Visual Cognition

Airport security relies heavily on the performance of screeners. In fact, the best x-ray equipment is of limited use if the human decision maker is not trained well enough. Consider the images depicted below. The image on the left is a state of the art x-ray image of a regular passenger bag. The image in the middle contains the same bag with a gun and a knife. The bomb in the image on the right is even more difficult to detect, although it contains more than enough explosive to remove a passenger aircraft from the sky.
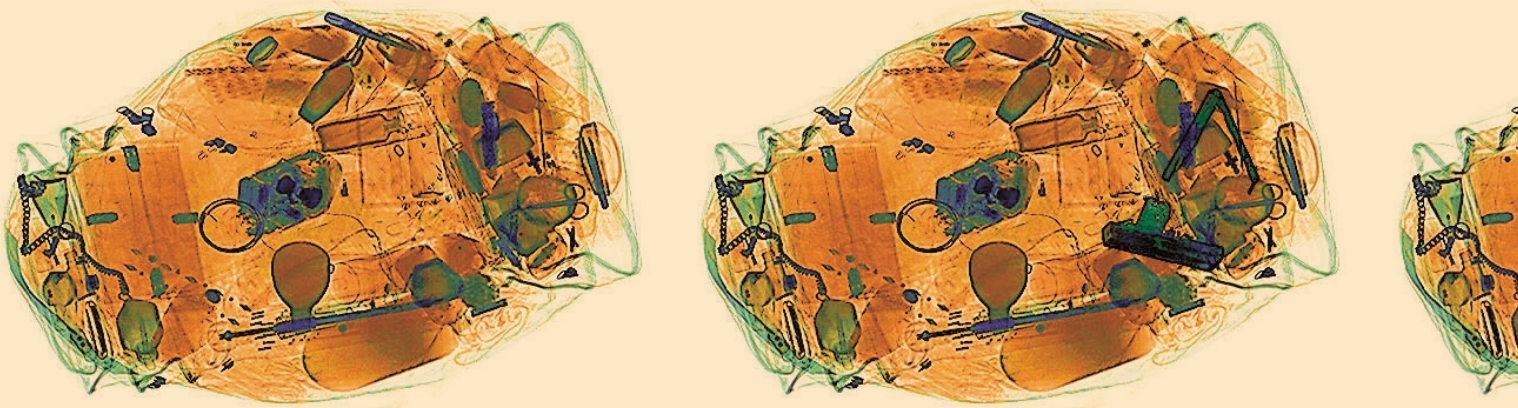

Fig. 1: Threats are difficult to detect. Left: harmless passenger bag. Middle: same bag with a gun and a knife. Right: same bag with a bomb.

Visual cognition is the scientific investigation of how we process visual information. This involves perceptual mechanisms, detection, attention, object recognition, categorisation and knowledge-based vision. Since June 2000 researchers from the University of Zurich have conducted several studies at Zurich Airport in which different aspects of visual cognition in airport security were investigated. These studies revealed important insights for the following issues: (1) reliable measurements of threat detection, (2) screener evaluation and selection, (3) training of screeners, and (4) pre-employment assessment. This article contains an overview of these studies. Detailed results will be presented separately in upcoming issues of AIRPORT. The scientific studies were conducted in close collaboration with Zurich State Police, Airport Division and were funded by Zurich Airport.

Measuring threat detection is not simple

How well are different threat objects detected? Are bombs more difficult than guns and knives? Precise measures are essential in order to determine the performance of individuals, companies and airports. Moreover, reliable measurements provide important information for calculating risks and designing specific training programmes in order to increase security and efficiency substantially. But how can detection performance be measured? Indeed, deriving precise measures is more difficult than many people would expect. Consider the following example: in a test 120 x-ray images are shown in random order. Half of them contain a threat item (e.g. a gun, knife or bomb), the other half contain no threat items. Intuitively, many people would think that the hit rate, i.e. the number of detected threats, would be a sufficient measure for detection performance. Unfortunately, this is not true. The reason is the
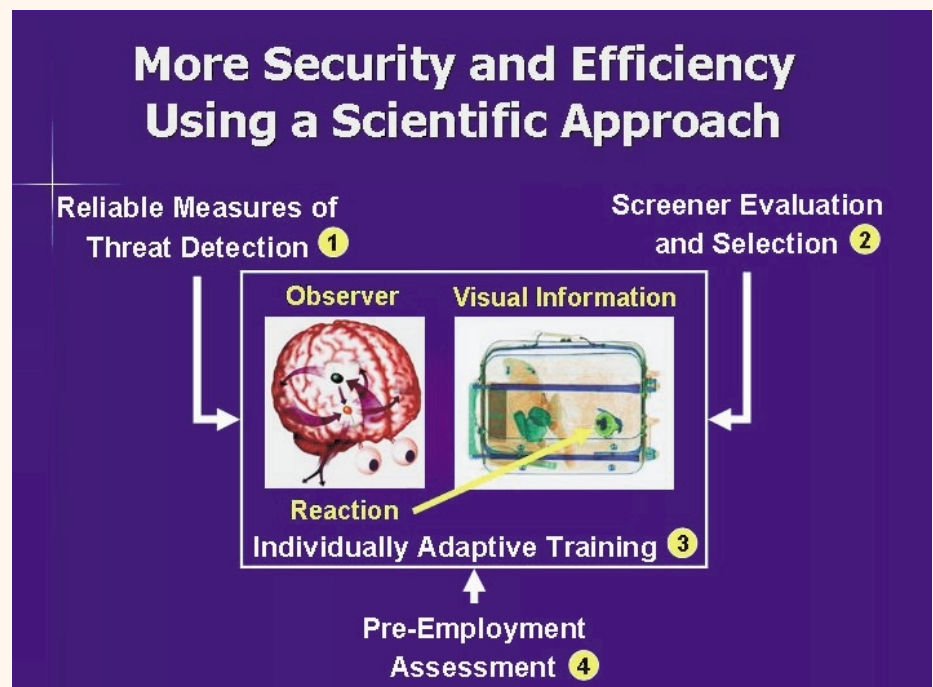

