# Now You See Me: Automation Aids Impact on Subsequent Search Misses Within A Driving Context

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**Project Summary**

**Overview**

The current proposed study will investigate the impact automated visual search cues have on subsequent search misses (SSM) within a driving context. Specifically, does the use of a direct visual search cue vs an indirect visual search cue reduce the likelihood of missing a second, low salience hazard, within a static driving scene? Additionally, this study will investigate if manipulating the automated system's reliability such that it fails to detect a hazard at a sufficient rate would decrease performance in dual hazard detection more than if no automation was used at all. An amalgamation of the Drive Aware Task (DAT) and an SSM task will be used to present participants with a static traffic scene from the perspective of the driver. Participants will need to identify if there are zero, one, or two hazards present in the scene that are impeding the ability to travel safely in the indicated direction. A direct or indirect search cue will assist the participant with an accuracy rate of 90% in the first experiment and 60% in the second. In situations where the automation is perceived to have "failed," it will simply not provide any cue. With this, the current proposal will expand the literature on subsequent search misses which has been a well-documented case in radiology but less so in a driving context.

**Intellectual Merit**

This study will advance the knowledge needed within the automotive industry as they strive to make automation a more standard component in everyday vehicles. The research team is uniquely equipped to handle this study having done previous work with the DAT for the purpose of training attentional functions within older adults. Additionally, a committee member overseeing the research is one of the investigators that first validated the SSM effect within a driving context. In terms of novelty, previous research has been done investigating automated visual search cues with regard to single-target detection performance in a luggage screening task however there has yet to be much work applying this to a reduction in SSM in dual-target tasks let alone doing so in a driving context (Rieger et al., 2021).

**Broader Impacts**

The intent of this research would be to publish its findings and widely distribute them to the scientific and automotive industries. The results of this research would help inform best practices in implementing automation, specifically those relating to a heads-up display (HUD) and augmented reality (AR) overlays. Should the research demonstrate a reduction in SSM, its implementation in future vehicles would reduce accident rates. There is a limited amount of screen real estate to be used in driving HUDs and research on what is most impactful will be vital in making informed decisions that benefit drivers as well as promote safety. Additionally, this research could be a stepping stone in promoting trust in automated vehicles. If implementing hazard detection software demonstrates to drivers that the automated vehicle is aware of its surroundings, drivers may have more trust in that system. Future work would be needed to validate that idea.

**Project Description**

Visual search is an important component in daily living, allowing us to do something as simple as finding our phones on a crowded desk or something more critical such as avoiding a pedestrian crossing the street while operating a vehicle. Failures in processing visual information while driving have been shown to increase driver errors and accident rates (Baldock et al., 2007; Ball et al., 1998; Hoffman et al., 2005) and are easily compromised through task-irrelevant events such as texting (Strayer and Johnston, 2001; Strayer et al., 2003) talking on the phone (McCarley et al., 2004), or engaging with in-vehicle systems (Heck and Carlos, 2008). However, recent work has demonstrated that even when a driver is focusing on task-relevant stimuli if there are multiple concurrent targets this too can lead to compromised visual processing (Sall and Feng, 2019). This phenomenon is currently known as Subsequent Search Misses (SSM) and was originally documented as a problem in radiology (Smith, 1967; Tuddenham, 1962). SSM is defined as a decrease in detection rates for a subsequent target when an initial target is found within the same scene (Adamo et al., 2021). Accounting for around one-third of radiological reading errors (Anbari and West, 1997), it was initially theorized to occur due to radiologists becoming "satisfied" with their visual search after finding a single target and would thus terminate any further investigation for a second target (Smith 1967; Tuddenham, 1962). This gave rise to SSM's original name of "satisfaction of search" (SOS). However, despite this theory being the prevalent explanation for over 30 years, it was never empirically validated until recently (Adamo et al., 2015a; Stothart and Brockmole, 2019). Now, researchers recognize that becoming "satisfied" with a search is likely only part of the story behind this phenomenon and other explanations justifying that the name "Satisfaction of Search" should be changed to a description of the phenomenon (i.e., Subsequent Search Misses) rather than an account of a theory behind its occurrence.

