# SCIENCE & SECURITY July 2018

CASRA NEWSLETTER – ISSUE 19

In this summer issue, two articles exemplify how applied research leads to important insights and solutions for our project partners and customers.

In the section "Research Put Across", we present a study conducted by CASRA on session duration of the X-ray screening task. In the "Security in Practice" section, we introduce you to the CASRA TIP Data Tool and show how it simplifies Threat Image Protection (TIP) data analysis and provides valuable information for the update of TIP libraries. It also helps to optimize the learning process by linking the work at the checkpoint to the computer-based training.

We hope you continue to enjoy reading our articles and we wish you a pleasant summer!

Dr. Diana Hardmeier
Director

Prof. Dr. Adrian Schwaninger
Chairman

**TOPICS IN THIS ISSUE:**

RESEARCH PUT ACROSS

## SESSION DURATION OF THE X-RAY SCREENING TASK UP FOR DEBATE

"Persons screening cabin baggage by X-ray or EDS equipment shall normally not spend more than 20 minutes continuously reviewing images. After each of these periods, the screener shall not review images for at least ten minutes." This is mandated by the European Commission implementing Regulation (EU) 2015/1998. To be compliant, screeners working at airport security checkpoints have to change from X-ray screening to another position after 20 minutes. In remote screening, such rotation is operationally more difficult and compliance with the strict ten-minute break can be challenging. Therefore, an interest in considering longer X-ray screening durations exists. CASRA has conducted a study to investigate how detection performance changes during 60 minutes of consecutive X-ray screening and what role ten-minute breaks play.

SECURITY IN PRACTICE

## TIP DATA ANALYSIS MADE EASY WITH THE CASRA TIP DATA TOOL

Threat Image Projection (TIP) is a technology of current X-ray machines that allows exposing screeners to fictional but realistic X-ray images during the routine baggage X-ray screening operation. TIP is used for several purposes, e.g. to keep security screeners' motivation and attention at a high level. However, the analysis of a large amount of TIP data by hand is complicated, error-prone and time-consuming. Hence, TIP data analysis could benefit from an automated process. To this end, we developed the CASRA TIP Data Tool, which is integrated into the CASRA Solution, as a means to facilitate the aggregation and to analyze large amounts of TIP data in an efficient and user-friendly, easy-to-use way. Results are presented in detailed and standardized reports. These reports include TIP performances of security personnel, hit rates, non-TIP alarm rates and the number of TIP images shown. Thus, the TIP Data Tool ensures the compliance with the EU's legal requirements with minimum expenditure of time.

# SESSION DURATION OF THE X-RAY SCREENING TASK UP FOR DEBATE

Text: Daniela Buser, Yanik Sterchi

**"Persons screening cabin baggage by X-ray or EDS equipment shall normally not spend more than 20 minutes continuously reviewing images. After each of these periods, the screener shall not review images for at least ten minutes." This is mandated by the European Commission implementing Regulation (EU) 2015/1998. To be compliant, screeners working at airport security checkpoints have to change from X-ray screening to another position after 20 minutes. In remote screening, such rotation is operationally more difficult and compliance with the strict ten-minute break can be challenging. Therefore, an interest in considering longer X-ray screening durations exists. CASRA has conducted a study to investigate how detection performance changes during 60 minutes of consecutive X-ray screening and what role ten-minute breaks play.**

