Effects of Spatial Cueing Errors on Trust and Performance

Juliana Goh, Douglas. A Wiegmann, Poornima Madhavan and Jason Wong

There is an increased need to ensure that the task of luggage screening is performed well because of its implications for public safety. Luggage screening is a visual inspection task that is inherently difficult; there are few occurrences of banned objects in luggage and such objects may be intentionally hidden or highly similar to other items and therefore not immediately obvious to the luggage screener. The use of an automated aid in this task may therefore improve performance and spatial cueing (circling of a target) is an example of automation that may be implemented in a luggage-screening task.

The use of spatial cues in visual inspection tasks have been shown to offer performance benefits. In studies of military target detection (e.g. Yeh and Wickens, 2001; Yeh, Wickens and Seagull, 1999) and radiology (Krupinski, Nodine & Kundel, 1993), results have shown that spatial cues guide attention to the most critical areas of the visual scene, reducing the impact of distractors and therefore helping target detection performance. However, costs are incurred when the cues are invalid because attention is captured almost exclusively by these cues. Errors in spatial cueing occur when the spatial cue (1) cues a non-target when the target is not present (false alarm) (2) does not cue a target when it is present (miss) or (3) cues a non-target even when a target is present in the visual scene (miscue). Wickens and colleagues (Yeh & Wickens, 1999; Wickens, Canejo & Gempler, 1999) describe the costs that may result from these errors. Type T (trust) costs are incurred when observers overtrust the cue and indicates a target is present although the cue is invalid and highlights a non-target. Type A (attention) costs are incurred when attention is drawn to a cued region resulting in participants missing target(s) elsewhere in the visual scene.

It is important to consider these errors in spatial cueing and their associated costs because failures in automation affect trust in the system, which in turn affect the extent to which users rely on it. Extant literature has not considered whether the two types of misses (regular misses and miscues) can differentially affect the trust participants have in the automation. It is conceivable that miscues may result in lower levels of trust in the automation than regular misses because miscues could cause observers to miss the target by “trapping” their attention in one region of the visual scene. The present study, therefore, seeks to examine the impact of errors in spatial cueing, namely misses and miscues, on trust and reliance within a luggage-screening task.

METHOD

Forty-five students from the University of Illinois participated in the experiment. Participants were required to detect the presence of a knife in X-ray images of luggage. The knife was present in 20% of the 100 images. Aided-miss participants performed the task with a spatial cue that committed regular misses, aided-miscue participants used a spatial cue that committed miscues and control participants performed the task unaided. The spatial cue had a hit rate of 0.66 and false alarm rate of 0.28. Participants viewed each image for 3 seconds, then indicated whether to “Stop the bag” or “Pass the bag”. Feedback was then provided. Participants in the aided groups were asked to indicate their level of trust in the aid and perceptions of how

well the aid performed while control participants indicated their level of trust in their own abilities and perceptions of how well they performed manually.

RESULTS

Performance. Aided performance was better than unaided performance as measured by hit rate (Aided-miss - Hit: M=.777, SD=.11; Aided-miscue – Hit: M=.75, SD=.107; Control – M=.56, SD=.121), ANOVA: F(2, 44)=16.428, p<.001. A comparison of misses was made between the aided and control groups. For the aided groups, the conditional probability P(miss|automation miss) was compared to P(miss) for the control group as an indicator of whether participants in the Aided-miscue group were more susceptible to missing the target because of the invalid spatial cue. An ANOVA [F(2,44)=1.951, p=.155] suggests a trend showing Aided-miscue participants (M=.557, SD=.219) being more likely to miss the target when the automation miscued compared to Aided-miss (M=.462, SD=.163) and control participants (M=.44, SD=.121).

Trust. Participants in the Aided-miscue group (M=46.73%, SD=28.44) tended to trust the aid less than participants in the Aided-miss group (M=54.47%, SD=28.92) and these were less than the level of trust control participants had in the own abilities (M=65%, SD=24.98). These differences were, however, not statistically reliable as indicated by a one-way ANOVA, p>.05.

Estimates of Performance. Focusing on estimates of how often misses were committed, the results indicate that participants in the Aided-miscue group (M=.353, SD=.23) tended to have a larger estimate of how often the aid missed targets compared to participants in the Aided-miss group (M=.24, SD=.172). Control participants had similar estimates to the Aided-miscue group (M=.363, SD=.18). An ANOVA revealed these differences to be not statistically significant, p=.172.

CONCLUSIONS

The results indicate that participants who used an aid that missed targets through miscuing not only missed more targets, but also tended to trust the aid less and tended to think that the aid made more misses compared to participants who used an aid that missed targets through not cueing. While this did not lead to underreliance in the aid after 100 trials (since hit rates were above the hit rate of the automation), one could argue that continued exposure to a spatial cueing system that miscues could lead to underreliance in the longer term.