

SERC DOCTORAL STUDENT FORUM 2023 | NOVEMBER 14, 2023

System at a Glance: Eye-Tracker-Enabled Real-Time Adaptive Decision Support for Commanders in Dynamic Environments

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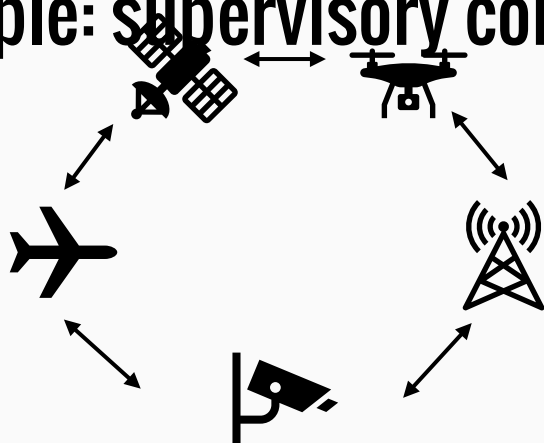
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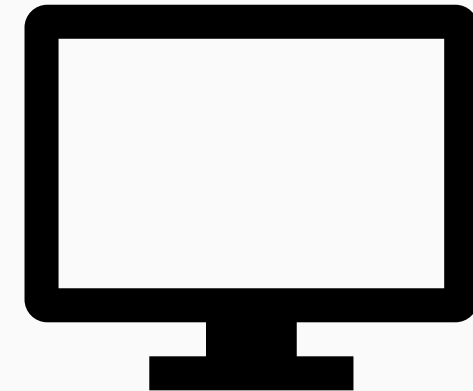
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Introduction

- Mission commanders & supervisors → dynamically changing situations regularly
- Example: supervisory control (SC) of ISR missions



Data provided via a network of sensors

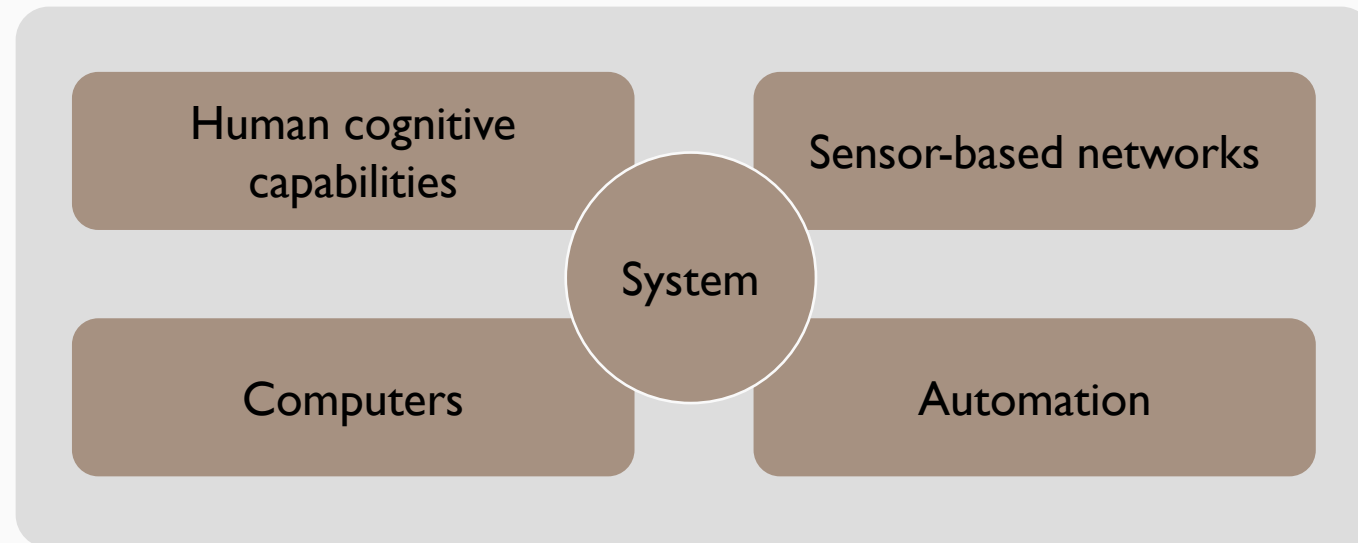


Transmitted to the command center interface
(in real-time)

- Successful decision-making & maintaining good situation awareness depend on **perceiving and processing the flow of large amounts of information** displayed on interfaces.

