Conference Agenda

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Session Overview

Session

Symposium 4.08: Psychology at work considering technological developments - examples from airport security screening

Time: **Tuesday, 06/Sept/2022: 4:00pm - 5:30pm**

Location: **AND-4-02**

Size: 32

Presentations

Psychology at work considering technological developments - examples from airport security screening

Chair(s): **Adrian Schwaninger** (University of Applied Sciences and Arts Northwestern Switzerland)

Abstract:

Automation, artificial intelligence, and other technological developments create new opportunities but also new challenges and risks for employees, organizations, and work. Psychology plays an important role for understanding interactions between humans and technology, and how to improve them for optimizing human well-being and overall system performance. Baggage screening at airports is an interesting field for research due to several technological developments in recent years. In this symposium, we present five studies that illustrate how psychological research can make important contributions for understanding and improving human-machine interaction, visual search, and work design considering new technological

developments. One study examines the application of artificial intelligence for automated prohibited item detection as an operator support system by investigating automation response bias and automation reliability in baggage screening with a student sample. A second paper addresses the use of automation as a decision support system for detecting explosives in passenger bags with highly realistic images and real-world airport security officers (screeners). A third contribution discusses the benefits of new 3D imaging based on computer tomography, again with highly realistic images and real screeners. The fourth presentation examines effects of time on task using a field study over four months at an international airport. The fifth paper investigates human performance depending on different work environments by comparing data over two years from remote baggage screening in a quiet work environment to data from more distracting and noisy baggage screening at airport security checkpoints. Implications for theory and practice (including airport security regulations) will be addressed.

Summary:

This symposium illustrates how psychological research can make important contributions for human-machine interaction and work design considering technological developments by presenting five studies in the context of airport security screening.

Presentations of the Symposium

Influence of automation bias and automation reliability in baggage screening

Alain Chavaillaz[1], Adrian Schwaninger[2], Stefan Michel[2], Jürgen Sauer[1]
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In recent years, automated detection of prohibited articles in X-ray images of passenger bags has become available using artificial intelligence. This study investigated how automation response bias (ARB) and system reliability of such systems, important parameters in automation design, influenced critical variables of the human-machine system such as performance, automation use and trust. A 3x2 experimental design was used, with ARB settings and automation reliability as between-subject variables. ARB was manipulated at three levels: miss-prone (more misses than false alarms), 'false alarm'-prone (more false alarms than misses) and neutral (same amount of both error types), while automation reliability was manipulated at two levels: high versus low. A computer-based simulation of an X-ray baggage screening task was used to test 96 student participants. As expected, a high-reliability system led to better detection performance than a low-reliability system, but ARB showed no impact. Furthermore, lower trust ratings, reduced reliance on the system but increased compliance were observed under miss-prone automation compared to 'false alarm'-prone automation. The neutral condition showed more often similar effect patterns to the miss-prone condition than to the 'false alarm'-prone condition. Altogether, these results suggest that ARB settings should be taken into consideration in automation design to improve automation use.

The occurrence of miscues by decision support systems: A study with airport security screeners supported by automated explosives detection systems for cabin baggage screening

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Decision support systems (DSS) are one type of automation that supports human information acquisition to improve decision-making. At airport security checkpoints, explosives detection systems for cabin baggage (EDSCB) as a DSS support airport security operators (screeners) by highlighting areas in X-ray images that might contain explosives. However, EDSCB are not perfectly reliable. They sometimes make mistakes, resulting in three types of failures: misses, false alarms, or miscues. When the EDSCB displays a miscue, screeners experience a false alarm, but another prohibited item (e.g., a gun or knife) is located elsewhere in the bag. The screeners could miss the other prohibited article because they were too focused on the EDSCB alarm. Misses and false alarms of DSS are well investigated, but hardly any study addressed the effect of miscues on detection performance. This study examined the impact of the different failure types. We tested 115 professional screeners with realistic X-ray images of cabin baggage. They were randomly assigned to three different experimental conditions: Miscue prone, false alarm prone, or multiple failures. Screeners had to detect bombs, guns, and knives and were supported by EDSCB. Results showed that screeners missed more knives when EDSCB miscues occurred than when EDSCB did not alarm. Also, miscues misled screeners into thinking that X-ray images contain bombs while missing other prohibited articles. We conclude that miscues of DSS harm operators' detection performance during a visual inspection task and that miscues are a problem to be considered when working with EDSCB.

3D imaging for hold baggage screening: The relevance of rotation and slicing functions

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At European airports, 2D multi-view imaging technology is still a widely used technology for security screening of bags that are transported in the hold of airplanes (hold baggage). However, advanced 3D computed tomography (CT) imaging technology is increasingly being used, becoming the state-of-the-art in hold baggage screening (HBS). Static 2D multi-view images offer a better image quality than 3D CT images, whereas advanced 3D CT systems offer the possibility to rotate a bag around 360 degrees (rotation function) and to cut through a bag slice per slice (slicing function). This study investigated if these 3D-specific functions can compensate the poorer image quality of 3D CT images. For this purpose, 70 2D-experienced HBS screeners were tested in a realistic computer-based 3D CT image interpretation task. The screeners were split into two experimental groups. One group performed the task without being able to rotate or slice the bag, while the other group had the option of using the 3D-specific functions rotation and slicing. As expected, screeners performed better in detecting bombs when they could use rotation and slicing. We found no difference in efficiency (false alarm rate and reaction time) between the two experimental groups. These results confirm the benefits of 3D imaging for hold baggage screening compared to 2D imaging.

Field study regarding the work duration for the visual inspection of X-ray images of passenger baggage

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At airport security checkpoints, security officers (screeners) visually inspect X-ray images of passenger baggage to prevent that prohibited items (bombs, guns, knives, and other threats) can be brought into an aircraft. EU regulation limits continuously reviewing X-ray images to 20 minutes. Therefore, screeners must change to another position at the checkpoint after 20 minutes of X-ray screening. Due to advancing technology and other operational requirements, the question arises whether screeners can inspect X-ray images for longer periods of time and how this affects their performance and well-being. In a field study at a European airport, two groups of screeners inspected X-ray images of carry-on baggage over a four-month period. The experimental group was instructed to inspect X-ray images for up to 60 minutes but to stop if they felt tired. The control group screened for 20 minutes according to EU regulation. Results showed that screeners of the experimental group inspected X-ray images for longer than 20 minutes without a significant decline of performance. There was, however, an interaction between screening duration and workload: Whereas no decrease in hit rate was observed when the workload was low or average, the detection of prohibited articles decreased when workload was high. Preferred and actual screening durations varied strongly between individuals. Overall, the results suggest that the current regulation on restricting the screening duration to 20 minutes should be reconsidered and further investigated in practice.

X-ray baggage screening performance in different work environments – a field study comparing remote screening and screening at the lane

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Security officers at airports visually inspect X-ray images of passenger baggage and decide whether they are harmless or not. Maintaining a work environment that fosters high performance is crucial not only for security reasons but also regarding checkpoint efficiency. In the current study, we focus on two work settings that are widely used in cabin baggage screening: In one setting, X-ray images are inspected at the lane, the other is a remote room that is separated from the checkpoint. The settings are expected to differ with regard to different stressors (i.e., environmental noise and socially induced stress) that might affect screening performance. We therefore examined whether the two work settings are associated with differences in performance by analyzing data gathered over two years at a European airport that has both work settings in place. Results show that remote screening was associated with increased detection of prohibited articles. As expected, screening performance decreased with increasing workload (number of processed bags per minute) and time on task in both work settings. Practical implications for optimizing screener performance are discussed.