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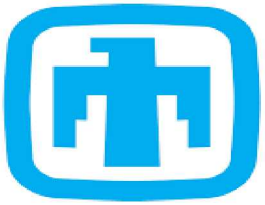

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Sandia National Laboratories

BEHAVIORAL ANALYSIS IN AVIATION SECURITY – COPING WITH COGNITIVE LOAD

TSA's Behavior Detection Analysis Program – Cognitive Task Analysis Study 2016

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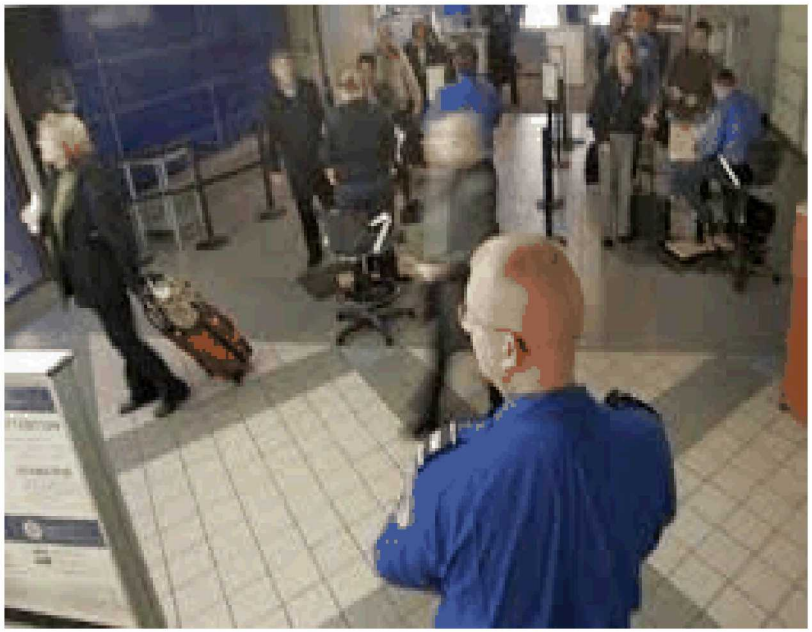
Problem Statement

- **Behavior Detection Analysis (BDA) is comprised of trained Behavior Detection Officers (BDOs) conducting a series of (often parallel) cognitive tasks in complex environments.**
- **Task performance depends on:**
  - Attention demand (how hard tasks are relative to the person's capacity).
  - Allocation policy (which tasks the person chooses to direct their attention to).
- **Attention demand and allocation policy can increase cognitive load.**
- **Cognitive load measures which tasks elicit the highest level of mental effort to complete.**



- **TSA tasked Sandia National Labs to measure the correlation between cognitive load and BDA task performance to inform BDA optimization efforts—Cognitive Task Analysis (CTA).**

Cognitive Load Measurement

- **Cognitive load sources can be intrinsic to the task and/or external. For BDOs they are often linked.**
- **Extensive cognitive load can lead to cognitive fatigue.**
- **Measuring cognitive load:**
  - Subjective – ask subjects to introspect the task performed.
  - Objective - manipulate task difficulty to induce low / high loads, and record task performance (e.g. response times, error rates, etc.) to assess correlation between load and performance.

- **Chosen measurement method was the NASA Task Load Index (TLX) - a widely validated and established subjective rating.**