The Problem

- Humans have **limited** information-processing capability
- Information can be missed due to **change blindness** and/or **inattention blindness** resulting in **non-optimal allocation of attention**
- Need to understand the interplay of different elements as a whole (**system**) and provide necessary **decision support tools (DST)**, especially for **timely attentional guidance**

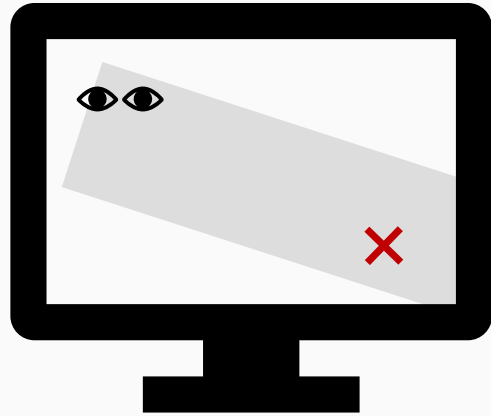


SEEV Model (Wickens et al., 2001)

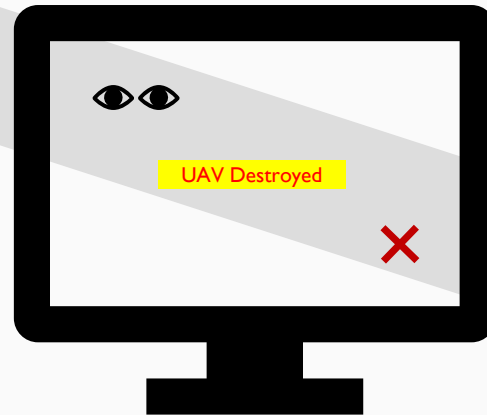
$$P(\text{Visual allocation}) = \text{Saliency} - \text{Effort} + \text{Expectancy} + \text{Value}$$

Diagram illustrating the SEEV Model equation: $P(\text{Visual allocation}) = \text{Saliency} - \text{Effort} + \text{Expectancy} + \text{Value}$. The terms "Saliency - Effort" are highlighted in a light orange box, and "Expectancy + Value" are highlighted in a light blue box. An upward arrow labeled "Bottom-up" points to the "Saliency - Effort" box, and a downward arrow labeled "Top-down" points to the "Expectancy + Value" box.