With the transition away from SOS to SSMs, two new theories have been proposed to explain the phenomenon in addition to the satisfaction hypothesis. Perceptual Set theory postulates that people may miss a second stimulus because observers are biased in looking for targets that are similar to the initially detected one and thus are more likely to miss dissimilar targets (Berbaum et al. 1990). Briggs et al. (2015) found evidence for the Perceptual Set theory when examining 100 possible targets. SSM occurred most in the condition where targets were dissimilar compared to the condition where targets were similar. The largest decrease in SSM was when both targets were identical. Despite this evidence, SSM still occurred even when targets were identical suggesting that Perceptual Set theory is not enough to fully explain all SSM errors.

Resource Depletion theory suggests that detecting the first target reduces the amount of attentional and working memory resources making fewer available to detect a secondary target (Berbaum et al 1991). Cain and Mitroff (2013) provided evidence for this theory in their study where they removed the first target once it was detected. They found that participants were more likely to find the second target as compared to conditions where the first target remained in the display. This suggests that the presence of the first target increases the working memory load making it harder to detect a second stimulus. Once the first target was removed upon a participant finding it some of the working memory load was alleviated making detecting the second target easier. It should be noted the SSM didn't disappear entirely after removing the first target. Adamo et al. (2015b) also corroborated this theory finding that when a large number of distractors occurred around a second target that increased SSM due to the higher attentional resource demand to process the information. Additionally, Adamo et al. (2013) found that when a second target was fixated on within ~200-500 ms of finding the first target a participant was more likely to miss it. This is evidence of attentional blink occurring indicating that some SSM errors can be attributed to the attentional processing of the first target. Finally, Stothart et al. (2017) found that when all elements of a display moved compared to the same image being stationary it increased the occurrence of SSM further.

With these causes in mind, a potential solution to reducing SSM may be in automated visual search aids. Depending on the visual search aid used, it could help alleviate the need for participants to continue searching after they have become “satisfied” with finding all the targets. It could allow dissimilar targets to share some perceptual features and increase their likelihood of detection. It could also alleviate the amount of attentional resources needed to find additional targets by reducing what information needs to be processed to correctly identify a target. Visual search aids have also been shown to be effective tools in single-target detection (Chavaillaz et al., 2018; Goh et al., 2005; Liechty, 2019). However, not all visual search aids are created equal. Current research has investigated which types of search aids provide the most benefit with the least tradeoff in the event of automation failure. For example, Chavaillaz et al. (2018) found that for single target identification in a luggage screening task, a direct visual search cue (the system indicated the exact location of the target) had better detection performance as compared to an indirect cue (the system indicated a general target presence without an exact location) and a control group who received no search aid. Goh et al. (2005) found automated visual search may even provide a type of training such that even when the system is later removed participants still performed better on detecting single targets during a luggage screening task when using direct cues. This effect was not found for indirect cues.

Despite visual search cues' success with single target identification, there have been mixed results when applying them specifically to dual target scenarios. Research by Berbaum et al. (2007) found that when applying a computer-aided diagnosis (CAD) to radiographs subjects were still just as likely to experience SSM errors as without. However, in this study, the CAD was only applied to the additional nodules. Meaning only one target was ever highlighted, not both. Perhaps results may have been different if the first and second nodules were highlighted. On the other hand, Schartz et al. (2013) found that when they include CAD (and only highlighted the second target) in the detection of additional pulmonary nodules it did reduce SSM errors though it did not alleviate them completely.

Automated visual search cues may not be the only solution to reducing SSM. Visual search aids are a type of input aid to help identify a target but not provide any guidance on actions to take. In contrast, output aids are designed to support a user's decision making or response selection by specifically outlining the function that needs to be performed (Weigman et al., 2006). Output aids fall into a higher "degree of automation" (DOA) (Manzey et al., 2012) since it skips the need to find, process, and then make a decision about a target. A higher DOA is theorized to lead to greater performance from an operator as compared to a lower one however the trade-off is that as automation fails the higher DOA will have a greater negative impact as compared to a lower one (Onnasch et al., 2013). With this in mind, output aids could alert users to the appropriate action such as telling a driver to stop alleviating the need to even notice the second target that would have been missed. However, results on higher DOA leading to better performance have been mixed. Lichety (2019) found during a luggage screening task that an input aid was of greater benefit to an operator's asymptotic performance as compared to an output aid. Conversely, Crocoll and Court (1990) did find that operators had shorter reaction times using an output aid for an aircraft identification task as compared to an input aid.

