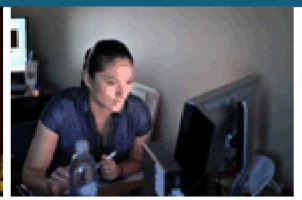
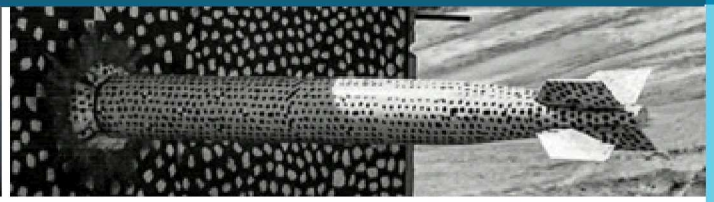
SAND2019-13547PE

Determining the Optimal Time on X-Ray Analysis for Transportation Security Officers





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ADSA21 – November 6th, 2019

Presented by Austin Silva

Senior Member of Technical Staff

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So What? Who Cares?

Mission: **Determine empirically when X-Ray interrogation performance begins to degrade, using an X-ray emulator, eye tracking, and signal detection theory metrics.**

- Currently 30-minute duty cycles are the standard.
- There is limited research around the limitations.

Problems needing solutions:

- Understand differences between individual TSOs and differences across airports.
- Develop novel methods to analyze eye tracking measures.
- Cross-training or specialization?

Methods for people with solutions to work with DHS/TSA

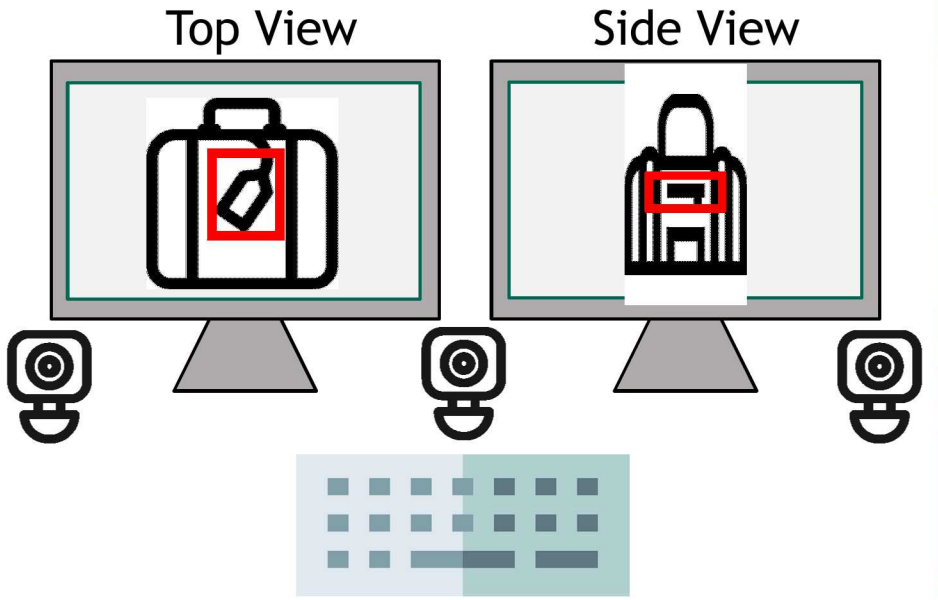
- Sandia National Laboratories have worked with TSA for many years now have conducted different experiments at the checkpoint.
- We are not able to share the results for this particular study at this time, but we are able to highlight the methodology and need for further empirical methods at the checkpoint.
- For questions about this presentation, contact Austin Silva (SNL). For detailed questions about the work, contact David Band (TSA).

Methods

- Approximately 200 TSOs were recruited for data collection to interrogate up to 1000 images on an X-ray emulator that mimics the Rapiscan AT-2 while their eye movements were recorded.
- TSOs performed the X-ray duty continuously for two hours.
- Afterwards, TSOs completed a 45-minute battery of visual cognition tasks.

6x2x2x2x12 mixed experimental design - factors include:

- Airport: between subjects (6 total airports)
- SOP: between subjects (PreCheck, Standard)
- Belt condition: between subjects (Static, Continuous)
- Threat type: within subjects (Clear, Threat Present)
- 10-minute epoch: (12 max total)