Eye-tracker-based Adaptive DST



An event happens but attention is elsewhere



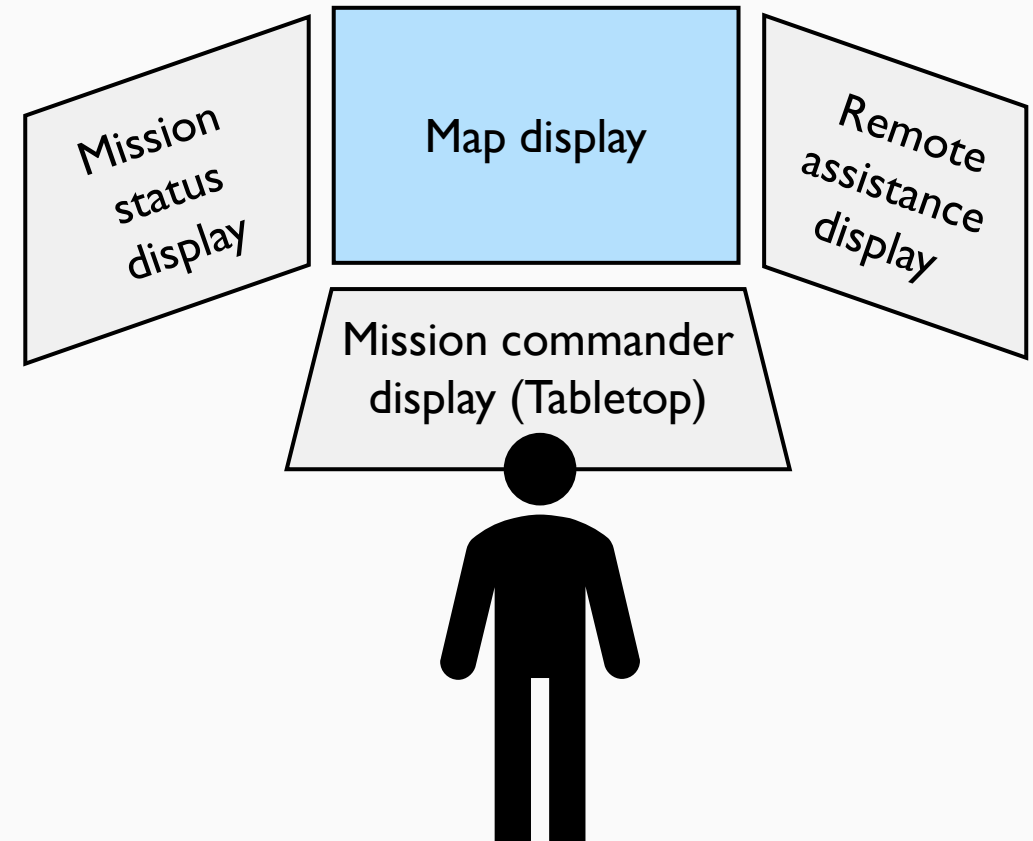
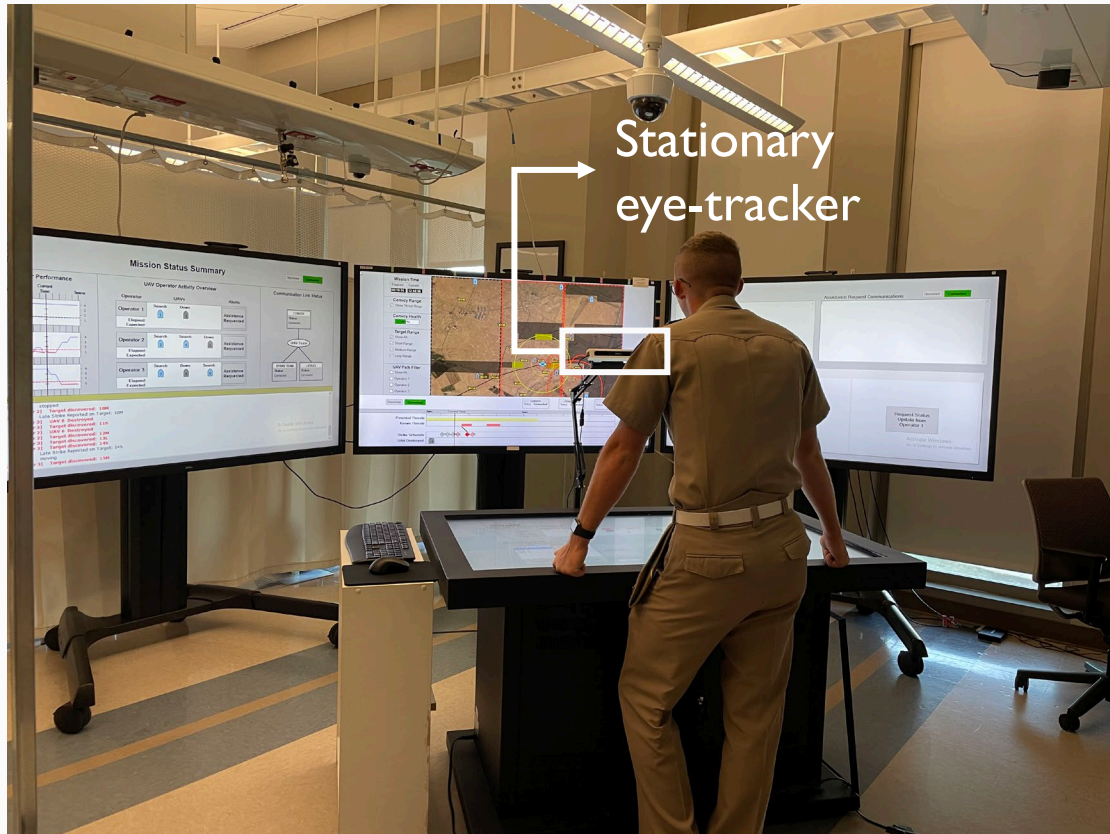
Attention-guiding feature is displayed



