Why do Airport Security Screeners Sometimes Fail in Covert Tests?

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Abstract—This paper discusses covert testing data and key human factors. First, different reasons why airport security screeners sometimes fail to detect threats when covert tests are conducted at airports are discussed. Key human factors are identified and analyzed with regard to covert test results. It is explained that pre-employment selection and training are indispensable prerequisites for good operational performance of airport security screeners. However, they alone cannot guarantee that screeners react appropriately when tested with real threat items at a security checkpoint. Humans often fail if something happens that they do not expect. Therefore, it is recommended to conduct covert tests on a regular basis so that screeners become prepared and get trained to react appropriately. A recently conducted study on covert tests provides empirical evidence in favor of this view.

Keywords—Aviation security; human factors; covert tests; selection and pre-employment assessment; training

I. INTRODUCTION

Covert tests have sometimes shown deficiencies at airport security checkpoints. Despite technological factors, there are several key human factors which influence covert test results:

- Abilities and aptitudes
- Training
- Motivation, attention and supervision
- Expectations regarding covert tests

In the following sections each of these factors is discussed to better understand why security officers sometimes fail at covert tests. Several of the cited studies were funded by the European Commission Leonardo da Vinci Program (VIA Project, see www.viaproject.eu for details).

II. ABILITIES AND APTITUDES

For x-ray image interpretation, [1] has specified three image-based factors which affect human threat detection performance significantly: View difficulty, superposition, and bag complexity. As can be seen in Figure 1, objects are more difficult to recognize when depicted from an unusual viewpoint (effect of viewpoint). When superimposed by other objects, detection is impaired as well (effect of superposition). Finally, objects become more difficult to detect, when there are many other objects in the bag which distract visual attention (effect of bag complexity). This has important implications for covert tests. For a reliable comparison of results obtained from different airports, companies, or screeners, it is important to know whether covert tests are comparable in terms of view difficulty, superposition, and bag complexity. [2] have developed image measurements to determine the degree of viewpoint difficulty, superposition and bag complexity automatically (see also [3]). This model is very powerful and the most recent formulae [4] provided the basis for a study conducted in collaboration with QinetiQ at 5 European airports in order to investigate the relative importance of image based factors (including bag size) and computer-based training [5].

There are large differences between people regarding their visual abilities to cope with image-based factors [6]. Therefore, it is important to use a reliable, valid and standardized object recognition test in pre-employment assessment to select...
screeners who have the abilities needed to cope with viewpoint, superposition and bag complexity. For example, [7] could show that screeners selected with the X-Ray Object Recognition Test (X-Ray ORT) performed significantly better in an x-ray image interpretation test already after one year than other screeners who worked at the airport for several years but were not selected using this test (Figure 2).

III. TRAINING OF AIRPORT SECURITY SCREENERS

For the x-ray screening task, training is very important. Visual cognition and object recognition studies have shown that an object can only be recognized if it is similar to something you have seen before ([9]; [10], [11]). The consequences for x-ray screening are illustrated in Figure 3. Each of the depicted bags contains a threat object and each one looks quite different in the x-ray image than in reality. This is one reason why many threat items are difficult to recognize without training. A second reason is that several objects are not known from everyday experience, which accounts at least for the self defense gas spray depicted in Figure 3c and the improvised explosive device (IED) depicted in Figure 3d. Additionally, some threat objects may bear resemblance to harmless objects when seen in an x-ray image. For example the switch-blade knife depicted in Figure 3b resembles a pen or a laser pointer.

Another problem is impaired recognition resulting from viewpoint changes (e.g., [10]; [12]). If an object is depicted from an unusual viewpoint, it becomes difficult to recognize. This is illustrated in Figure 4. Most people have already seen each of the three objects in real life. However, if seen from an unusual viewpoint like at the top, most people have great difficulties in recognizing the images without training. These examples illustrate the importance of initial and recurrent training to achieve and maintain a sufficient level of x-ray image interpretation competency.

Several studies in the last years have provided converging evidence showing that computer-based training which is adaptive and features a large threat image library (e.g. X-Ray Tutor) is a very effective tool for increasing x-ray image interpretation competency (e.g., [13]; [14]; [15]). As mentioned above, in a study conducted in collaboration with QinetiQ at 5 European airports the relative importance of image based factors and training for threat detection performance of human operators in airport security x-ray screening was investigated [5]. Again, computer-based training turned out to be a key driver to improving threat detection performance in x-ray

![Figure 2. Detection performance in an x-ray image interpretation test (X-Ray Prohibited Items Test) of screeners who were selected with the X-Ray ORT within pre-employment assessment (right) and those who were not selected with the X-Ray ORT (left).](#)

![Figure 3. Different types of threat items in x-ray images of passenger bags. a Electric shock device, b switch blade knife, c self defense gas spray “Guardian Angel”, d improvised explosive device (IED).](#)
screening and seemed to mediate the effects of some image based factors. In fact, amount of hours of computer-based training (with X-Ray Tutor) could predict detection performance almost as well as all image-based factors together.

