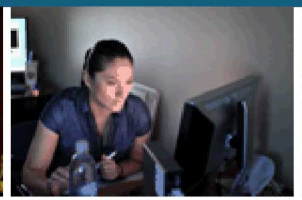
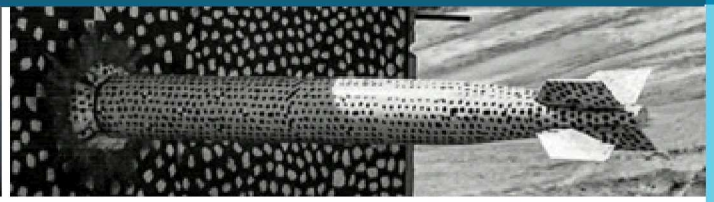
SAND2018-11940C

Physical Security Operators and Cognitive Science





PRESENTED BY

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Monitoring physical security systems can be very complex

The ultimate goal is operator situation awareness (SA) to:

- Aid rapid differentiation between threats and benign events
- Aid in guiding responding forces when an event does happen
- Aid team SA – making sure all PSS operators are on the same page

These systems are often not designed to maximize SA

Involvement of autonomy at any level further complicates the system

An example of a physical security system at HealthEast in Minnesota.

Taken from https://www.sdmmag.com/articles/90915-new-operations-center-enhances-healthcare-security

There exist well-established methods for designing interfaces that enhance job performance

Subjective methods

Task Analyses
- Job Task Analysis
- Cognitive Task Analysis
- Hierarchical Task Analysis
- Goal Directed Task Analysis (GDTA)
- Etc.

Workflow Analyses

Field Observations

We will discuss GDTA (Endsley & Jones, 2012)

Objective methods

Experimental methods, which include
- Experimental Design
- Independent and Dependent variables
- Quantitative measurements such as accuracy and decision time
- Statistical analysis

We present an example of a study on false alarm rates

What is Situation Awareness (SA)?

Four levels

No SA

SA level 1: basic perception of the environment (e.g., noticing alarms)

SA level 2: developing a big-picture understanding of the *current state* of the facility

SA level 3: the ability to *anticipate likely events* in the near future

Many factors destroy SA, such as:

Workload, anxiety, fatigue

Too much information

Interface complexity

Humans being out of the loop when automation/autonomy is involved

Information highlighted in interface that isn't critical to the job

etc.

Examples of principles that aid SA

Organize information in interface around goals of the operator
- Ensure salient information supports information needs

Provide visualizations that will support Levels 2 and 3 SA

Don't be afraid of multiple sensory modalities, but make sure they make sense and don't contradict one another

Display age/timeliness of information in an easy-to-identify manner (e.g., color)

Make system operations transparent

Automate only when necessary

etc.

For additional principles, see Endsley & Jones, 2012, Designing for Situation Awareness.