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Dependent Variables

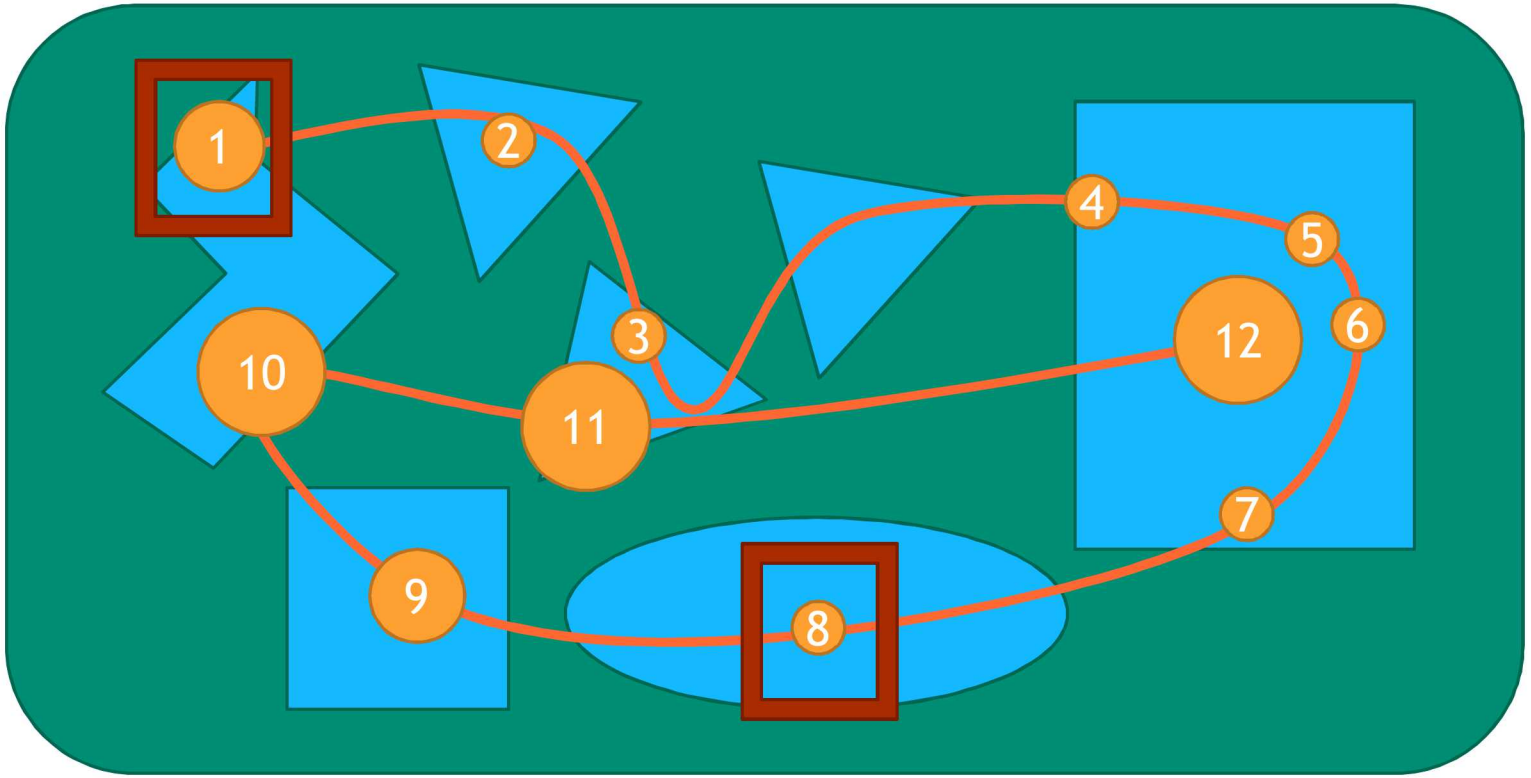
All variables are calculated overall as well as a function of 10-minute epochs.

- Image manipulation tool use (zoom, color changes, etc.)
- Probability of Detection (Pd), Probability of False Alarm (Pfa)
- Decision Time
- Calculated variables – including d', c, search time consistency [STC] (Biggs, Cain, Clark, Darling, & Mitroff, 2013)
- Image product use (e.g., order of image manipulation tools, which tools selected,

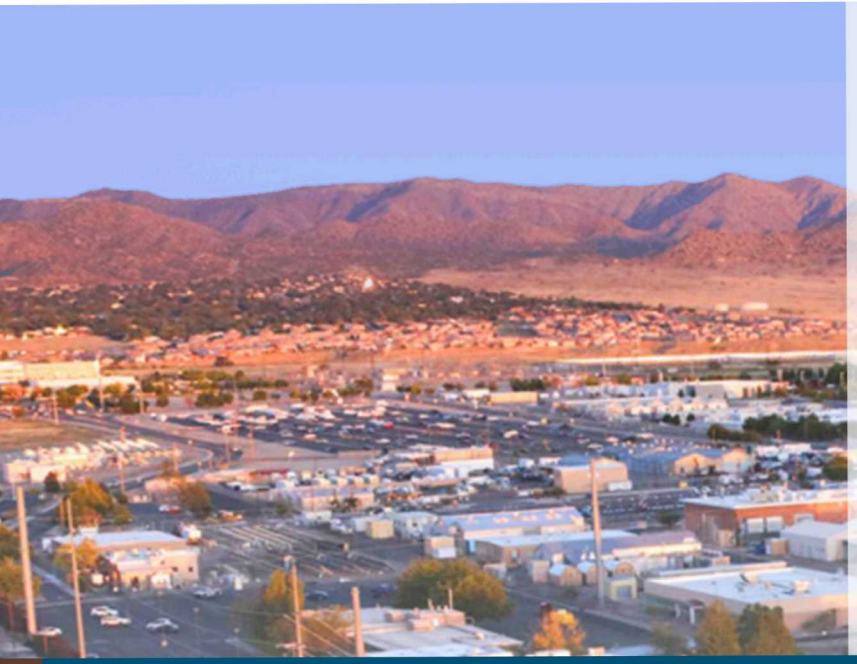
  eye tracking patterns associated with each bag, etc.)