Despite these being potential solutions, the reliability of the system must always be considered. Faulty automation, whether an input aid or an output aid, may do more harm than good. Specific to input aids, found that when automation failed indirect cues lead participants to search significantly longer for a target than the no cue group during target present and target absent trials. Interestingly direct cues during automation failure had no difference in reaction times as compared to the no cue group (Chavaillaz et al., 2018; Goh et al., 2005). In regard to output aids, a theorized trade off in the higher DOA is that as automation fails the higher DOA will have a greater negative impact as compared to a lower one (Onnasch et al., 2013). If a driver is only told to stop the car in response to multiple hazards in the event of the automation's failure the driver is not left in the loop potentially leading to more accidents. However, more research is needed to confirm this as yet again Lichety (2019) found that there was no greater detriment to performance from the output aid once automation had failed as compared to the input aid.
With all this in mind, the current study will investigate how different input aids (direct cue vs indirect cue) influence SSM errors as the goal of output aids would be to bypass the operator even needing to notice and process two targets in the first place.

Considering potential solutions for SSMs is especially relevant within a driving context as the ability to visually scan one's environment is vital for noticing safety information such as pedestrians or cyclists (Chapman and Underwood, 1998; Chapman et al., 2002) and traffic information (Ho et al., 2001; McPhee et al., 2004). Additionally, drivers must do so while tracking multiple objects over time, in cluttered environments and need to respond in a timely manner, all of which were discussed previously as factors that increase SSM errors (Adamo et al. 2015; Fleck et al., 2010; Stothart et al., 2017). To further support this notion Sall and Feng

(2019) recently validated that SSM errors do in fact occur within a driving context. Due to this, the current research incorporates a similar methodology to Sall and Feng using static driving images to verify if visual search aids help reduce SSM errors.

Static images of driving scenarios allow for more granular control in ensuring that dual hazard trials actually contain both hazards which can be harder to validate in moving displays. Additionally, static images allow for a larger number of highly controlled trials to be presented in a shorter amount of time and several previous research has validated their use in examining driver perceptual and attentional processing (Caird et al., 2005; Feng et al., 2015, 2018; Wetton et al., 2010). Continued support for the use of static images is that most work with this paradigm has also used static images due to coming from radiology and luggage screening tasks (e.g., Adamo et al., 2013; Cain et al., 2013; Fleck et al., 2010). It is recognized that to fully understand the nuisances in hazard perception static images may only be a stepping stone. The ability for drivers to recognize but also anticipate the trajectory of a potential threat may change how SSM errors occur.

**Objectives**

The objective of this current study is to investigate the impact automated visual search aids have in reducing SSM for drivers using static images. Previous research is mixed on the success automated search aids can have in reducing SSM and the proposed study will advance the field's understanding in worthwhile measures to decrease accidents caused by compromised visual information processing.

**Rationale and Scope**

SSM errors are a prevalent issue in visual search paradigms originally found in the reading of radiographs. Despite being heavily researched in the field for the past 50 years it is only recently that SSM has been investigated in other contexts such as luggage screening or driving (Smith, 1967; Sall and Feng, 2019). Cognitive psychology has come up with a few theories as to what impacts the frequency of SSM such as satisfaction of search, perceptual set theory, or resource depletion theory but few studies have investigated specific ways it can be mitigated. This is especially pertinent in a driving context were accurately identifying, and anticipating hazards are vital components to reducing traffic accidents (Baldock et al., 2007; Ball et al., 1998; Hoffman et al., 2005). With this in mind, success has been found in increasing rates at which operators identify single targets by using automation aids. Specifically, input aids whose function is to help reduce attentional resources by highlighting either directly or indirectly potential areas of interest in cueing the target location (Chavaillaz et al., 2019). Few studies up to this point have investigated if input aids could be a successful way to reduce SSMs and the ones that have done so see mixed results and only within the field of radiology (Berbaum et al., 2007; Schartz et al., 2013). Research is needed to see how automated visual search aids interact with the SSM paradigm within a driving context. Doing so may provide valuable information on worthwhile technologies to implement in future vehicles as work is already being done to see how Augmented Reality and Heads-Up Displays can be developed to integrate with vehicles (Chua et al., 2016; Fremont et al., 2020; Gerber et al., 2019; Tippey et al., 2017).

**Research Management Plan**

**Experiment 1** will recruit a total of 40 individuals participating via Amazon's Mechanical Turk (MTurk) and the SONA recruitment pool at North Carolina State University. This sample size is estimated using a power analysis assuming a small effect size of Cohen's d = 0.2 and an error probability of .05. In order to be included participants must be 18 years of age or older, have normal or corrected to normal vision and a valid driver's license. Participants via Mturk will be compensated at $7.25/hr while those through SONA will receive 1 research credit per half hour of participation.