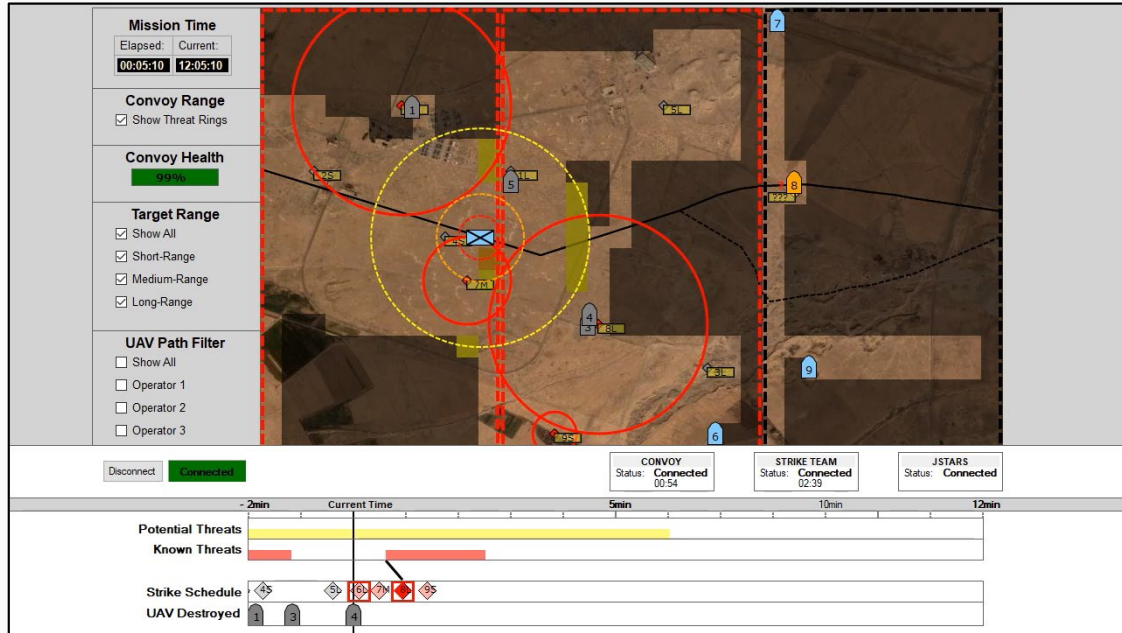
Attention is directed to the area of interest

- The attention-guiding message will **not** be displayed if attention is already allocated

