios, we introduced changes salient to the driving task, such as: condition of traffic signals, presence of vehicles in the driver's line of sight and rear-view mirrors, presence of pedestrians in the roadway ahead (see Figure 2), changes in road signage, and presence of alert lights on the vehicle dashboard.

Images were captured with a mobile phone camera placed to record the driver's first-person point of view while driving around the author's local area. After selecting a variety of raw images to represent the desired scenarios, we selectively edited areas of interest in the images with Adobe Photoshop 2024 to generate variations within the scene. This selective editing method was chosen to avoid introducing unwanted artifacts outside the area of interest which may be produced by switching to entirely new stimulus images during trials.

Areas of Interest (AOIs) were created in the publishing application Scribus[1]. Each AOI was an area that is of high importance for the driving task (e.g. road signs, pedestrians, rear-view mirrors, etc.). All images contained 4-5 AOIs. For consistency the AOI that would contain the change was numbered "1" and the vehicle's dashboard was numbered "3".

During trials, subjects were initially exposed to one form of a stimulus image, which was then switched back and forth with an altered version of the same scenario at a regular interval.

Subjects in the task condition were additionally exposed to a reading comprehension passage. Those in the visual distraction condition were exposed to a text passage overlaid in the driving scenario. The text was placed in the bottom of the image, away from the driver's line of sight. Those in the auditory distraction condition were played a Text-To-Speech rendering from the same set of passages. Subjects in both conditions were asked a set of reading comprehension questions following the trial to ensure that they interacted with the stimulus.

Text passages and accompanying reading comprehension questions were generated using OpenAI's[2] GPT3.5 large language model to ensure they were of a length matching our chosen trial duration. These passages were then read by ElevenLabs[3] Text-To-Speech generation model to create the auditory versions.

3.3 Participants

For convenience participants were recruited through the researchers' personal connections. Fifteen people completed the study. Participants were between the ages of 20 and 31 with the average age being 24.4. Eight (53.33%) did not wear corrective lenses, six (40%) wore glasses, and 1 (6.67%) wore contacts. Zero participants reported having a degenerative eye condition (e.g. glaucoma, eye implants, etc.). Participants drive an average of 6.3 days each week, with the minimum number of days being three.

3.4 Procedures

Participants were first taken through the informed consent process and asked to complete a demographic survey. They were then given an explanation of what they would be doing during the experiment. If they were in the task condition, they were also informed that we would be asking questions related to the task. They were given a chance to ask any questions about their participation before proceeding to complete the eye-tracker calibration.

For each trial, they were shown a repeating pair of images representing changes within a typical driving scenario, which flickered back-and-forth. They were tasked with scanning the image presented as if they were driving. If they detected a change, they were instructed to press the space bar to report this. If no change was detected, the trial ended in a timeout after 45 seconds.

After each trial participants were asked to report their confidence in whether or not there was a change in the scene. Participants in the task conditions were also asked a series of questions about the passage they just read/listened to.

Participants completed 5 trials in this manner. After all trials were completed, they were asked to complete the NASA TLX workload assessment [3].

3.5 Experimental Design

We developed a three-factor between-subjects design for our experiment. Every participant saw the same set of image pairs (described in Section 3.2); changes are reversible (addition vs deletion) with little-to-no effect on detection rate [11]. In order to measure the effect of cognitive load, each participant received either no secondary task, an auditory task, or a visual task. The auditory and

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[1] https://www.scribus.net/

[2] https://openai.com/

[3] https://elevenlabs.io/

visual tasks required comprehension of short passages of text. In the auditory task, text was read by a text-to-speech service, and in the visual task was displayed in the stimulus image near the vehicle dashboard. Visual text passages were displayed for the same duration as the auditory task reading.

Following the “flicker” paradigm, [7] a trial either ends after a timeout period or when the participant indicates that they noticed a change. After the trial, we recorded participants’ confidence in their perception of the images and any changes reported. To ensure they were engaging with the secondary task, we asked them to also asked them to answer three questions relating to the passage. To measure their cognitive load, participants finally completed a subjective workload assessment survey [3].