There will be two experimental conditions one that receives visual search cues and another that is unaided. The task for the proposed study is a modified version of that devised by Sall and Feng (2019) which utilizes a hybridization of the Drive Aware Task (DAT; Feng et al., 2015, 2018) and an SSM task (Fleck et al., 2010). In each trial, a 100ms fixation cross will appear on the screen followed by 1000ms of an arrow indicating the direction of travel (straight, left, or right). A simulated traffic scenario will then be presented following the arrow for 1000ms. This scene will contain either zero, one, or two hazards that the participants will be instructed they need to pay attention to. Trials that only contain one hazard will be of either low or high salience depending on the trial. Dual hazard conditions will always contain one high salience hazard and one low salience hazard. This breakdown of high and low salience hazards provides the most conservative measure of the SSM effect (Biggs and Mitroff, 2014; Cain et al., 2011; Cain and Mitroff, 2013; Clark et al., 2014; Fleck et al., 2010). If participants notice two targets both should be reported in the order those targets were noticed (following procedures outlined in Sall and Feng 2019, and Fleck et al., 2010) Where this task deviates from those previous is in the use of direct and indirect visual search cues for the aided experimental condition. In this first experiment, a direct or indirect cue will appear on the screen indicating a hazard at a rate of 90% accuracy. A direct cue will provide a circle highlight around the target in the single hazard condition and around both targets in the dual hazard condition. The indirect cue will highlight the border around the whole traffic scene in both single and dual hazard conditions. The unaided condition will receive no such cues but otherwise, the task is unchanged. Examples of the task as well as the cue types can be seen in Fig. 1 and Fig. 2 respectively.

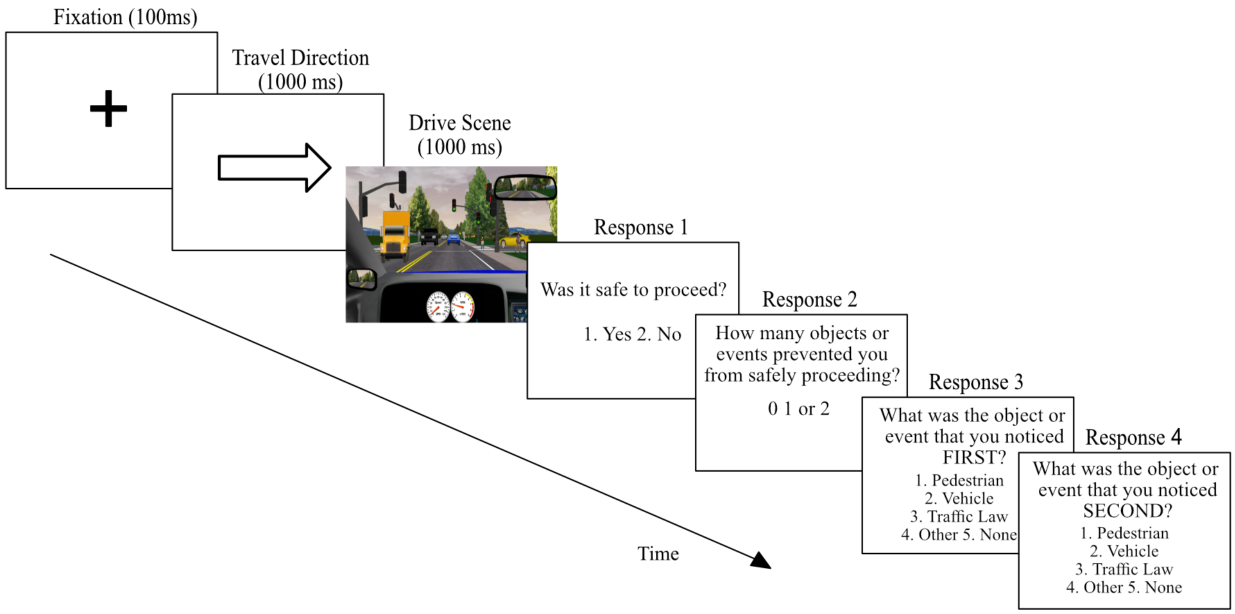


*Figure 1.* An example trial of the dual hazard perception task.

