THEORY OF AUTOMATICITY IN CONSTRUCTION

by

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ABSTRACT

Automaticity, an essential attribute of skill, is developed when a task is executed repeatedly with minimal attention and can have both good (e.g., productivity, skill acquisitions) and bad (e.g., accident involvement) implications on workers' performance. However, the implications of automaticity in construction are unknown despite their significance. To address this knowledge gap, this research aimed to examine methods that are indicative of the development of automaticity on construction sites and its implications on construction safety and productivity. The objectives of the dissertation include: 1) examining the development of automaticity during the repetitive execution of a primary task of roofing construction and a concurrent secondary task (a computer-generated audio-spatial processing task) to measure attentional resources; 2) using eye-tracking metrics to distinguish between automatic and nonautomatic subjects and determine the significant factors contributing to the odds of automatic behavior; 3) determining which personal characteristics (such as personality traits and mindfulness dimensions) better explain the variability in the attention of workers while developing automaticity. To achieve this objective, 28 subjects were recruited to take part in a longitudinal study involving a total of 22 repetitive sessions of a simulated roofing task. The task involved the installation of 17 pieces of 25 ft2 shingles on a low-sloped roof model that was 4 ft wide, 6 ft long, and 3 ft high for one month in a laboratory. The collected data was analyzed using multiple statistical and data mining techniques such as repeated measures analysis of variance (RM-ANOVA), pairwise comparisons, principal component analysis (PCA), support vector machine (SVM), binary logistic regression (BLR), relative weight analyses (RWA), and advanced bootstrapping techniques to address the research questions. First, the findings showed that as the experiment progressed, there were significant improvements in the mean automatic performance measures such as the mean primary task duration, mean primary task accuracy, and mean secondary task score over the repeated measurements (p-value < 0.05). These findings were used to demonstrate that automaticity develops during repetitive construction activities. This is because these automatic performance measures provide an index for assessing feature-based changes that are synonymous with automaticity development. Second, this study successfully used supervised machine learning methods including SVM to classify subjects (with an accuracy of 76.8%) based on their eye-tracking data into automatic and nonautomatic states. Also, BLR was used to estimate the probability of exhibiting automaticity based on eye-tracking metrics and ascertain the variables significantly contributing to it. Eye-tracking variables collected towards safety harness and anchor, hammer, and work area AOIs were found to be significant predictors ($p < 0.05$) of the probability of exhibiting automatic behavior. Third, the results revealed that higher levels of agreeableness significantly impact increased levels of change in attention to productivity-related cues during automatic behavior. Additionally, higher levels of nonreactivity to inner experience significantly reduce the changes in attention to safety-related AOI while developing automaticity. The findings of this study provide metrics to assess training effectiveness. The findings of this study will also aid in improving human-AI teaming since the AI will be better able to understand the cognitive state of its human counterpart and can more precisely adapt to him or her. The findings of this study may be used by project managers to gain a better understanding of the impact that individual worker characteristics have on automatic behaviors and, therefore, performance on job sites. In conclusion, this research is proof of the concept that eye movement metrics are predictive indicators of feature-based automaticity development.