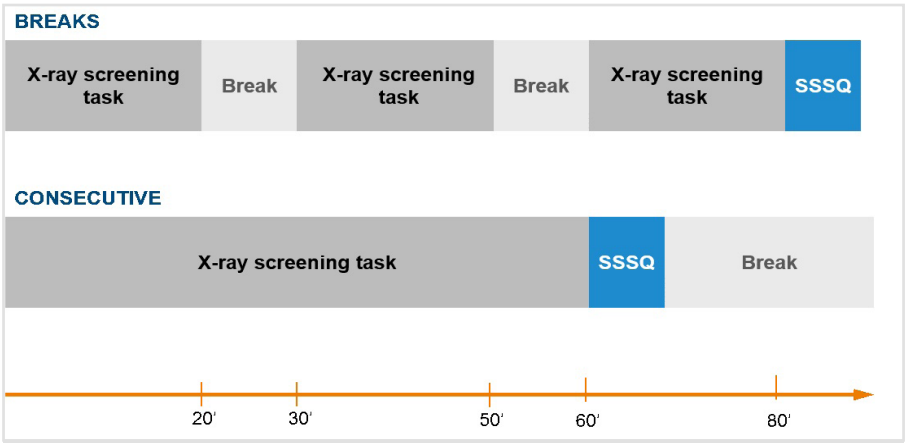


*Figure 1: Study setup for the two groups.*

Tasks, at which attention has to be maintained over a longer period, with targets rarely occurring, are called vigilance tasks. It has been shown that people have difficulties to stay focused in vigilance tasks over a longer period, with performance often decreasing within the first 30 minutes [1]. However, whether this also applies to the X-ray screening task and how performance changes over a longer period of 60 minutes of consecutively reviewing X-ray images is unclear.

## EXAMINING PERFORMANCE OVER TIME

Previous studies on vigilance tasks have shown that a decrease in performance can already be observed after five to ten minutes if the task is highly demanding [1]. A study with screeners working at airport security checkpoints using threat image projection data found a decrease in performance after ten minutes when workload was high [2]. The percentage of detected prohibited items (i.e. hit rate) dropped by 2% and then declined at an increasing rate with ongoing shift duration.

When a decline of performance in a vigilance task appears, breaks can help to increase performance again. In general, a positive effect of breaks can be observed in various attention tasks [3]. For example, breaks make people faster, more accurate, less tired or more awake. Even small breaks can already help to induce these positive effects. However, there are no clear findings yet on how attention and performance evolve in a remote screening environment.

In order to evaluate the effect of breaks, we conducted a research study with Oslo Airport when they introduced remote screening. Screeners were asked to conduct a simulated cabin baggage screening task for one hour. Participants were divided into two groups: one performed three 20-minute sessions of X-ray screening with ten-minute breaks in between; the other group performed the task for one hour without breaks. Both groups filled in the Short Stress State Questionnaire (SSSQ) [4] after 60 minutes of X-ray screening (see Figure 1).

The screeners' task was to visually inspect X-ray images and decide whether the bag is "OK" (does not contain a prohibited article) or "NOT OK" (might contain a prohibited article). Figure 2 shows the interface of the simulated X-ray screening task. As usual in remote cabin baggage screening, if the bag was "NOT OK", screeners additionally had to mark the location of the prohibited article in the bag and choose if it belonged to one of the following threat categories: "gun", "knife" or "IED". Screeners had twelve seconds per image for a decision.

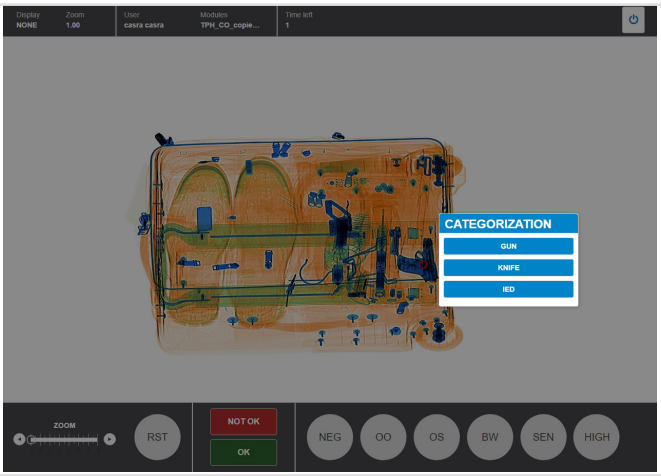


*Figure 2: User Interface of the simulated X-ray screening task.*

## STABLE PERFORMANCE OVER ONE HOUR OBSERVED

We found that screeners were able to sustain their performance over the duration of one hour (see Figure 3). Strikingly, the hit rate stayed stable during the entire test, i.e. the percentage of bags containing a prohibited article that were correctly rejected for secondary search did not change over time. Figure 4 depicts the false alarm rate, which is the percentage of falsely rejected bags, classified as "NOT OK" while they were actually harmless. We found that within the first 20 minutes the screeners' false alarm rates initially decreased a little and then stayed stable.