Prevalence of threats was set at 10%

Eye Tracking Metrics



- Fixations
  - Time to 1st
- Fixation Durations
- Error Types
- Search Path
- Image Saliency



Questions?

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For paper, see: Speed, A., Silva, A., Trumbo, D., Stracuzzi, D.J., Warrender, C., Trumbo, M. Divis, K. *Determining the Optimal Time on X-ray Analysis for Transportation Security Officers*. 17th International Conference on Human-Computer Interaction. Springer. (2015).

Background

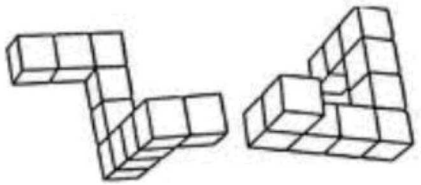
The study is informed by three main research fields: Vigilance, Visual Search, and Inspection.

Traditional Visual Search or Inspection tasks	Traditional Vigilance tasks
Complex scenes under the control of the searcher	Complex dynamic scene not under the control of the searcher
Can have multiple targets / classes of targets simultaneously	Usually has only one event at a time
Task is self-paced; observer can adjust how long decision can be made before moving on	The task is usually task-paced in that targets appear and disappear as a function of the task timing, not as a function of the observer's decision process
Momentary lapse of attention won't result in an error	Momentary lapse of attention can result in a miss error that is not correctable

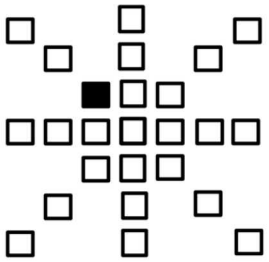
Visual Search Battery Tasks

Behavioral Tasks

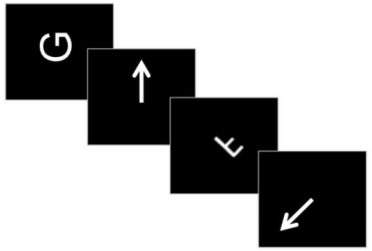
Mental Rotation



Attention Beam

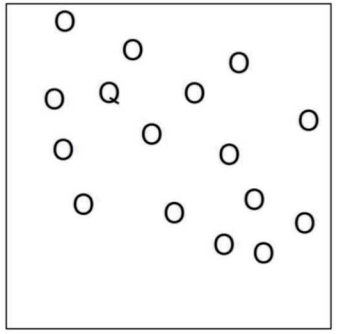


Spatial Working Memory

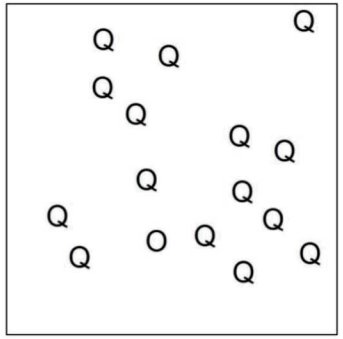


Eye Tracking Tasks

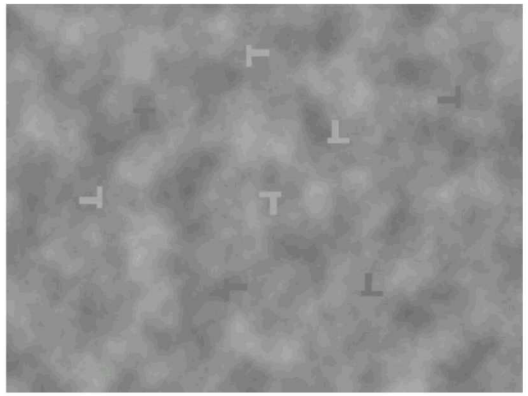
Parallel Visual Search



Serial Visual Search



Visual Inspection



Images from Matzen, L. E., Haass, M. J., Silva, A. R., Trumbo, M. C. S., Stevens-Adams, S. M., McNamara, L. A., & Speed, A. *Effects of Expertise on Domain-General and Domain-Specific Visual Search.*. United States. doi:10.1037/e524912015-054.