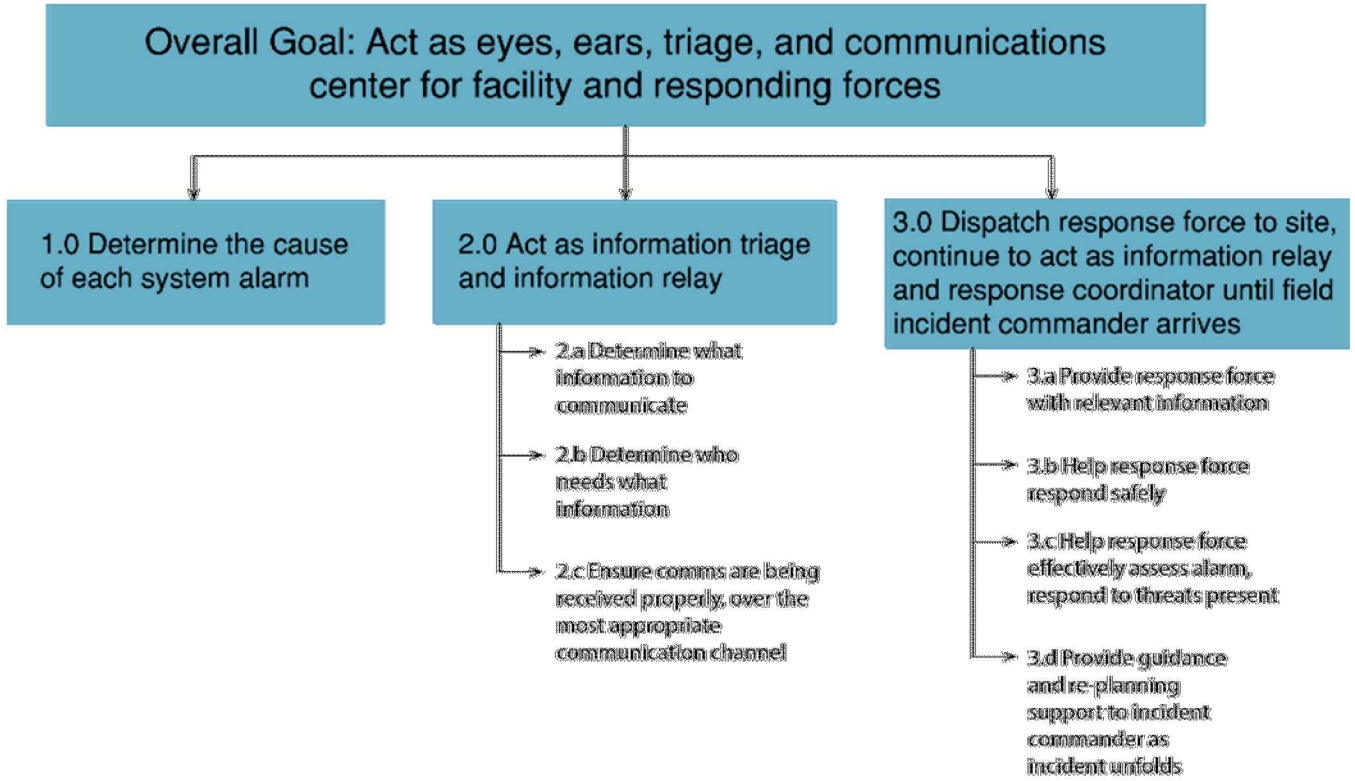
Examples of principles that aid SA

Developed by Mica Endsley and colleagues in order to get at factors that drive (or destroy) SA

GDTA focuses on:

- Goals the operator has in their job
- The decisions that must be made to meet those goals
- The information needed in order to make those decisions

Represented as a hierarchy – goals on top, decisions below, information needs at the bottom



High-level GDTA Process

1. Identify and read all documentation relevant to the job of interest
2. Identify multiple subject matter experts (SMEs) who can participate in interviews
3. Develop first set of questions for SMEs based on documentation, focusing on goals, decisions, and information needs
4. Conduct multiple interviews with each SME, iterating as you learn more about the domain
5. Represent output as goal hierarchy, vet with SMEs and make corrections as needed

Applying the results of the GDTA

First, identify most critical goals, decisions

- In this case, determine whether an alarm is an event or NAR/FAR

Then, identify what are the most critical pieces of information the operator needs in order to make this decision quickly and accurately

Examine current interface, noticing gaps between information presented and easily available and that identified through GDTA

Redesign data collected, analytics computed, and the interface, taking into account

- Goals, decisions, and information needs identified in GDTA
- Standard Operating Procedures (SOPs)
- Concepts of Operation (CONOPs) that are required
- Principles for enhancing SA

Determine whether interface helps or hurts PSS operator SA

Asking if operators like the interface is insufficient –

- People are often not aware of how effective their decision making is
- Nor are they aware of factors that impact that decision making.