When comparing the groups with and without breaks, no difference in performance was found. The group working without breaks simply did not show any performance decrements on which breaks could have had a restorative impact.

While performance was the same for both groups, they differed in perceived stress. The results of the stress state questionnaire revealed that the group working for one hour without breaks felt more stressed than the screeners who had breaks (see Figure 5). While the reported stress levels (1.4 and 1.7 on a scale of 5) were not large, we found substantial individual differences (standard deviations in Figure 5) and this was more evident in the group without breaks.

In summary, working for a longer period without breaks did not affect detection performance of prohibited articles but caused more stress.

## LIMITATIONS

As it is the case with any scientific study, limitations should be mentioned before addressing practical implications.

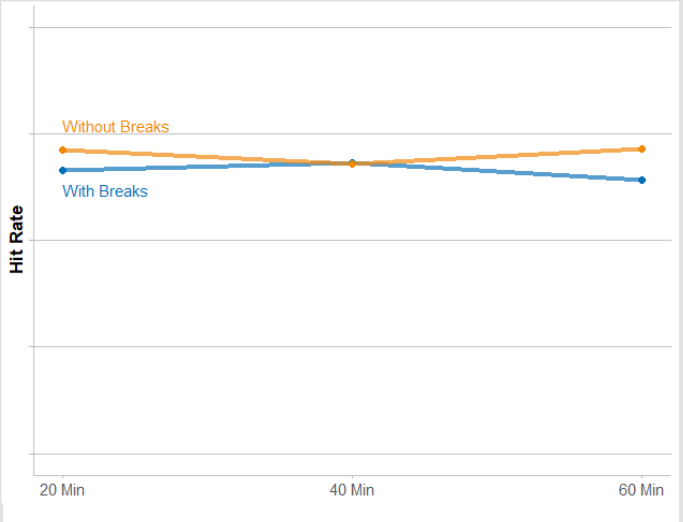


*Figure 3: Hit rate as a function of time on task for the group with breaks and the group without breaks.*

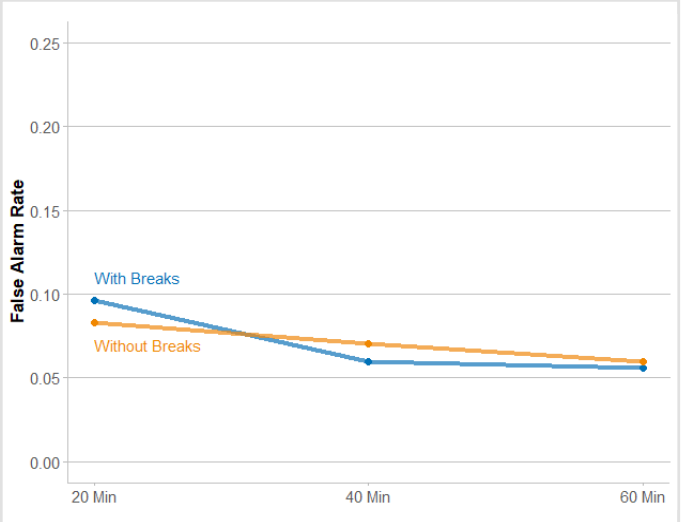


*Figure 4: False alarm rate as a function of time on task for the group with breaks and the group without breaks.*

First, because screeners knew that they were tested, they might have been more motivated and therefore might have shown a prolonged attention span. Second, one should also keep in mind that increasing the duration of the screening task might have long-term effects. Being able to conduct one hour of consecutive screening once does not necessarily mean it can be easily repeated several times a day over multiple months without negative impact on performance. The increased stress reported by participants who performed the test without breaks could be an indication of negative long-term effects.