The Simulation Testbed

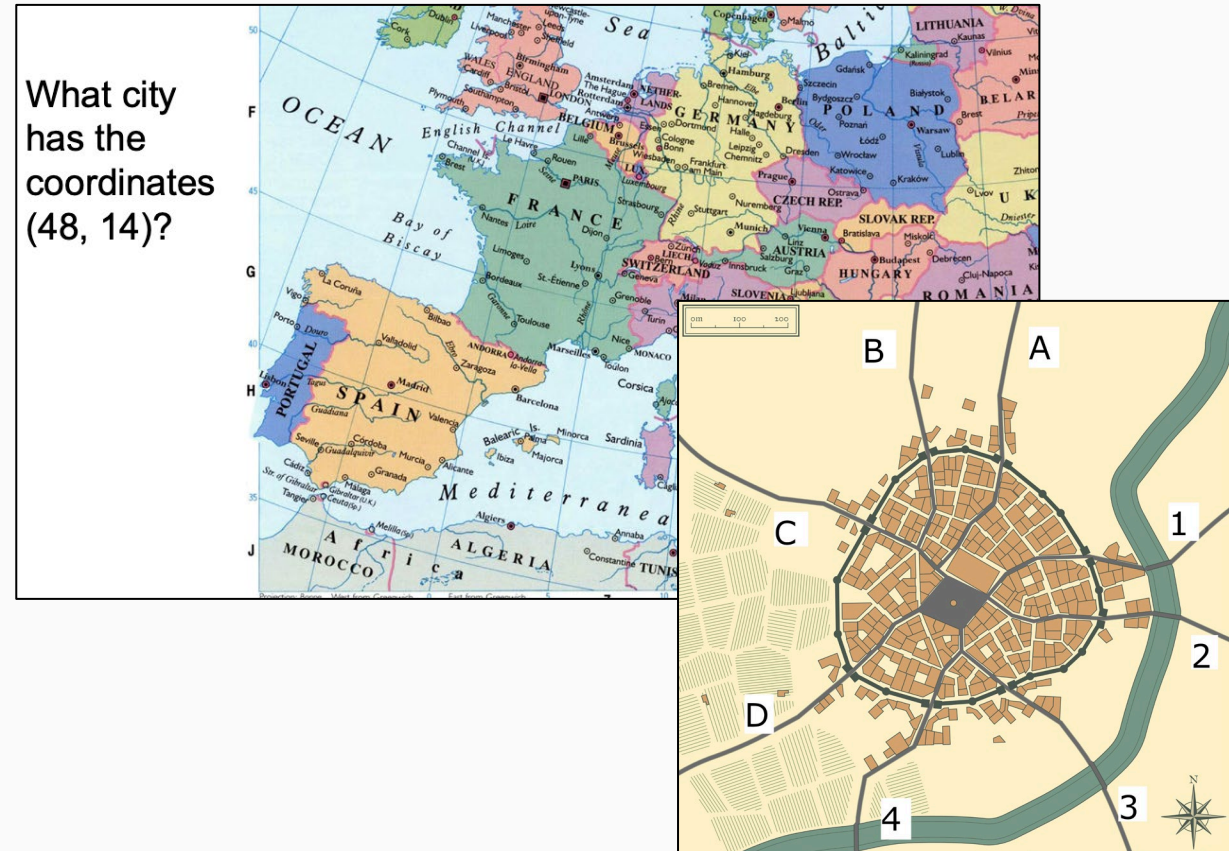


Tasks



Main task:

Ground force protection mission utilizing various ISR assets (UAVs, JSTARS, etc.)



What city has the coordinates (48, 14)?

Interruption task:

1. Write the city name/coordinates
2. Plan for another convoy mission (verbal reasoning)

Intervention: Real-Time Adaptive DST

Notification
(visual alert)

ALWAYS:

1) Convoy under attack

GUIDED:

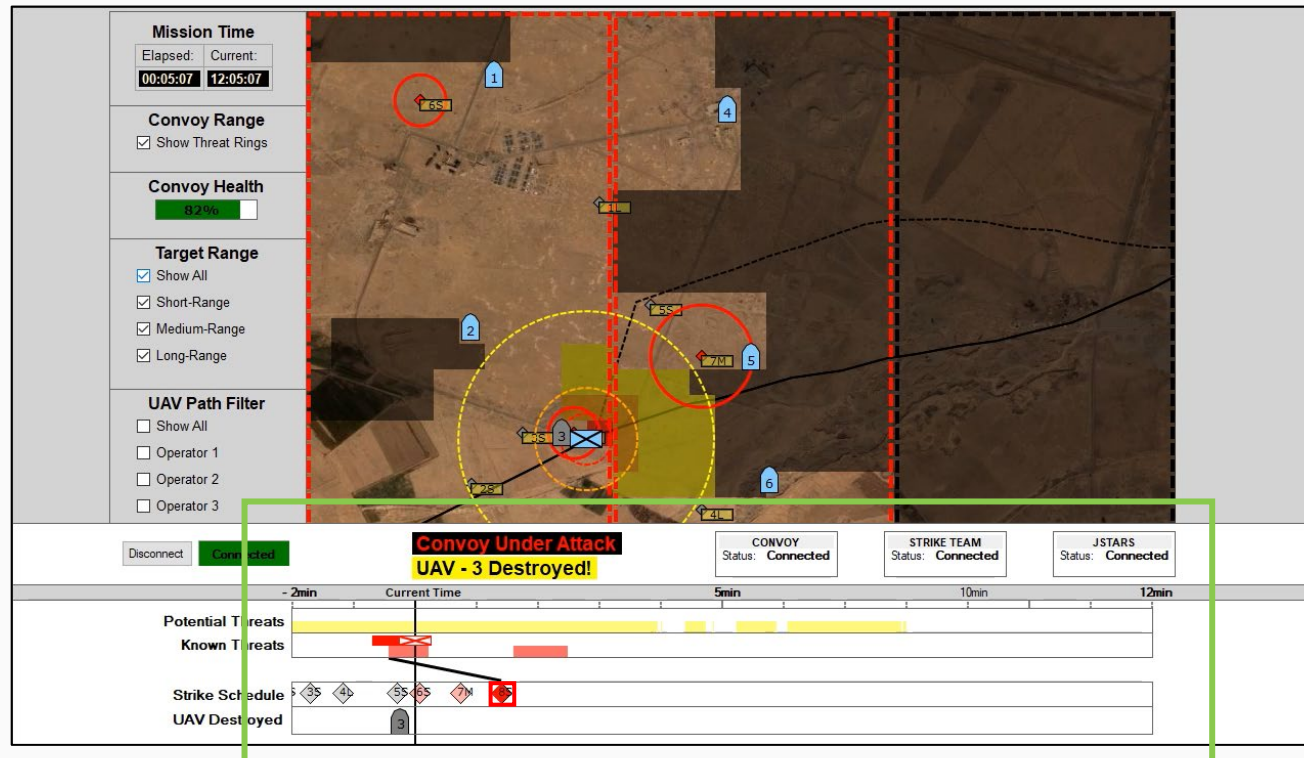
1) Not looking

2) Looking but no action for 3 seconds

a. UAV destroyed (highlighted message box)

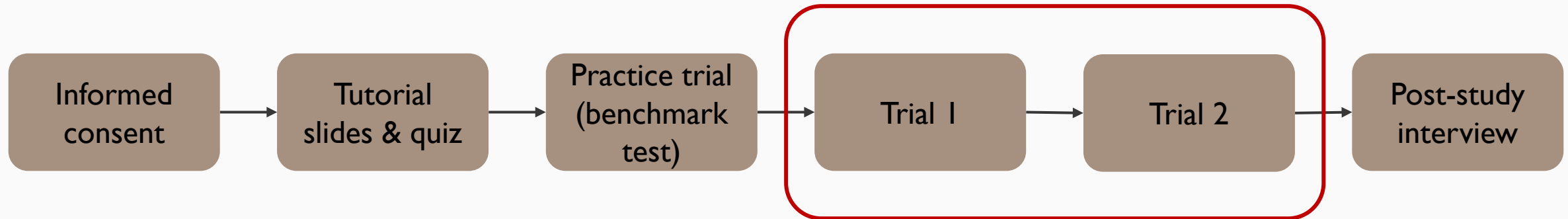
b. Target late strike (diagonal line)

c. Communication issues (flashing box)

