ABSTRACT

The U.S. construction sector ranks second in fatal occupational injuries in 2021 among other sectors. Although many research efforts have been conducted for decades to improve safety at construction job sites, fatal occupational injuries did not reduce to the desired level. Specifically, previous studies argued that still more than 70% of hazards often remained unrecognized by construction workers even after receiving safety training. In addition to the enforced safety regulations, the Organizational Safety and Health Administrator (OSHA) has mandated safety training for construction workers to train them regarding potential hazards and risks at job sites while mainly focusing on a general overview of the hazards and preventive measures. However, in the last decade, it was extensively argued that workers' low performance in hazard identification may not only be related to their hazard knowledge and more related to the cognitive processing of information to identify and perceive the cues in a construction environment to remain situationally aware (i.e., cognitive failures). Therefore, there is a critical need to identify a new approach for customizing training construction workers to address the lack of knowledge and cognitive failures that workers may experience. Thus, this thesis aimed to develop multi-modal personalized safety training to reduce human errors and construction workers' unsafe behaviors by improving their hazard identification abilities. To do so, workers' hazard identification skills were assessed through subjective and objective non-invasive psychophysiological metrics (e.g., visual attention, emotional responses) in an immersive 360° virtual environment and customized training for them. The effectiveness of the developed personalized training was tested and validated, and the findings indicate considerable improvements in subjects' hazard identification performance after receiving this customized training.

This thesis contributed to the body of knowledge and practice by proposing an advanced personalized safety training framework that automatically translates workers' subjective test results and objective psychophysiological responses into customized training recommendations. The outcomes lay the necessary foundations for building tailored training regimens to improve construction worker safety using comprehensive cognitive analysis and effective intervention strategies. The developed personalized safety training will not only improve workers' hazard

identification performance but will also save construction companies time delays and cost overruns by eliminating the need for a repetitive retraining of the workforce.

Thesis Title: Multimodal Personalized Safety Traininig to improve construction workers hazard identification performance

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