Third, this study was conducted with screeners from one airport and it remains to be seen whether the results would generalize to screeners from other airports and different work environments. Other security companies might have different hiring practices, which could mean that screeners from other airports would not necessarily have the same endurance. And, of course, when screening is conducted at the checkpoint and not remotely in a quiet office, it might be more challenging to keep performance up. When looking for potential explanations why Meuter and Lacherez [2] found a decrease in performance at checkpoint screening while our experiment on remote screening did not, possible causes may be the different environment, the above mentioned test situation, and/or the different airport screeners.

## PRACTICAL IMPLICATIONS

In summary, our study did not find performance decrements over 60 minutes of consecutive X-ray screening in a remote screening task. This is good news for airports that are interested in extending the duration of screening. However, despite the positive results, extending screening durations without breaks should be carefully piloted. Such a pilot study should not only monitor performance but also screener wellbeing (including perceived stress) over an extended period and should consider that individuals might greatly differ in how well they can handle such a change. It might also be beneficial to take break policy, workload, and shift plan into consideration. Further consideration should also be given to the possibility of flexible work rest schedules, taking into account differences in the ability of coping with longer screening sessions. Additional studies could help to improve the work of security officers well beyond checking the feasibility of extended screening periods.

## REFERENCES

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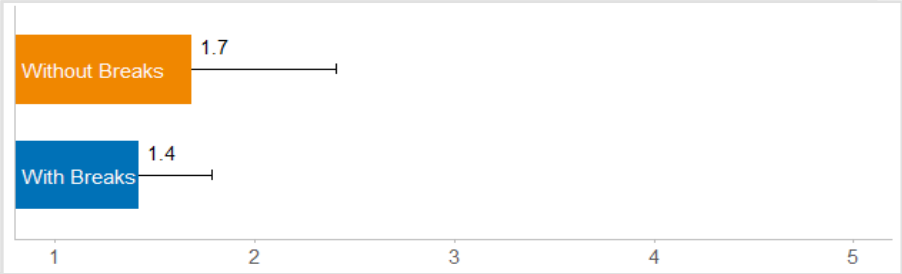


*Figure 5: Perceived stress levels for both groups, rating from 1 = "not at all" to 5 = "extremely". Error bars represent standard deviations and indicate variation between screeners.*

# TIP DATA ANALYSIS MADE EASY WITH THE CASRA TIP DATA TOOL

Text: Angela Fantuzzi, Céline Delay

**Threat Image Projection (TIP) is a technology of current X-ray machines that allows exposing screeners to fictional but realistic X-ray images during the routine baggage X-ray screening operation. CASRA has developed the TIP Data Tool in compliance with the EU Regulation as a means to facilitate the aggregation and to analyze large amounts of TIP data. Using the TIP Data Tool is very easy, efficient, user-friendly and allows displaying TIP results in detailed and standardized reports.**