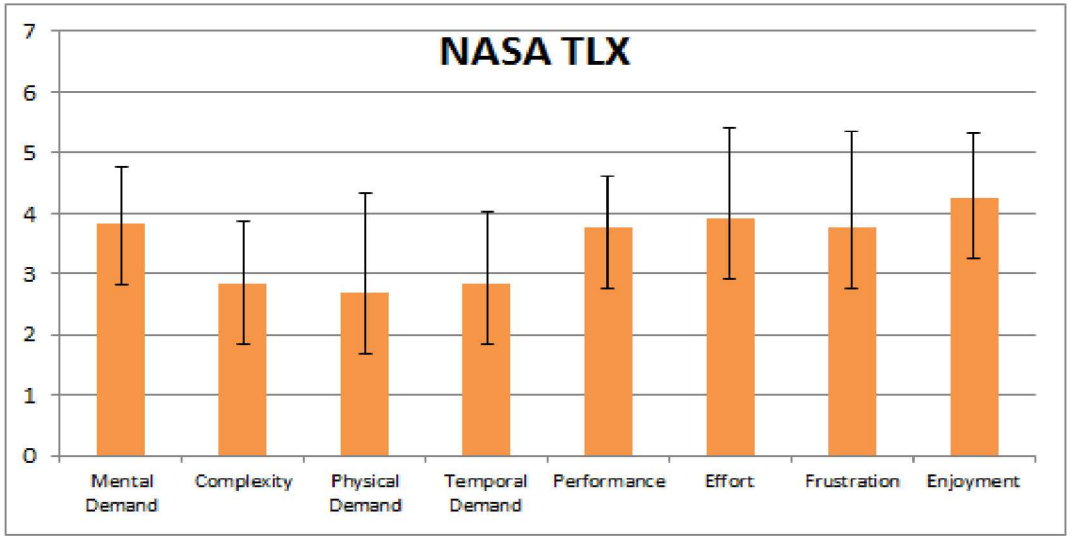
Cognitive Fatigue and BDOs

- **Four types of BDA cognitive activities that are most susceptible to cognitive load and fatigue:**
  - Working memory
    - The temporal storage of information.
    - Passenger evaluation by BDOs for referral[1]
  - Concentration and vigilance
    - Maintaining a consistent behavioral response during periods of sustained, repetitive activity.
  - Visual Scanning
    - Looking for something notable amidst a field of distractors.
  - Long-term Memory
    - Holding and recalling relevant information (without manipulation of information).

- **Mitigating the impact of cognitive fatigue requires:**
  - Understanding the cognitive activities that are most affected by fatigue.
  - Exploring possible ways to reduce the degree to which a BDO's tasks rely on taxing, top-down mental processes (e.g. working memory, maintaining attention, visual scanning) or decrease BDO task duration.

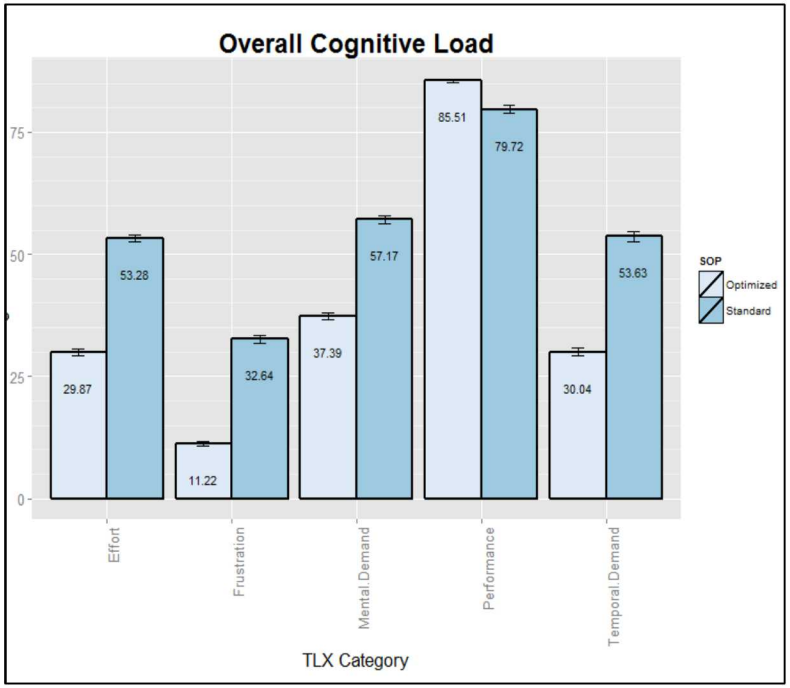
Cognitive Task Analysis Methodology

- **Leveraged extensive BDA job analyses**
  - A systematic analysis of the components which make up a job.
- **CTA Components:**
  - Study group was 18 BDO SMEs from multiple airports.
  - Parsed two BDO's Standard Operating Procedures (SOPs) - standard BDA and optimized, into hundreds of identified cognitive tasks per each of the physical (observable) task (identified in previous Job analyses).
  - BDO SMEs ranked each cognitive task using the NASA TLX scoring method (on a 1-100 scale).
  - Qualitative results discussions were also conducted with BDO SMEs.



Results and Analysis

- **Overall Optimized SOP was significantly lower in cognitive load vs. the Standard SOP.**
  - Having more discretion and flexibility over how to perform the SOP and being able to more actively engage passengers reduced cognitive load.
- **Most taxing cognitive tasks:**
  - Public interaction (e.g. self regulating while dealing with hostile passengers).
  - Memorization (e.g. storing and recalling indicators under time pressure[1]).
  - Many such tasks fall into the Executive Function categories (Working Memory, Concentration and Vigilance and Visual Scanning).



Conclusions

- **A refined understanding of sources of cognitive load informs the optimization of SOPs as well as other elements of the job (e.g. staff development, technology, job environment, etc.).**
- **Aspects of cognitive load tend to cluster together (e.g., Mental Demand, Temporal Demand, and Effort).**
- **The cognitive model of Executive Functions helps with further optimization.**
- **Experiments focused on directly measuring cognitive load should focus on these kinds of cognitive functions.**
- **Efforts to reduce cognitive load should focus on reducing the requirements on BDOs' working memory and attentional control.**