![Figure 4. Effect of viewpoint on recognition.](image)

Training is a very important factor for achieving and maintaining good operational performance, which has also been shown by examining how adaptive CBT results in large increases of threat image projection (TIP) performance [16]. As will be discussed below, training is also an important prerequisite for good operational performance in covert tests of x-ray screening operations.

For other tasks, like for example pat-down or manual bag search, training might be less important than other factors such as motivation to conduct the task thoroughly (see below). However, more research is needed to investigate the importance of training for non x-ray security screening tasks.

IV. MOTIVATION, ATTENTION AND SUPERVISION

Let’s assume a security company conducts a reliable, valid and standardized pre-employment assessment procedure to select the right people for airport security screening. Let’s assume further that this security company conducts highly effective initial and recurrent computer-based training of x-ray image interpretation. If the screeners are not motivated and as a consequence do not pay attention to what happens on the x-ray screening monitor they will still miss threats in x-ray images. Thus, although pre-employment selection and training are indispensable prerequisites for good operational performance of airport security screeners, they alone cannot guarantee good operational performance. In addition to pre-employment selection and training, measures must be taken to keep motivation and attention of screeners at a sufficient level. One possibility is to use threat image projection (TIP). This technology of state-of-the art x-ray screening systems allows projecting fictional threat items (FTIs) into x-ray images of real passenger bags during the routine baggage screening operation. This way, screeners are exposed to different types of threat objects, which can help increasing attention and motivation of screeners substantially.

Unfortunately, for obvious reasons, such a technology does not exist for other tasks such as for example manual bag search or pat-down search. As will be further elaborated below, this is another reason why covert tests are important and have a training value. In addition, a good screener supervisor could help increasing operational performance by carefully supervising screeners and giving them feedback while working at the security checkpoint. However, more research is needed to determine the exact role of supervision for operational performance and what good supervision actually means.

V. EXPECTATIONS REGARDING COVERT TESTS

As explained above, with TIP, screeners are exposed to improvised explosive devices, guns, knives and other threats during the routine baggage screening operation. When they detect a threat, they immediately press a key on the x-ray machine (the “TIP key”). Then screeners receive immediate feedback on whether they have detected or missed a TIP. This technology is very valuable to increase motivation and attention. However, there are also risks associated with TIP when not used properly.

The following true story was observed about one year ago at a security checkpoint of a European airport. It was a busy day. There was a long waiting line and passengers were stressed. Screeners got stressed, too and tried to do their best to decide as quickly as possible for each x-ray image of a passenger bag whether it is OK, or whether it needs to be hand-searched. Suddenly, a screener noticed that an x-ray image of a passenger bag seemed to contain an improvised explosive device (IED). Because the screener was familiar with TIP and he had seen similar fictional threat items many times since TIP had been activated at this airport, the screener immediately pressed the TIP key. However, this time the feedback message was “No TIP was projected”. The screener knew that this means that he should send the bag to manual search because theoretically it could be a real bomb. However, the waiting line at the checkpoint was quite long, passengers were stressed, and the screener realized that this time there was no TIP. After working at the airport for many years, the screener was well aware that the probability of a real bomb is extremely low. As he explained later, his thoughts were “Alright, that can happen, it just looked like a bomb, next time I will press the button only if I am really sure there is a TIP” and the bag was not sent to manual search. A couple of minutes later a supervisor told the screener that he had just failed at a covert test conducted by an EU official.

Psychology tells us that humans often fail when something happens that they do not expect. Examples are wrong reactions when there is a fire alarm, failures of reacting correctly when somebody has a heart attack or another type of accident, as well as many other examples. When screeners do not expect that they could be tested with real threat objects in a covert test at the security checkpoint, there is a substantial risk of failure. Therefore, it is quite important that covert tests are conducted on a periodical basis. With TIP it is possible to test whether screeners can detect threats in x-ray images. With covert tests it can be examined whether they also react appropriately after detecting a threat item in an x-ray image. Thus, covert tests and TIP are rather complementary than interchangeable tools to enhance operational performance. This is especially important if TIP is used with a small threat image library and as a result, screeners become eagle eyed for TIP images but might miss real threats if no covert tests are conducted.