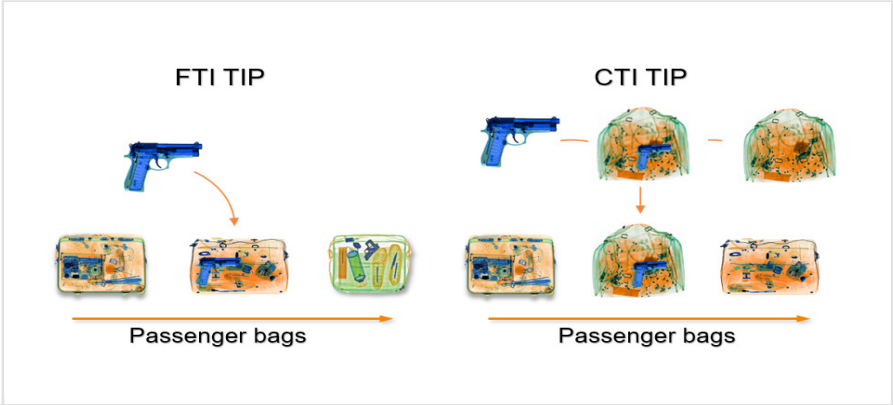


*Figure 1: Difference between FTI and CTI TIP*

## WHAT IS TIP?

If screeners are not exposed to prohibited articles regularly or if they are not motivated and as a consequence do not pay attention to what is displayed on the X-ray screen, they will very likely miss prohibited articles in passenger bags [1]. Although pre-employment selection tests and training are indispensable prerequisites for good operational performance of airport security screeners, this alone does not guarantee good operational performance. Humans often fail when something happens that they do not expect. Screeners at airports are more likely to miss prohibited articles that they encounter very rarely during the routine X-ray operation as opposed to objects that they see every once in a while. Therefore, in addition to pre-employment selection and training, further measures must be taken to keep motivation and attention of screeners at a high level. One possibility is to implement TIP.

TIP is a technology of current X-ray machines that allows exposing screeners to fictional, pre-recorded X-ray images during the routine baggage X-ray screening operation [1]. The frequency of how often threat images are displayed – also called the TIP-to-Bag ratio – can be configured. When a screener detects a prohibited article, he or she presses a key on the X-ray machine (the "TIP key") and receives immediate feedback on whether or not he or she detected a TIP correctly. Due to the more frequent exposure to threat items and the immediate feedback function, this technology is very valuable to increase screeners' motivation and attention.

Two types of TIP exist: **Fictional Threat Item (FTI) TIP** and **Combined Threat Item (CTI) TIP** (Figure 1). In the case of FTI TIP, fictional threat items are displayed in real time in the X-ray images of the actual passenger bags. By contrast, CTIs are specifically prepared X-ray images, in which X-ray images of prohibited items are combined in advance with X-ray images of real passenger bags and then displayed to the screener within the flow of X-ray images of the actual passenger bags. FTI TIP is mostly used in Cabin Baggage Screening (CBS)[1] and CTI TIP can be found mostly in Hold Baggage Screening (HBS) – however this is not a strict separation as CTI TIP is also used in remote cabin baggage screening for example. For both types of TIP images, the TIP response data, such as hits, misses, reaction time and more are recorded and can be exported to be further analyzed.

## WHAT IS THE TIP DATA TOOL?

Airports in the EU have to evaluate their screeners' TIP data periodically. The analysis of this data is often complicated, time-consuming and error-prone. To automate and simplify the process of analyzing large amounts of TIP data, CASRA has developed the TIP Data Tool in compliance with the EU regulation.[2] Furthermore, if screeners fail to meet the required criteria of the hit and non-TIP alarm rate, they will have to undergo remedial training before facing the next evaluation cycle. By mapping TIP users to CASRA's training solution X-Ray Tutor (XRT), the requirements for remedial training are met, without any additional administrative effort.

[1] For more information on RCBS, see Newsletter Issue 17 (2017).

[2] EU Regulation 2015/1998.

The CASRA TIP Data Tool:

- Facilitates the aggregation and analysis of large amounts of TIP data in an **efficient and user-friendly, easy-to-use way**. No additional evaluation and only minimum expenditure of time is needed.
- Shows the **screeners TIP performances in detailed and standardized reports**. These reports include hit rates, non-TIP alarm rates and the number of TIP images shown. They also present **TIP library and TIP image properties in detailed and standardized reports**. This way, the analysis makes it possible to make solid statements about the compliance with the EU Regulation 2015/1998 both for the TIP performance of security personnel and TIP libraries/images. If TIP libraries do not meet the defined criteria, the TIP Data Tool indicates which images should be removed to improve the existing library.
- Allows **TIP objects missed by screeners to be synchronized directly with the training system XRT**. This way, missed TIP Objects combined with bags from the training library are displayed to the respective users in the next training session (remedial training [2]) to fill knowledge gaps immediately.

## HOW DOES IT WORK?

In order to get your data structured, simply **import your own TIP reports into the TIP Data Tool and they will be converted into detailed customized reports.** The following sections describe this process in a more detailed manner.

