

Research Statement

The theme of my research can be broken down into its core component; investigating ways to reduce hazard perception errors whether through the use of advancing artificial intelligence (AI) technologies or training. My current work includes finding the best ways to alert immersed virtual reality (VR) users to changes happening in their real world environments, testing the efficacy awareness training has on detecting road hazards with older adult drivers, and finally seeing how the use of automated visual search aids may be beneficial in reducing subsequent search misses among drivers.

Notifications for Intrusions While in Virtual Reality

My first area of research was concerned with how to alert and orient head-mounted display (HMD) VR users to real world hazards, such as another person entering their play area, without the user confusing those notifications for elements in VR. Previous research in this space has provided design recommendations for such alerts that work well in non-video game VR environments but would otherwise overlap with typical game notification systems (i.e. using footsteps to indicate a person has entered the room would overlap with a common way to indicate an enemy within the game). With this in mind, notifications were designed to alert users to a change in their real world environment as well as orient those users to the external hazard while remaining in VR. To investigate which modality would be best for these tasks the notifications took place across auditory only (A), visual only (V), and auditory + visual (AV) modalities combined. A survey was developed and given before the experiment to assess how participants' perceptions of a notification's efficacy would align with the actual performance. A simple VR video game was created with the help of colleagues to have a controlled environment for testing.

Results of the survey portion of the study indicated that participants perceived the auditory modality as more effective regardless of whether it was for alerting or orienting the user. In corroboration with the survey, when notifications were purely visual participants were more likely to miss them altogether suggesting a potential inattentive blindness. It could also be that the constraints of the game were more visual in nature allowing for auditory stimuli to be more useful as explained by multiple resource theory. When participants did perceive a hazard notification, visual notifications were also the slowest in reaction time responding to the alert. These results suggested that without an auditory component for alerting users explicitly that another person has entered the room, participants are not as aware a change has taken place. In contrast to the survey, the visual modality had the fastest dwell time compared to the auditory modality for orienting users to the hazard. This pattern suggests that the visual modality conveys the direction of an intrusion better than the auditory. This work was presented and published as a proceedings paper at the 64th Annual HFES Conference (Crowson, Pugh, Wilkinson, & Mayhorn, 2020).

Drive Aware Training and Older Adult Driver's Detection of Road Hazards

The second area of research I was involved with investigated the efficacy of the Drive Aware training program to improve older adult drivers' ability to detect road hazards and increase their performance on a simulated drive. Current validated cognitive training includes in-person on-road sessions or the use of driving simulators. These processes can be expensive to implement or ill-fitted for those who experience simulator sickness. As such, the goal of this research was to create a computer-based training program to help increase rates of hazard detection that is easier to implement and more cost effective. To do so, we adapted the Drive Awareness Task (DAT) to provide feedback on correct or incorrect hazard detection and compared this group's accuracy to the accuracy of matched pairs within a passive training group and a no-contact control group.

The adapted DAT training group did in fact have significantly improved accuracy in hazard detection as compared to the pre-test. In contrast, those in the passive group that only watched a video of the training had marginal but not yet significant results. The no-contact control had no increase in accuracy from pre to post-test. Additionally, those in the active training group had improved simulated driving performance (fewer errors) which was not seen in the other groups. In conclusion, this study demonstrated that the computerized Drive Aware training could improve older drivers' hazard perception skills and potentially driving outcomes. These findings suggest that hazard perception skills are possible to improve through training but also have the potential to be transferred to driving-related outcomes. This work was published as a journal article *Traffic Injury Prevention* (Yuan, Crowson, Richardson, Feng, 2021)

Automated Visual Search Aids and Subsequent Search Misses

The work within extended reality (XR) and driving hazard perception made me wonder if there was a way to intersect these two research areas to increase hazard detection rates in driving using the advantages of continually emerging AI technologies. A phenomenon recently validated within a driving context is subsequent search misses (SSM), which postulates that there is a decrease in detection rates for a subsequent target when an initial target is found within the same scene. A potential solution to reducing SSM for drivers may be in automated visual search aids. My future work is planning to focus on this question. I also would like to investigate how the reliability of the automated system may actually become a greater determinant. Potentially due to a driver's over-reliance or by taking away additional valuable mental resources than if no aided system was put in place. This work would contribute to the growing research that is currently looking into how to best implement augmented reality and heads-up displays within newer vehicles and is a great intersection between my previous two areas of research.