4 RESULTS

4.1 Change Detection

Across all of the trials there were three false positives (i.e. reported a change when there was no change) and three false negatives (i.e. failed to detect a change). Two of the three false negatives had fixations in the AOI that contained the change as seen in Figure 1. Each of these false negatives had a different task condition (i.e. each condition had one false negative). There were two false positives in the Visual Task and one false positive in the Auditory Task. We even had three instances of a change being detected with zero fixations within the changed AOI.

4.2 Eye Tracking Metrics

4.2.1 Saccades. We used a one-way ANOVA for analyzing saccade amplitudes across the three task-conditions. The full results of the ANOVA can be found in Table 1. We found that the Task had a significant effect on saccade amplitudes ($p < 0.05$). Using contrasts we found that there was only a significant difference ($p < 0.05$) between the No Task (mean = 100) and Visual Task (mean = 131) conditions as seen in Figure 3a. There was almost a significant difference between the Visual Task and the Auditory Task ($p = 0.0558$).

Effect	Df	MSE	F	p.value
task	2	247.12	5.77	0.018

Table 1: ANOVA results for saccade amplitude

4.2.2 Fixation Duration. We used a one-way ANOVA for analyzing fixation duration across the three task-conditions. The full results of the ANOVA can be found in Table 2. We found that Task had a significant effect ($p < 0.05$). Using contrasts we found a significant difference between the Visual Task (mean = 0.125) and Auditory Task (mean = 0.205) conditions as seen in Figure 3b.

Effect	Df	MSE	F	p value
task	2	0.00199	4.57	0.033

Table 2: ANOVA results for fixation duration (per task)

We used a one-way ANOVA for analyzing fixation duration across the different stimuli. The full results of the ANOVA can be found in Table 3. We found no significant effect or difference for fixation duration across the different stimulus ($p > 0.05$).

Effect	Df	MSE	F	p value
stimuli	4	0.01	0.83	0.514

Table 3: ANOVA results for fixation duration (per stimuli)

To see if there were a difference in how long the change was fixated for depending on the image we used a one-way ANOVA for analyzing fixation duration, specifically on the AOI that contained the change. The full results of the ANOVA can be found in Table 4. We found no significant effect or differences ($p > 0.05$).

Effect	Df	MSE	F	p value
stimuli	4	0.03	1.42	0.239

Table 4: ANOVA results for fixation duration on the changed AOI (per stimuli)

To see if there was a difference in how long each AOI was fixated on for we used a one-way ANOVA across the different AOIs. The full ANOVA results can be found in Table 5. We found no significant effect or differences ($p > 0.05$).

Effect	Df	MSE	F	p value
AOI	4	0.0003	1.49	0.243

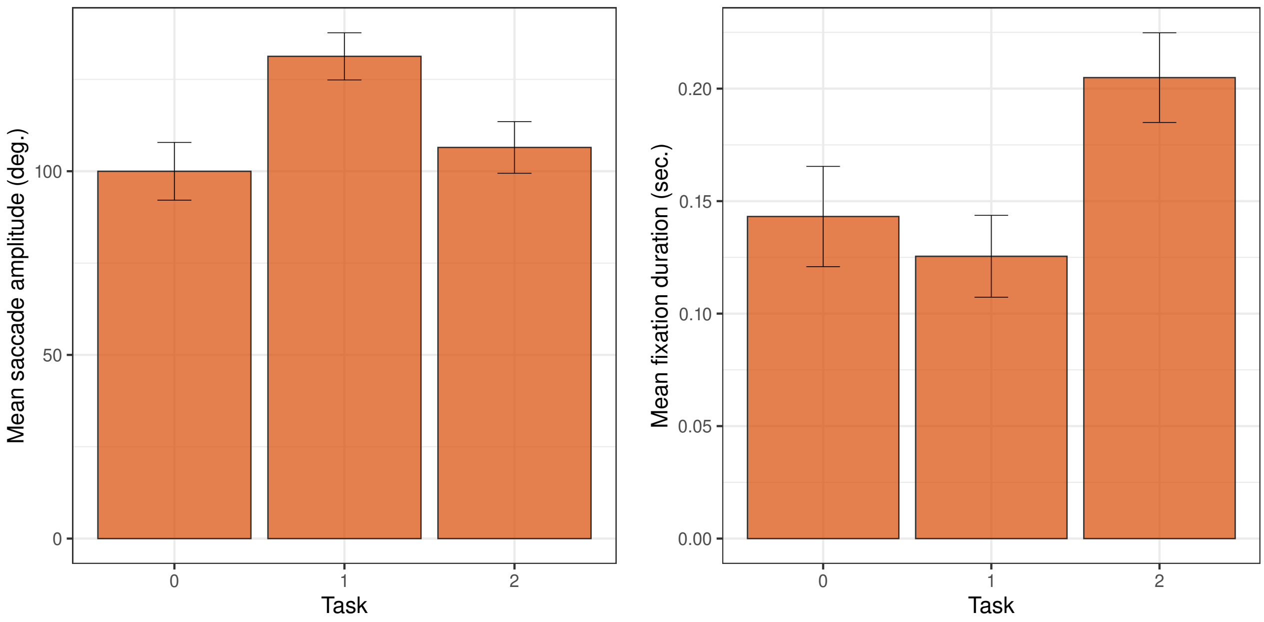
Table 5: ANOVA results for fixation duration on each AOI