- TIP Libraries can be registered in the *TIP Library Management*. The tool currently supports libraries by CASRA, Smiths Detection and Rapiscan.

- The parameters of the TIP data analysis can be edited by the users in the *Configuration Management*. These parameters include for example:
  - the time interval in which the TIP users' performances are evaluated
  - the minimum number of TIP images that screeners have to analyze in order to make a statement about their performance
  - the minimal hit rate that has to be achieved by each user during an evaluation period.

- In order to display missed TIP items in the next training session (remedial training [2]), the TIP user can be mapped to the XRT user in the User Mapping.[3] The integration of TIP and the training enables remedial training adapted to each individual user and allows to fill knowledge gaps immediately.

The **Report function** is the most important menu. Results of the data aggregation and analysis are displayed in the form of different detailed and standardized reports (see Figure 2).

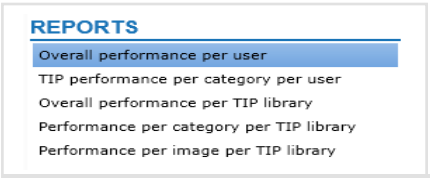


*Figure 2: Available Reports (the access to each report depends on the assigned rights).*

If desired, each report can be sorted and filtered by columns. It can also be edited using different filter functions (such as user, date, minimum TIP images) or may even be exported as an Excel file.

Drag a column header here to group by that column

| User name | Start date | End date | Status | TIP images analyzed | Criterion min. TIP images | % Hits | Hits | Library name |
|---|---|---|---|---|---|---|---|---|
| 1000 | 6/1/2017 | 7/31/2018 | Re-evaluation | 13 | 20 | 69% | 9 | CASRA TIP LIB |
| 1001 | 6/1/2017 | 7/31/2018 | Re-evaluation | 0 | 20 | 0% | 0 | CASRA TIP LIB |
| 1003 | 6/1/2017 | 7/31/2018 | Passed | 39 | 20 | 94% | 37 | CASRA TIP LIB |
| 1004 | 6/1/2017 | 7/31/2018 | Passed | 36 | 20 | 94% | 34 | CASRA TIP LIB |
| 1005 | 6/1/2017 | 7/31/2018 | Passed | 239 | 20 | 93% | 224 | CASRA TIP LIB |
| 1006 | 6/1/2017 | 7/31/2018 | Passed | 489 | 20 | 86% | 424 | CASRA TIP LIB |
| 1007 | 6/1/2017 | 7/31/2018 | Passed | 463 | 20 | 96% | 449 | CASRA TIP LIB |
| 1008 | 6/1/2017 | 7/31/2018 | Passed | 142 | 20 | 92% | 131 | CASRA TIP LIB |
| 1009 | 6/1/2017 | 7/31/2018 | Passed | 176 | 20 | 85% | 151 | CASRA TIP LIB |
| 1010 | 6/1/2017 | 7/31/2018 | Passed | 502 | 20 | 92% | 464 | CASRA TIP LIB |
| 1011 | 6/1/2017 | 7/31/2018 | Passed | 279 | 20 | 94% | 263 | CASRA TIP LIB |
| 1012 | 6/1/2017 | 7/31/2018 | Passed | 331 | 20 | 90% | 301 | CASRA TIP LIB |
| 1013 | 6/1/2017 | 7/31/2018 | Failed | 92 | 20 | 98% | 91 | CASRA TIP LIB |
| 1014 | 6/1/2017 | 7/31/2018 | Passed | 258 | 20 | 89% | 231 | CASRA TIP LIB |
| 1015 | 6/1/2017 | 7/31/2018 | Passed | 120 | 20 | 90% | 108 | CASRA TIP LIB |
| 1016 | 6/1/2017 | 7/31/2018 | Passed | 355 | 20 | 97% | 345 | CASRA TIP LIB |

*Figure 3: Screenshot of report function (overall performance by user with activated "Minimum number of TIP Images" function)*

[3] This is only possible if the same objects occur in both TIP and the training.