*Figure 2*. An example of a direct cue (left) and an indirect cue (right) for a dual hazard trial in the travel direction is right but there is a car crash ahead and a pedestrian crossing

At the end of each trial, participants will be presented with four questions. First, was it safe to proceed in the indicated travel direction (dictated by the arrow) yes or no. Second, how many objects or events directly impacted safe travel in the desired direction, either zero, one, or two. Third, what object or event specifically did they notice prevented safe travel with the fourth question being the same as the third for more than one notices hazard. Participants will be instructed that when answering the last two questions that the order in which they noticed the targets is important and should be consistent with how they report them. So in an instance where a participant notices a cyclist as a hazard and then a vehicle their response for question 3 would be “cyclist” followed by “vehicle” for question 4. In trials where no targets are present participants will still be asked to respond to all four questions however they will be told to indicate no hazards. In doing so we will allow participants to self correct accidentally selected options within the first two probes. Previous research has demonstrated that allowing for self correction like this can decrease false-alarm rate during low prevalence visual search tasks (Fleck and Mitroff, 2007; Kunar et al., 2017)

The task will be created using the STISIM driving simulator (STISIM Drive® 3, Systems Technology, Inc.) by initiating a drive in the simulator and capturing a screen recording of the drive. The screen recordings will then be reviewed and appropriate scenes will be selected. The selected scene will be edited using Affinity Photo (a graphics manipulation software similar to Photoshop) to exclude any extraneous hazards (people, vehicles, stop signs, traffic lights) and to create the direct or indirect cues. Each scene will be designed to either have the targets present or absent. Target absent scenes will contain several distractor items (i.e., items that would not prevent safe travel in the intended direction), while task-present scenes will include hazards (1 or 2 depending on the trial) that would have directly prevented safe travel in the intended direction. The task will then be presented on Qualtrics. Prior to starting the task, participants will be randomly assigned to a condition and complete a consent form followed by a standard demographics survey assessing age, gender, education, and level of driving experience. Participants will then complete practice trials to familiarize themselves with the task. Accuracy feedback will be given during the practice but ends during the actual experimental trials. Participants will then complete the experimental trials. 16% will be dual-target trials, 16% single low-salience targets, 20% single high-salience target trials and 48% no target. This distribution was selected based on prior research (Fleck et al., 2010; Sall and Feng, 2019). All participant data will be collected anonymously with no way to connect the participant's responses to their identity and stored in a password protected secure university provided google drive.

To analyze the influence of the visual search cues on the rate of subsequent search misses a Repeated Measures (RM) ANOVA will be conducted with salience type (high/low), the number of targets (1 or 2), and visual search cue type (direct/indirect) as within-subject factors and unaided search vs aided search as between-subjects factors for the dependent variable of target identification accuracy.

**Experiment 2** will expand upon the findings of experiment 1 in order to test how the reliability of the system impacts accuracy in detecting a second target. A novel aspect of experiment 1 is investigating how automation can reduce the occurrence of the SSM effect. The second proposed experiment will expand this even further by investigating what happens when automation does a poor job of accurately identifying potential hazards. In this way, we can verify if performance in identifying a second target is worse than if no automation had been introduced in the first place. Together these studies will provide a comprehensive review of the influence automation can have on the SSM effect within the context of driving.

A total of 40 participants will be recruited for the experiment. The methods of recruitment and compensation will be the same as outlined in the previous experiment. The task, procedure, and group breakdown will follow those detailed in experiment 1 with the only difference being a direct or indirect cue will appear on the screen indicating a hazard at a rate of 60% accuracy rather than at 90% accuracy. All images will be readjusted using Affinity Photo to meet the 60% accuracy criteria.

**Future Research** should investigate how various types of visual search aids impact the SSM effect. For instance, the cues used in these experiments fall under what would be considered input aids such that they support early stages of human information processing (sensation and perception) however operators still need to perform aspects of decision making and action selection (Parasuraman et al. 2000). The direct or indirect cues alert a potential hazard but don't necessarily tell the operator what to do about it. Conversely, output aids support an operator's decision making or response selection by specifically outlining or even performing the function that needs to be done. This can be seen in the lane keeping assistance technology where when a deviation from lane parameters is detected by the vehicle it auto corrects itself moving back within the constraints of the lane (Horowitz & Timmons, 2016). With this in mind, an output aid may increase accuracy and response time to detecting a secondary hazard reducing the SMM effect greater than that of an input aid. Conversely, output aids tend to leave operators out of the loop leading to decreased performance when the system fails as compared to input aids as demonstrated in a luggage screening task (Liechty 2019). Future work should be done to consider these approaches and tradeoffs within a driving context and specifically for the SSM effect.