Experiments are critical – including:

- Relevant baseline (old PSS interface)
- Redesigned interface
- Example events and non-events to display via the interface
- PSS operators to participate in the study

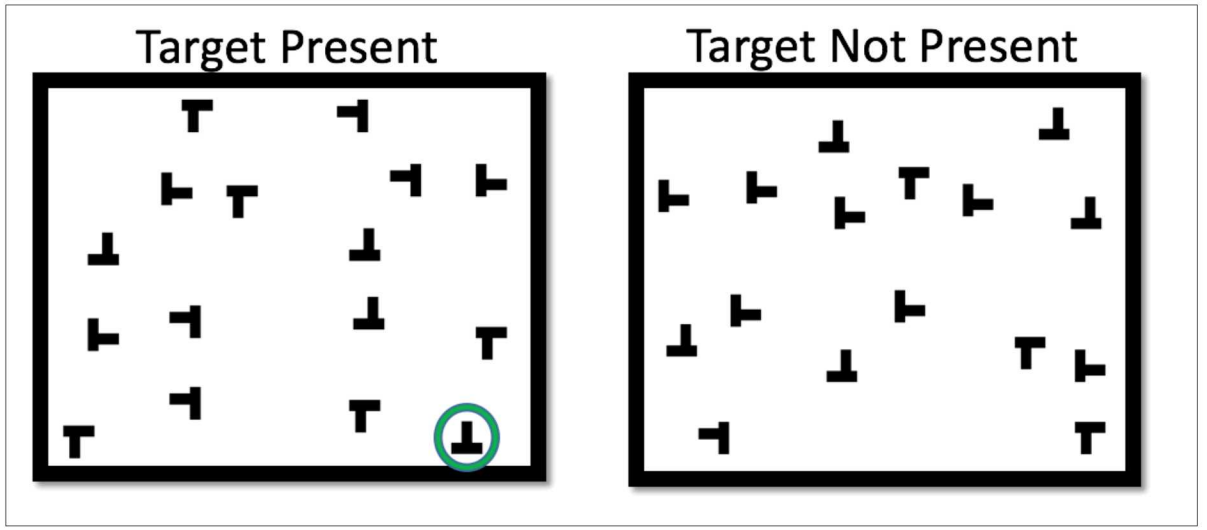
We present a related study using a domain-general task

- Future work would make this a task specific study related to PSS event detection
- Wheeler, J., Speed, A., Silva, A., & Russell, J.R. (2018). Low probability events and high false alarms. Internal research & development project.