4.2.3 Change Fixation Percentage. To determine if how long a participant fixated on the changed AOI could be used to determine we employed a generalized linear mixed model (GLMM) using the lme4 library. We built our model with total fixation duration on the AOI (in m.s.) and the percent of fixations (in total # of fixations / # of fixations on AOI). The results are summarized in Table 6. We found no significant effect ($p > 0.05$).

Fixed Effects	Estimate	Std. Error	p value
Intercept	-0.8147	0.9908	0.411
duration	-0.4785	0.7574	0.528
percentFixated	1.9985	7.6259	0.793

Table 6: Fixed Effects Estimates with Std. Error

We wanted to see if looking at only the fixations near the end of the trial would have a better chance of being a predictor. We built the same model but this time only with the last twenty fixations per trial. The results are summarized in Table 7. We found no significant effect ($p > 0.05$).



(a) Saccade amplitudes per task.

(b) Fixation duration per task

Figure 3: Saccade amplitudes and fixation duration. Task 0 is No Task, Task 1 is Visual Task, Task 2 is Auditory Task. Error bars represent ± 1 SE.

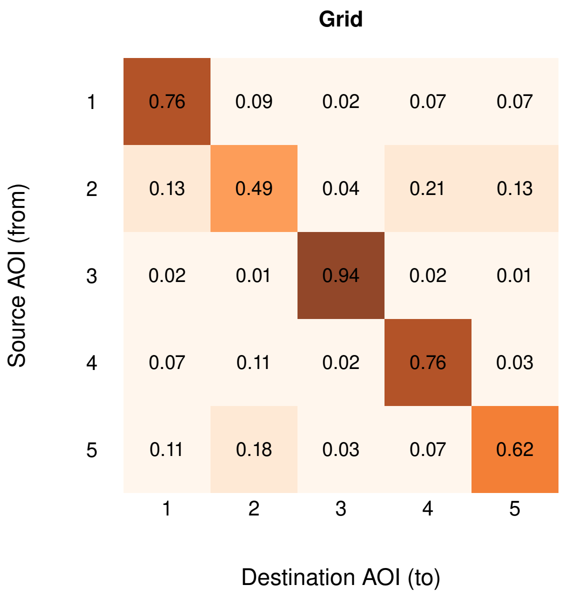


Figure 4: A heat map of fixation spans (i.e. a shift in fixation).

We built the model one last time but with only the last ten fixations. The results are summarized in Table 8. We found no significant effect.

Fixed Effects	Estimate	Std. Error	p value
Intercept	0.4777	1.466	0.745
duration	-1.7356	2.2519	0.441
percentFixated	-2.5853	11.1193	0.816

Table 7: Fixed Effects Estimates with Std. Error (Last 20 Fixations)

Fixed Effects	Estimate	Std. Error	p value
Intercept	5.855	8.010	0.465
duration	1.927	5.483	0.725
percentFixated	-60.922	87.137	0.484

Table 8: Fixed Effects Estimates with Std. Error (Last 10 Fixations)

4.3 Task Duration

To see if the task affected how quickly participants were able to detect a change we performed a one-way ANOVA test analysing task duration across the different tasks. This test only included the trials in which a change was present and detected. The full results of the ANOVA can be found in Table 9. We found no significant effect or differences ($p > 0.05$).