Additionally, this proposed research is specifically investing when automation fails to detect a hazard and thus does not provide any cues. This is different from an automation failure that still provides a visual search cue but is incorrect in highlighting the appropriate hazard. For example, if the hazard that was preventing safe travel was a child crossing the street for a right hand turn but the system highlighted a cyclist crossing the road on the left. Future work should consider how this type of automation failure may impact the prevalence of the SSM effect differently as compared to when the system fails to cue a hazard in general. One potentially requires active suppression from the participant to ignore the incorrect cue of the automation system while the other requires the participant to maintain awareness with a lack of cues. This would be an important consideration when designing a visual search aid system to better program automation.

**Contributions to Education**

The current proposed research contributes to education in two primary ways. First, the current study will be aided by undergraduate research assistants eager to gain experience and understanding of the processes involved with conducting experiments. They will be heavily integrated at every stage of the research process from concept generation to analysis and conclusions. Through this, the undergraduates will gain valuable knowledge in conducting their own personal research allowing the students to apply lessons learned for their future academic and professional careers. Second, this research is primarily being investigated by a doctoral student, under the guidance of faculty members. All aspects are designed, conducted, and analyzed by the primary researcher. Due to this, the current study will help further a Ph.D. student's path toward graduation. There will not be any specific outreach component included with this proposal.

**Intellectual Merit and Broader Impacts**

This study will advance the knowledge needed within the automotive industry as they strive to make automation a more standard component in everyday vehicles. The research team is uniquely equipped to handle this study having done previous work using the DAT for training attentional function within older adults. Additionally, a committee member overseeing the research is one of the investigators that first validated the SSM effect within a driving context. Outside of the principal investigator's own institution, other work in SSM has been conducted by Duke University allowing for a collaboration opportunity with others within the research triangle.

The intent of this research would ultimately be the publication of its findings in journals such as psychological science or accident analysis prevention where previous work of this nature has also been published. In this way, it may be widely distributed to the scientific and automotive industries in places where it has the most success in reaching the target audience. The results of this research would help inform best practices in implementing automation, specifically those relating to heads-up displays and augmented reality overlays. Work in constructing these devices is already underway (Chua et al., 2016; Fremont et al., 2020; Gerber et al., 2019; Tippey et al., 2017) thus should the research demonstrate a reduction in SSM its implementation in future vehicles would reduce accident rates. There is a limited amount of screen real estate to be used in driving HUDs and research on what is most impactful will be vital in making informed decisions that benefit drivers as well as promote safety. Additionally, this research could be a stepping stone in promoting trust in automated vehicles. Highly reliable automated systems have been shown to increase trust in the system an operator interacts with (Chavaillaz et al., 2017) as compared to less reliable systems. Thus, this work has the potential to advocate for better automation aids when implementing them in new vehicle technologies so that drivers have increased buy-in to use the, Additionally, previous research has shown that system transparency can increase trust toward said system (Oliveria et al., 2020). Thus, if implementing hazard detection software demonstrates to drivers that the automated vehicle is aware of what it may need to respond to, drivers may have more trust in that system, though continued work would need to validate that idea.

**Biographical Sketch**

**Aaron D. Crowson**

## (a) Professional Preparation

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| Winona State University | Winona, MN | Psychology | B.A. | 2016 |
| North Carolina State University | Raleigh, NC | Human Factors & Applied Cognition | Ph.D. | 2023 |

## (b) Publications & Presentations

Ferrell, T., **Crowson, A.,** Mayhorn, C. B. (2022). How we perceive and trust advice from virtual humans: The influence of voice quality. *Proceedings of the Human Factors and Ergonomics Society 66th Annual Meeting.*

Richardson, K., McLaughlin, A. C., McDonald, M., **Crowson, A.** (2021). The effects of diminished reality on the detection of and response to notifications. *Proceedings of the Human Factors and Ergonomics Society 65th Annual Meeting.*

Yuan, J., **Crowson, A.**, Richardson G., Feng, J. (2021). Drive aware training: A computerized training program for older drivers' detection of road hazards. *Traffic Injury Prevention*.