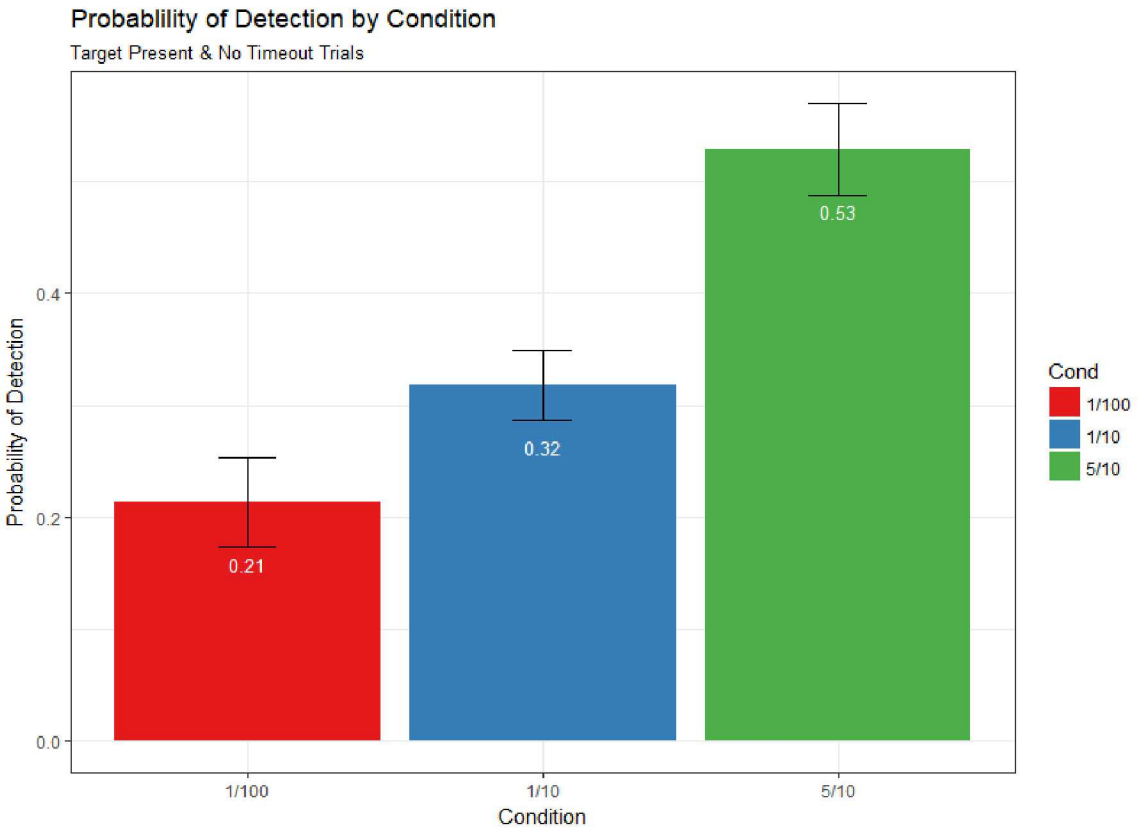
False alarms and event detection

- 58 subjects tested in one of four conditions (14-15 per condition)
- 1000 trials per experiment
- Final trial always contained a target (the only target in the 1/1000 condition)
- Trials were self-terminating after 7 seconds
- Dependent variables:
  - Number of targets detected
  - Number of false alarms
  - Number of subjects who detected target on final trial
  - Response time
  - Response bias

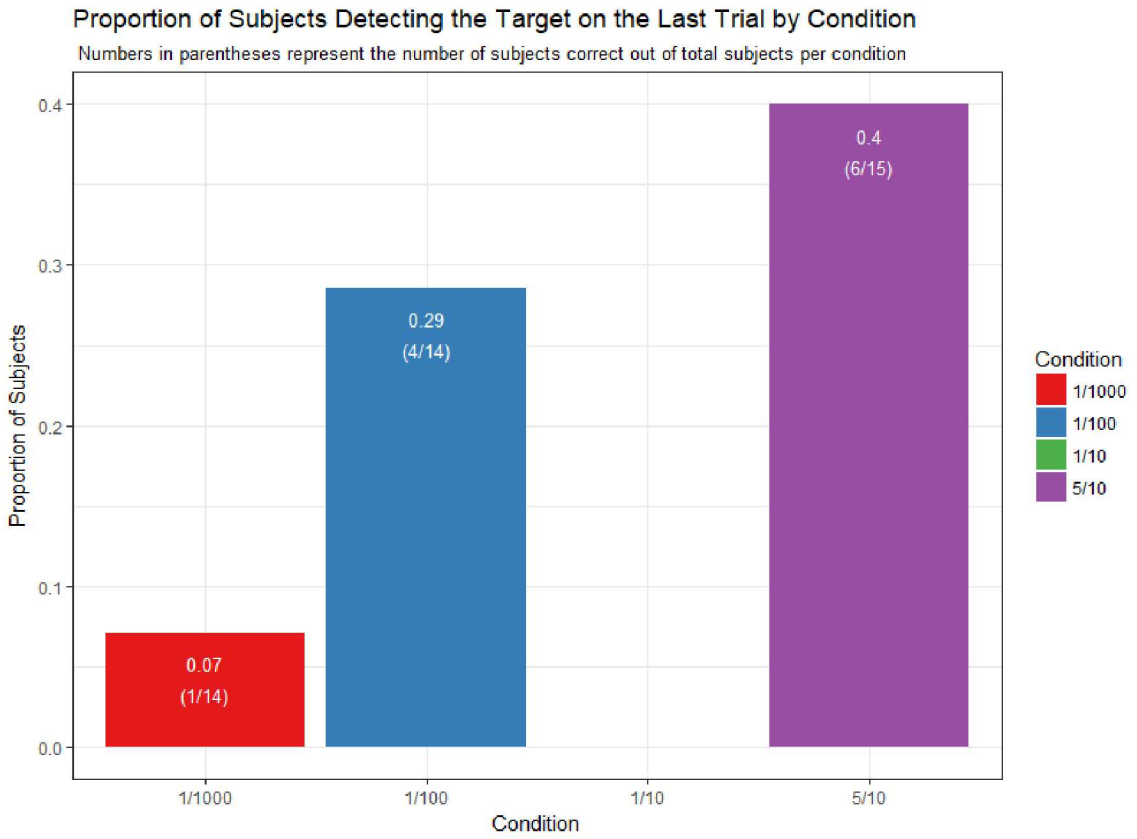
Number of Targets	Prevalence Rate
1	0.001
10	0.01
100	0.1
500	0.5



