Abstract

Increasing automation in aviation has an impact on the role of the air traffic controller (ATCO). New support tools and changing work environments require the monitoring of multiple display systems and the detection of potential system failures. In training these requirements, eye tracking holds great promise for gaining a deeper insight into the perceptual and cognitive processes of trainees. Since there are hardly any studies on the effects of training on gaze behavior in air traffic control (ATC), the aim of the present work was to evaluate the applicability of the method in this domain. Three experimental studies were conducted with novices with no ATC experience, and it was investigated whether training effects are reflected not only in common performance measures such as accuracy and speed, but also in gaze parameters such as relative fixation count, time to first fixation and normalized entropy. It was further examined to what extent future monitoring tasks can be trained and what kind of additional factors play a role in this. An adapted version of the abstract monitoring test (MonT) was used to investigate the research questions. Each study consisted of three test blocks in which air traffic had to be monitored in up to three automatically controlled airspaces. In a first study (N = 60), the adapted simulation environment was evaluated and initial results on the effect of practice were collected. Improvements occurred primarily at the beginning of the test and were reflected in a more accurate failure detection performance and a more strategic gaze behavior. The traffic load, and therefore the amount of information to be monitored, played a decisive role in the results. In another, second study (N = 139), the influence of different interventions for directing attention was investigated. Highlighting relevant information (bottom-up approach) moderated the effect of practice significantly more than an attention strategy (top-down approach) or no intervention (control). Relevant information was viewed more frequently and failures were anticipated more easily - even when a manual control task was added. Repeating the test after an average of four months showed little to no significant changes in performance and gaze behavior (N = 19). Overall, with an average detection rate of 83%, the results indicate that monitoring can be trained to a high level in the future. However, the design of the system, the difficulty of the task and the prior knowledge of the individual must always be considered. Since it was shown that gaze behavior predicted performance, the recording of eye movements in future ATC training is encouraged. In this context, current developments in the use of artificial intelligence promise to facilitate the classification of individual scan patterns and promote adaptive training.

Keywords: air traffic control, eye tracking, training, monitoring, automation, aviation