Lawson, P., Pearson, C. J., **Crowson, A**., Mayhorn, C. B. (2020). Email phishing: Role of persuasion principle and personality on identification accuracy. Contribution to signal detection response pattern. *Applied Ergonomics*.

**Crowson, A.**, Pugh, Z., Wilkinson, M., Mayhorn, C.B. (2020). Who is in the room? Notifications for intrusion while in virtual reality. *Proceedings of the Human Factors and Ergonomics Society 64th Annual Meeting.*

**Crowson, A.**, Wilkinson, M., Wagner., R. B., Wilson, R., Gillan, D., (2020). Emotion task analysis: Proposing a tool for the assessment of emotional components in a task. *Proceedings of the Human Factors and Ergonomics Society 64th Annual Meeting.*

Wilkinson, M., Pugh, Z., **Crowson, A**., Feng, J. (2019). Manipulating arousal in virtual reality: A feasibility study using slow motion experience. *Proceedings of the Human Factors and Ergonomics Society 63rd Annual Meeting.*

Lawson, P., **Crowson, A**., Mayhorn, C.B. (2018). Baiting the hook: Exploring the interaction of personality and persuasion tactics in email phishing attacks. *Proceedings of the 20th World Congress of the International Ergonomics Association.*

**Crowson, A**., Colligan, R., Matteson, E., Davis, J., Crowson, C (2017). Explanatory style in patients with rheumatoid arthritis: an unrecognized predictor of mortality. *Journal of Rheumatology.*

Altum, J., **Crowson, A**., Sargent, A., Casselman, R. Parental factors, rejection, and emotional dysregulation: a mediation study. *Poster* presentation at the Minnesota Psychological Association meeting, Minneapolis, MN, April 2016.

Sargent, A. **Crowson, A**., Altum, J. Casselman, R. Parental rejection and emotional dysregulation: examining the roles of self-esteem and insecure adult attachment. *Poster* presentation at the Minnesota Psychological Association meeting, Minneapolis, MN, April 2016.

**(c) Synergistic Activities**

1. User Experience Researcher/Designer: Aaron is currently working full time with Joint Special Operation Command. Prior and current projects include research development, implementation, analysis, and application design for internally funded projects whose goals are to provide software solutions and modernization for the command.

2. Professional activities: Aaron has served as webmaster for North Carolina State University's graduate association for students in psychology (GrASP) from 2018-2021 and is a continued member. Aaron is also a member of the Human Factors and Ergonomics Society student chapter as well as a member of the Triangle User Experience Professionals Association.

3. Teaching: At North Carolina State University, Aaron has Abnormal Psychology (PSY 470) for three semesters, which gives an overview of the history of psychology and covers topics of mental health/disorders. Aaron has also taught Cognitive Processes (PSY 420) for three semesters conveying to students the importance of considering the mind in day-to-day life as well as covering topics such as memory, decision making, attention, problem solving, etc.

**Proposed Budget**

The current proposed study will be conducted entirely online using Qualtrics and distributed via Amazon's Mechanical Turk (MTurk) participants pool with a criterion of 95% approval rating and have completed at least 100 surveys prior. Participants will be compensated at a rate of $7.25/hr in line with minimum wage. The study is expected to take 30 minutes thus for 80 total participants for experiments 1 and 2 it will cost an estimated $290. To supplement MTruk, the survey will be distributed to North Carolina State University students through the online recruitment system (SONA) where students receive compensation in the form of research credits needed to pass introduction to psychology courses thus no cost is incurred through that process. The study plans to hire two research assistants part time for 10 hours a week to help build the stimulus, run the pilot study, collect data, and analyze results. The research assistants will be compensated at $12/hr and are estimated to be needed from January 1st 2023 until Dec 31st 2023 costing a total of $6,240. The total proposed budget for this research for both the research assistant help and participant compensation is $6,530.

**Facilities, equipment, and other resources**

The current proposed study will use static driving images that participants will use to identify hazards. These will be collected from the STISIM Drive3 simulator by screen recording simulated drives to gather appropriate environmental backgrounds. The images will then need to be edited using either Photoshop or Affinity Designer on a computer with high enough specifications to handle the work. Once the images include appropriate hazards and visual search cues, the stimulus will be uploaded to Qualtrics for the experiments and distributed to participants online. The data will be collected and stored in a shared university google drive and analyzed using R. No other equipment or resources are needed to develop, conduct, or analyze this proposed study.

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