Objective Measurement: Key Results

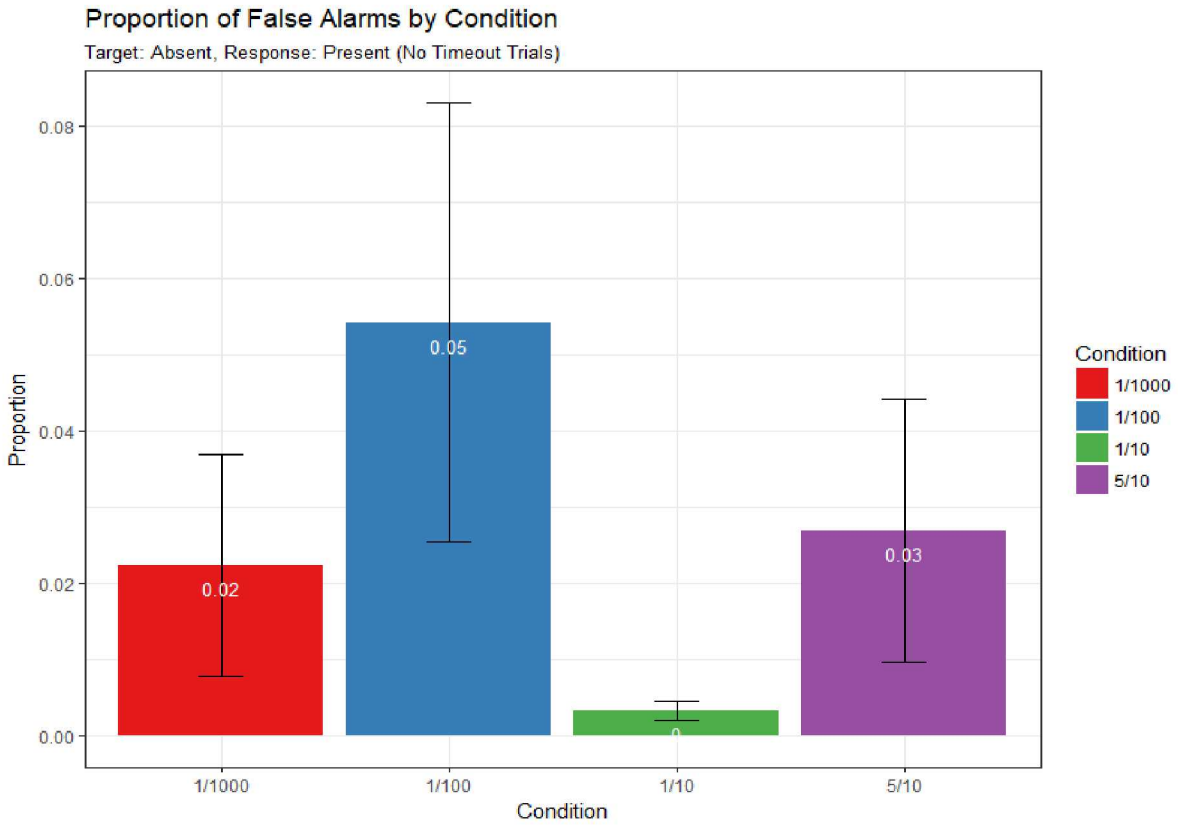


Error bars are standard error of the mean. 1/1000 condition not shown because of the low number of total targets (14) and because only 1 out of 14 subjects detected the final target.