As mentioned above, there are several other tasks at a security checkpoint in addition to x-ray screening where there
is no technology like TIP available. For these tasks the importance of covert tests as means of training and quality control are even more important as will be shown in the next section.

VI. AN EXAMPLE OF A SCIENTIFIC STUDY ON COVERT TESTS

Until today there have been many studies investigating the importance of pre-employment assessment, computer-based training and TIP in x-ray screening. In contrast, the area of covert testing has received much less attention. Recently, [17] have conducted a study on covert tests at one large European airport over the period of fourteen calendar months. The key findings can be summarized as follows:

- Covert tests are valuable for quality control and risk analysis purposes and also to train screeners to react appropriately in dangerous situations.

- Performance at covert tests increased significantly over the full period of fourteen months.

- Threats hidden in carry-on baggage were detected best, which according to the authors, is not surprising since at this airport, screeners conduct frequent recurrent computer based training since 2005.

- Compared to the detection rates observed in x-ray screening there was a loss in detection when threat items were carried on the body.

- There were substantial differences regarding different types of threat objects. IEDs were detected best and knives were detected worst. Although this result might seem at first surprising, in fact it is not, as pointed out by the authors, because IEDs and fuses were always hidden in carry-on baggage and screeners detected those items best because they had received adaptive computer-based training for cabin baggage screening since early 2005.

- The time taken to conduct pat-down search was an important variable, indicating that it is crucial that the security officers take enough time for this control task.

The authors suggest that by regular covert testing, a certain effect of training and awareness occurs. This is illustrated by the fact that when security officers were tested the second time, in almost all cases, they performed much better. Moreover, “some [screeners] have reported that until the experience of failure, they were not aware of the difficulty and importance of a thorough pat-down search. As a result, they afterwards conducted much more thorough controls than before” [5], p. 5.

The authors point out that it is unclear whether the same results would be obtained at other airports which have different procedures, training programs and employees. Nevertheless, it seems clear that this study provides good evidence for the view that covert tests have a training value and are important to make sure screeners react appropriately when confronted with a real threat.

VII. QUESTIONS TO BE ADDRESSED IN FUTURE STUDIES

Several questions remain to be addressed in future studies:

- How many covert tests are needed to achieve the optimal cost / benefit ratio?
- How many covert tests are needed for a reliable measurement of performance of an airport / a security company / a checkpoint, etc.?
- Which abilities / aptitudes are relevant for covert test results in non x-ray related tasks?
- How can we define a standardized method for conducting covert tests so that results for different countries / airports / companies, etc. become comparable?
- Do covert test results correlate with TIP data?

Ideally, such questions would be investigated in close collaboration between scientists, appropriate authorities and airport security providers. This would be very beneficial to better understand and provide a solid basis for the enhancement of current airport security controls.

VIII. SUMMARY AND CONCLUSIONS

A. Abilities and aptitudes

There are large differences between people regarding their ability to become a good screener. For x-ray screening, people need to have the ability to cope with image-based factors such as viewpoint, superposition and bag complexity. This can be tested using an object recognition test in pre-employment assessment. For other tasks, more research is needed to determine which are specific abilities/aptitudes that can be tested reliably in pre-employment assessment.

B. Training

For x-ray screening, initial and recurrent training is essential to learn and keep up to date regarding threat objects and what they look like in x-ray images. For other tasks it is currently assumed that initial training suffices. However, this should be further investigated.

C. Motivation, attention and supervision

If the screeners are not motivated and as a consequence do not pay attention to what happens on the x-ray screening monitor they will still miss threats in x-ray images. Thus, although pre-employment selection and training are indispensable prerequisites for good operational performance of airport security screeners, they alone cannot guarantee good operational performance. Means for increasing attention and motivation are TIP (for x-ray screening), good supervision (for all tasks) and other factors. More research is needed in this regard.

D. Why covert tests seem to be very valuable

Humans often fail if something happens that they do not expect. When screeners do not expect that they could be tested with real threat objects in a covert test at the security checkpoint, there is a substantial risk of failure. With TIP it is possible to test whether screeners can detect threats in x-ray images. With covert tests it can be examined whether they also react appropriately after detecting a threat item in an x-ray

44
image. Moreover, when TIP is operational, screeners become exposed to threat items on a regular basis. It is then even more important, that covert tests are conducted on a regular basis to ensure that screeners react appropriately when facing a real threat. Thus, covert tests and TIP are rather complementary than interchangeable. A technology such as TIP is not available for all other non-x-ray related tasks at a security checkpoint. For those tasks, covert tests are important for quality control purposes. Finally, covert tests seem to have a training value, since people get better when tested repeatedly.

REFERENCES