Effect	Df	MSE	F	p value
task	2	81.79	1.19	0.337

Table 9: ANOVA results for trial duration across tasks

4.4 TLX Scores

To see if the task had an affect on the perceived workload we performed a one-way ANOVA test for TLX scores. The full results can be found in Table 10. We found no significant effect or differences ($p > 0.05$). This holds true for the individual measurements as well.

Effect	Df	MSE	F	p value
task	2	145.02	0.197	0.824

Table 10: ANOVA results for TLX scores

5 DISCUSSION

5.1 Change Detection

H2 is not able to be accepted since there was an even spread of missed changes across the different tasks. Similar to what Pappas et al. found, we had participants detect the change without directly fixating on it [6]. A post-hoc examination of their fixations and scanpaths showed that they either fixated *near* the AOI or had saccades *cross* the AOI. This leads us to think that they noticed the change in their peripheral vision. We believe that the two participants who missed a change despite fixating on the changed area were distracted by the secondary task, as the participant that missed a change in the No Task condition never fixated in that area.

5.2 Saccades

These results were expected. It follows that participants in the Visual Task would have higher saccade amplitudes as the participants had to occasionally look back to the vehicle's dashboard to read the passage.

5.3 Fixation Duration

Surprisingly, the Visual Task condition had the lowest average fixation duration. We think this is because those participants had to take shorter glances at the scene in order to balance reading the passage and scanning the driving scene. Even though all of our AOIs were important to the task, it is unsurprising that there was no difference in the time spent fixating between them based on the findings from Strayer and Drew [14]. One possible explanation for why the Auditory Task had the highest fixation duration is they took more time to scan the scene while splitting their attention with the audio.

5.4 Change Fixation Percentage

We are unable to accept *H3* since neither fixation duration nor the number of fixations on a change AOI were able to predict if a participant would detect the change. Even though the last 10/20 fixations were also not able to predict if a participant would have detected the change, a post-hoc look at the last ten fixations does show a trend to be looking at the change. However, we found there was too much variance in the fixation duration for it to be an accurate predictive measure.

5.5 Task Duration

Given that there was no difference in the accuracy of task completion it gives to reason and is expected that the time to complete the task was the same.

5.6 TLX Scores

Unfortunately, we also have to reject *H1* as we found no significant difference in the TLX scores. We believe that this is because the secondary task was relatively simple in comparison to scanning the scene. The complexity of the primary task overshadowed the simpler secondary task, resulting in minimal effect.

6 CONCLUSION

In this study we attempted to further understand the eye movement patterns that are present in distracted driving scenarios. We found that participants in the Visual Task had higher saccade amplitudes, participants in the Auditory Task had a longer fixation duration, and unfortunately we did not find much in the way to support using workload or eye movement patterns as a means of determining whether a change should be detected or not.

Our study was limited by several factors, to wit: a limited recruiting pool led to a small participant population; our eye tracking hardware proved unreliable for darker-skinned participants, further limiting and biasing the participant pool; our use of static driving scenes only crudely simulated the driving task; and finally, we were able to conduct only a small number of trials. A surprising finding was the lack of confidence reported by several participants who identified scene changes. Further insight could have been gained by asking participants to identify the nature of any changes detected, allowing us to distinguish between correctly identified changes and any possible erroneous reports.

Future work in this area of inquiry would benefit from a larger participant pool and a higher number of trials. The high variance in our collected metrics coupled with small sample size hindered our ability to draw conclusions from our data. Additionally, as fixations alone proved to be an unreliable indicator of change detection, future studies may benefit from alternative measures. Potential indicators to explore may involve saccade amplitude and direction, such as if participants' saccades regularly traversed over the change area prior to detection.

A more complex task may better distinguish the cognitive load between participants in different task and control conditions. Task conditions involving working memory challenges, random visual distractions, or other paradigms may provide a more reliably impactful cognitive load to participants.

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Dr Duchowski. Caffeine addiction. My ADHD medication. Gorilla.