Fig. 2: The studies at Zurich Airport revealed important insights for the following issues: (1) reliable measurements of threat detection, (2) screener evaluation and selection, (3) training of screeners, and (4) pre-employment assessment.
This article presents an overview of the project. Detailed results will be presented in future articles of AIRPORT.

following: at test a participant could score each image as being not ok and thereby achieve a hit rate of 100 %. But such a person would also produce a lot of false alarms, i.e. she would categorize all harmless bags as "not ok". Such behaviour would result in quite long waiting lines at the check point. In fact, if screeners would be selected based on the hit rate alone, in many cases this would increase security at the expense of efficiency. But the main aim should be increasing security as well as efficiency.
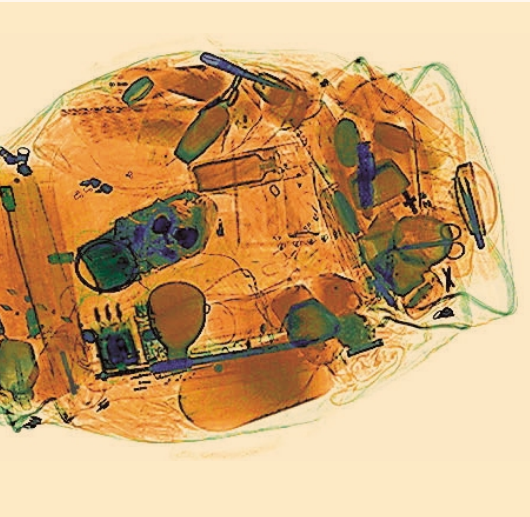
Reliable threat detection measures

Scientific methods from psychophysics and signal detection theory provide a solution for such problems. Although the underlying statistical model is a bit complicated, these methods essentially allow calculating detection measures that are independent of subjective response biases and provide exact measures of threat detection. This way it is possible to identify those screeners who are able to detect threats very well and at the same time are good in correctly identifying harmless bags. The scientific studies conducted at Zurich Airport applied signal detection theory and psychophysics in order to create tests for reliably measuring threat detection in x-ray images. Important insights were revealed concerning the detection of different threat types such as guns, knifes, dangerous goods, and bombs. Other aspects of the study were the time course of threat detection and the role of colour information (detailed findings will be presented in an upcoming issue of AIRPORT). Based on the results of these studies a specific training programme was designed in close collaboration with Zurich State Police, Airport Division. An individually adaptive training system on computer is now operational in order to increase security and efficiency of 100 % hold baggage screening at Zurich Airport.

Evaluation and selection of screeners

An essential element of the scientific projects since 2000 is the selection of operators for hold baggage screening with Heimann EDS workstations. Threat detection performance certainly is an important factor. But several other aspects need to be considered, too. For a good working performance job satisfaction and motivation could certainly play a relevant role. When hours are spent inspecting x-ray images sustained attention and vigilance could become important factors. Moreover, stress resistance and communication skills should be considered since working with passengers is not always an easy matter. Finally, when many people have to work together in the same room everyday, social factors can become essential elements of the working environment. Such issues were taken into account by using psychological tests and supervisor ratings in addition to measurements of threat detection performance. By selecting the right screeners according to the constraints of the working environment security and efficiency can be increased, which ultimately provides economical benefits.

Pre-employment assessment

A pre-employment assessment system that allows selecting people who are worth the substantial training costs would not only help increasing security and efficiency but at the same time save money. The results of the studies in Zurich were more promising than the scientists had expected initially. Several factors of visual cognition that are relevant for threat detection have been identified. Using multiple regressions and structural equations the scientists in Zurich are working on a model, which specifies the relative importance of cognitive factors for good performance. A pre-employment assessment system using a scientific approach could be possible in the near future.

In sum, the results from the studies at Zurich Airport in the last two years suggest that there is a remarkable potential for increasing security and efficiency when scientists work in close collaboration with airport and police authorities.

Adrian Schwaninger, lic. phil.
University of Zurich
Dept. of Psychology
Attenhoferstrasse 9 · 8032 Zurich
Switzerland
aschwan@allgpsy.unizh.ch

▶ Easy Info No. 209