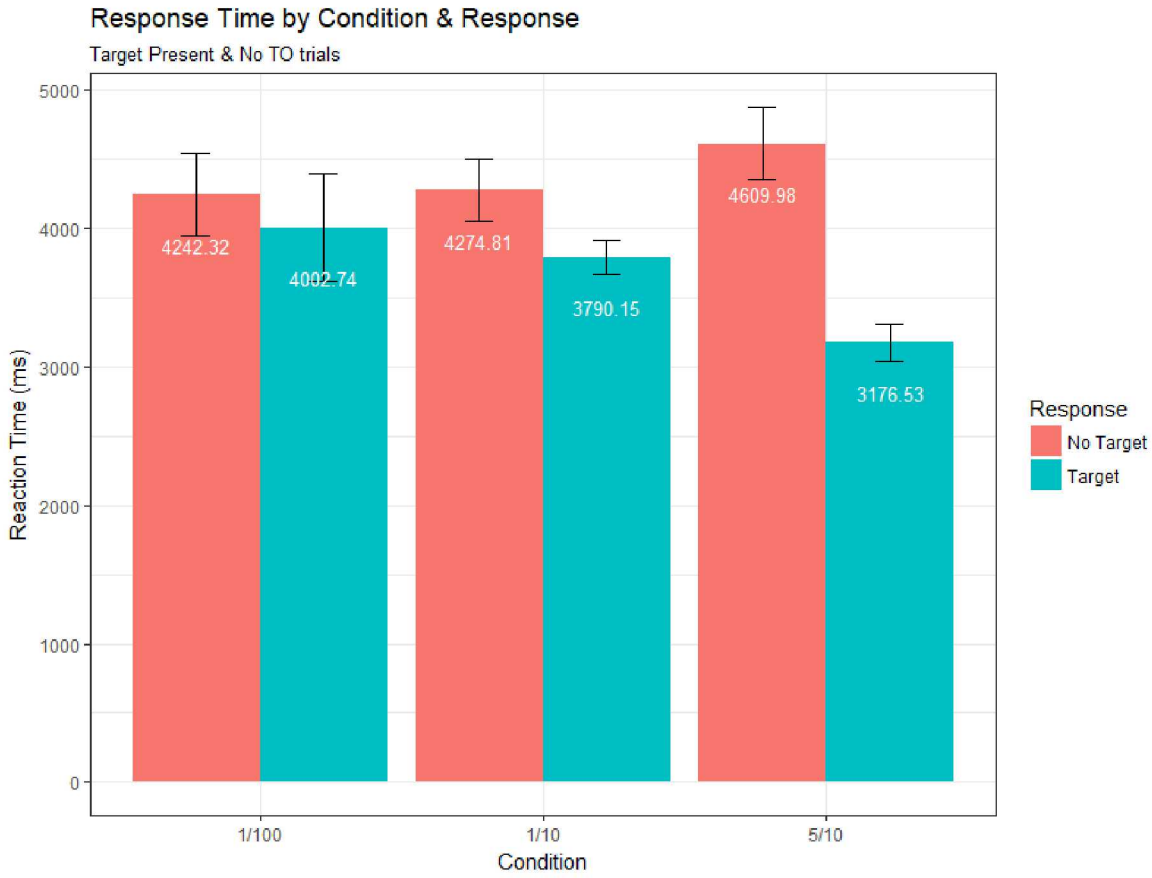


No subjects in the 1/10 condition detected the target on the final trial. It is unclear why this happened, but additional empirical work is planned to clarify this result.

Objective Measurement: Key Results



Error bars are standard error of the mean. The sole subject in the 1/1000 condition to detect the target also had zero false alarms.



It is expected that decision time when subjects respond "target present" will be shorter than when they respond "target absent" because once they find the target, they can stop searching.