Drag a column header here to group by that column

| Library name | Start date | End date | Last updated | Criterion min. # nev | New TIP images | Status | Criterion min. # TIP | TIP objects |
|---|---|---|---|---|---|---|---|---|
| Casra TIP LIB | 6/1/2017 | 5/31/2018 | 5/15/2018 | 100 | 1125 | Passed | 250 | 277 |

*Figure 4: Screenshot of Report function (Overall performance per TIP library)*

In the following, the reports are described more in detail.

- **Overall performance per user:** This report shows at a glance whether single TIP users have fulfilled the defined hit rate and false alarm rate (Figure 3). If one of the criteria is not fulfilled, the status "Failed" is displayed and the insufficient performance value is highlighted in red. As soon as the function "Minimum number of TIP images" has been activated, users who have not reached the minimum number of TIP images to be analyzed are displayed with the status 'Re-evaluation' and the field is highlighted in yellow.
- **TIP Performance per category per user:** This report gives a detailed overview over a user's TIP performance i.e. correctly identified TIP images including the response time and missed TIP images per threat category (guns, knives, IEDs, and other).
- **Overall performance per TIP library:** This report indicates whether a TIP library has fulfilled the defined regulatory requirements, i.e. the maximum overall hit rate, the minimum number of TIP objects and images, as well as the minimum number of TIP images that must be renewed each year (Figure 4).
- **Performance per category per TIP library:** This report shows whether the proportion of the four threat categories is compliant with the regulatory requirements.

## CONCLUSION

The CASRA TIP Data Tool is already being used at a number of airports in Europe. Persons in charge of TIP enjoy the straightforward application: the easy aggregation and analysis of large amounts of data, the presentation of the results in detailed and standardized reports, and the option to review missed TIP items in the XRT training as a form of remedial training. These features allow a significant reduction in working hours and error susceptibility as only a few clicks are needed to get the desired results.

Further, the integration of the TIP Data Tool in the CASRA Solution allows to support the whole lifecycle of a screener: from the X-Ray ORT, which helps to select the candidates with the relevant visual abilities, to XRT, which trains how prohibited articles look like, to TIP, which helps to keep attention and motivation at a high level and the TIP Data Tool, which evaluates the performance, to X-Ray CAT, which asses the initial and recurrent competency (Figure 5).

If you are interested in using the TIP Data Tool to perform TIP data analysis in a more efficient way, please feel free to contact us at: info@casra.ch.

## REFERENCES

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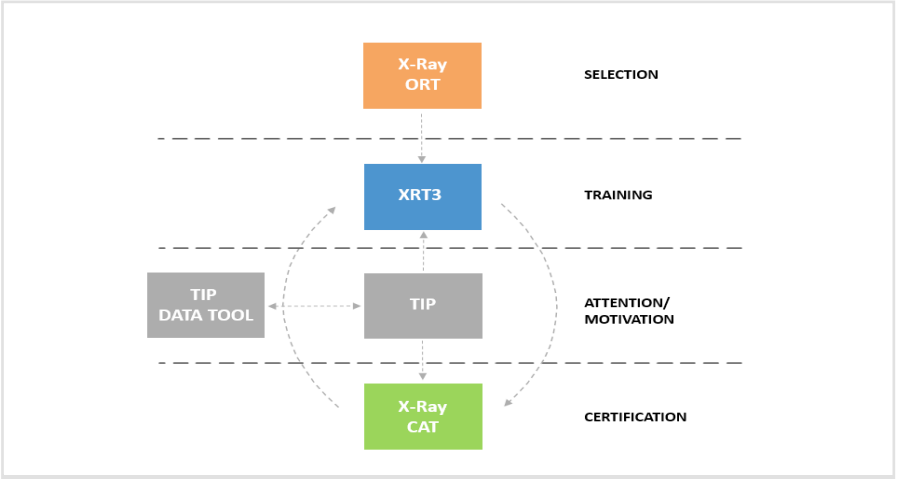


*Figure 5: Coverage of screeners' lifecycle within the CASRA Solution*

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