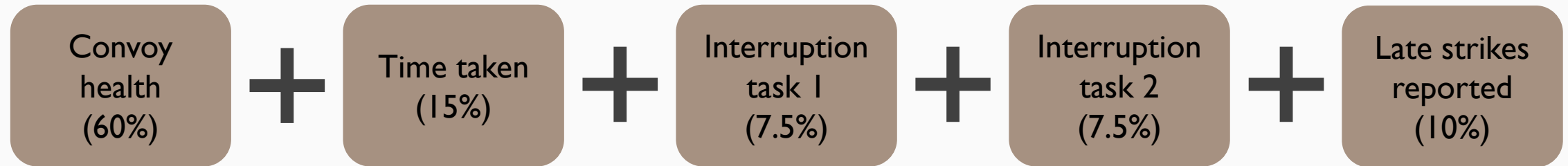


Experiment Procedure

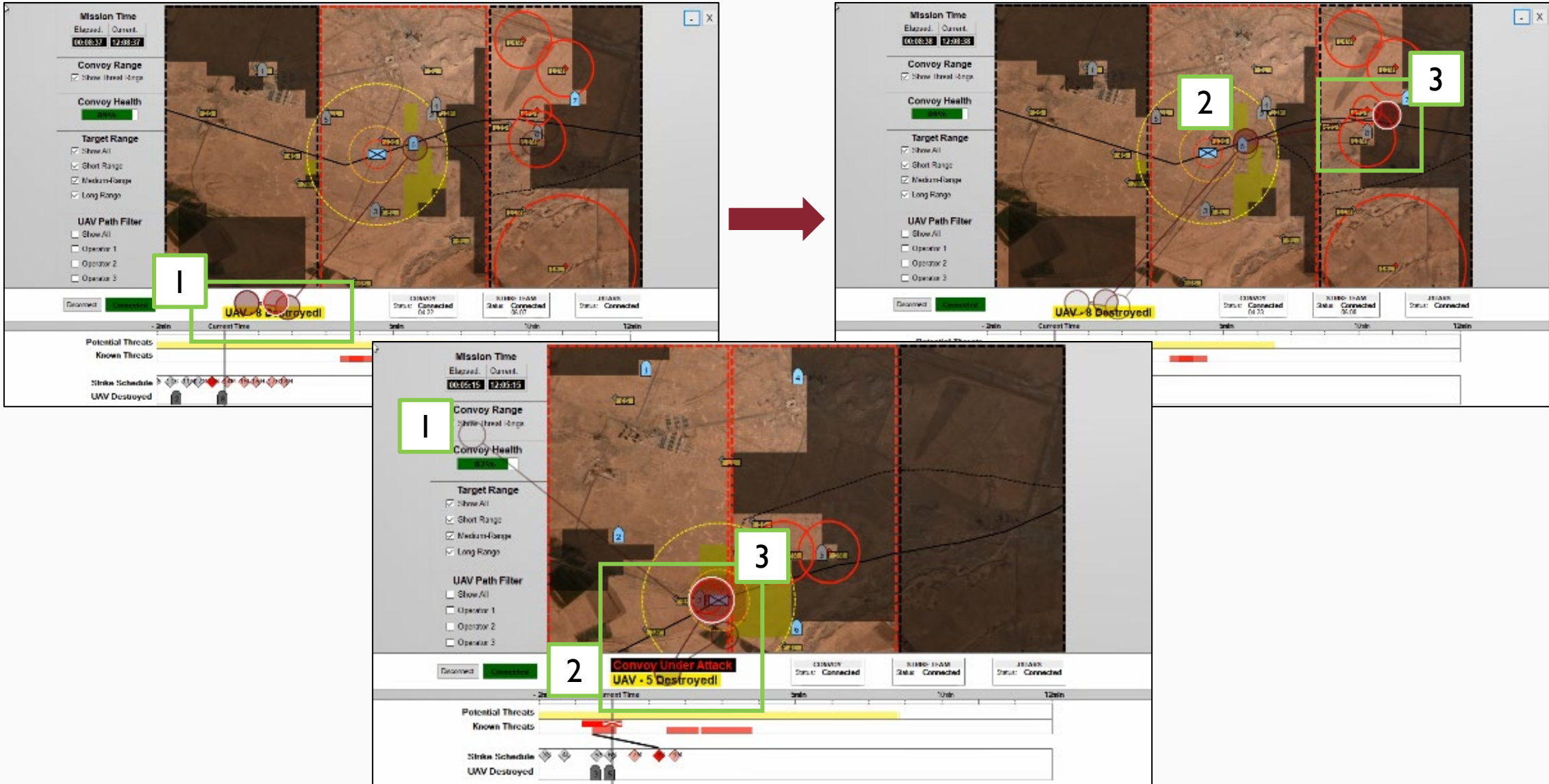
- 8 Texas A&M Corps of Cadet students (juniors & seniors)
- Within-subjects study
- Performance score measured for each condition (control vs. intervention)