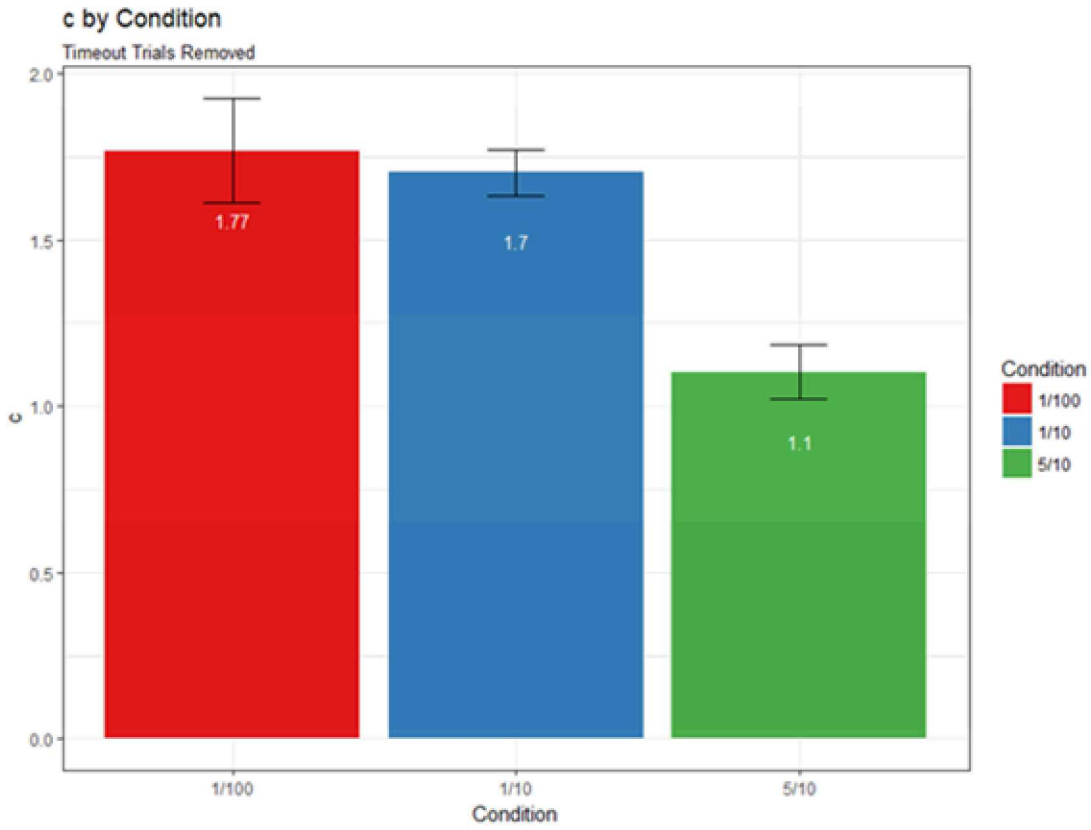
Interesting take-aways

Even in the condition with ½ of the trials being targets, detection was very poor – essentially a coin flip

Overall, false alarm rates were surprisingly low given the low detection rates

- This points to a strong bias towards saying "no target" – even when targets were constantly present
- The single subject in the 1/1000 condition who detected the final target also had zero false alarms

If these results generalize to PSS tasks, they could point to serious problems for detection of actual threats



"c" is a measure of response bias, and is measured in standard deviation units. Positive values of c indicate bias towards saying "no target" whereas negative values of c indicate a bias towards saying "threat."
Error bars are standard error of the mean. 1/1000 condition not shown because of the low number of total targets (14) and because only 1 out of 14 subjects detected the final target.

Summary

The ultimate goal is operator situation awareness

These systems are often not designed to maximize SA

Involvement of autonomy at any level further complicates the system

Both subjective and objective methods can be used to determine system effectiveness

- GDTA showed three primary roles an operator plays in a PSS central alarm station
- Quantitative testing showed false alarm rates have direct impact on probability of detection
  - Rarely occurring events impact human operator effectiveness in complex ways

As physical security moves towards more automated elements, the role of the human operator must be evaluated in order to create the most effective (and cost efficient) security system

Questions?

How Humans Interact with Automated Systems when Humans Aren't Accounted For