REFERENCES

[1] Evan T. Dill and Steven D. Young. 2015. Analysis of Eye-Tracking Data with Regards to the Complexity of Flight Deck Information Automation and Management - Inattentional Blindness, System State Awareness, and EFB Usage. In *15th AIAA Aviation Technology, Integration, and Operations Conference*. American Institute of Aeronautics and Astronautics. https://doi.org/10.2514/6.2015-2901

[2] Helene Gelderblom and Leanne Menge. 2018. The Invisible Gorilla Revisited: Using Eye Tracking to Investigate Inattentional Blindness in Interface Design. In *Proceedings of the 2018 International Conference on Advanced Visual Interfaces (AVI '18)*. Association for Computing Machinery, New York, NY, USA, 1–9. https://doi.org/10.1145/3206505.3206550

[3] Sandra G. Hart and Lowell E. Staveland. 1988. Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research. In *Advances in Psychology*, Peter A. Hancock and Najmedin Meshkati (Eds.). Human Mental Workload, Vol. 52. North-Holland, 139–183. https://doi.org/10.1016/S0166-4115(08)62386-9

[4] Melinda S. Jensen, Richard Yao, Whitney N. Street, and Daniel J. Simons. 2011. Change Blindness and Inattentional Blindness. *WIREs Cognitive Science* 2, 5 (2011), 529–546. https://doi.org/10.1002/wcs.130

[5] Zhimin Li, Zexu Li, and Fan Li. 2023. Visual Attention Analytics for Individual Perception Differences and Task Load-Induced Inattentional Blindness. In *Cross-Cultural Design (Lecture Notes in Computer Science)*, Pei-Luen Patrick Rau (Ed.). Springer Nature Switzerland, Cham, 71–83. https://doi.org/10.1007/978-3-031-35939-2_6

[6] Jennifer M. Pappas, Stephanie R. Fishel, Jason D. Moss, Jacob M. Hicks, and Teri D. Leech. 2005. An Eye-Tracking Approach to Inattentional Blindness. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* 49, 17 (2005), 1658–1662. https://doi.org/10.1177/154193120504901734

[7] Ronald A. Rensink, J. Kevin O'Regan, and James J. Clark. 1997. To See or Not to See: The Need for Attention to Perceive Changes in Scenes. *Psychological Science* 8, 5 (1997), 368–373. https://doi.org/10.1111/j.1467-9280.1997.tb00427.x

[8] Ronald A. Rensink, J. Kevin O'Regan, and James J. Clark. 2000. On the Failure to Detect Changes in Scenes Across Brief Interruptions. *Visual Cognition* (2000). https://doi.org/10.1080/135062800394720

[9] Daniel J. Simons. 2000. Current Approaches to Change Blindness. *Visual Cognition* 7, 1-3 (2000), 1–15. https://doi.org/10.1080/135062800394658

[10] Daniel J Simons and Christopher F Chabris. 1999. Gorillas in Our Midst: Sustained Inattentional Blindness for Dynamic Events. *Perception* 28, 9 (1999), 1059–1074. https://doi.org/10.1068/p281059

[11] Daniel J Simons, Steven L Franconeri, and Rebecca L Reimer. 2000. Change Blindness in the Absence of a Visual Disruption. *Perception* 29, 10 (2000), 1143–1154. https://doi.org/10.1068/p3104

[12] Daniel J. Simons and Daniel T. Levin. 1998. Failure to Detect Changes to People during a Real-World Interaction. *Psychonomic Bulletin & Review* 5, 4 (1998), 644–649. https://doi.org/10.3758/BF03208840

[13] Tim J. Smith and John M. Henderson. 2008. Edit Blindness: The Relationship between Attention and Global Change Blindness in Dynamic Scenes. *Journal of Eye Movement Research* 2, 2 (2008). https://doi.org/10.16910/jemr.2.2.6

[14] David L. Strayer and Frank A. Drews. 2007. Cell-Phone–Induced Driver Distraction. *Current Directions in Psychological Science* 16, 3 (2007), 128–131. https://doi.org/10.1111/j.1467-8721.2007.00489.x

[15] Evan A. Suma, Seth Clark, David Krum, Samantha Finkelstein, Mark Bolas, and Zachary Warte. 2011. Leveraging Change Blindness for Redirection in Virtual Environments. In *2011 IEEE Virtual Reality Conference*. 159–166. https://doi.org/10.1109/VR.2011.5759455

[16] Alaska White and David O'Hare. 2022. In Plane Sight: Inattentional Blindness Affects Visual Detection of External Targets in Simulated Flight. *Applied Ergonomics* 98 (2022), 103578. https://doi.org/10.1016/j.apergo.2021.103578

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