Measure of Performance (MOP)

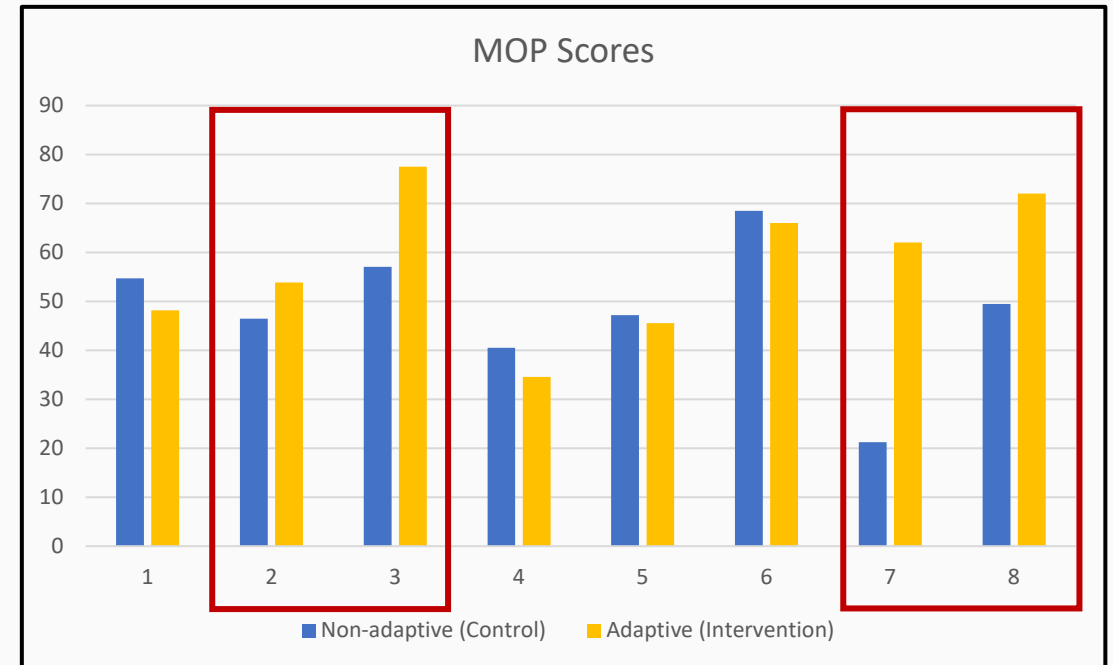


Results: Did the Intervention Capture Attention?



Results: Did the Intervention Improve Performance?

Participant #	Non-Adaptive (Control)	Adaptive (Intervention)	Score difference
1	54.69	48.15	6.54
2	46.5	53.83	7.33
3	57.05	77.5	20.45
4	40.55	34.57	5.98
5	47.2	45.55	1.65
6	68.5	66	2.5
7	21.25	62.05	40.8
8	49.45	72.05	22.6



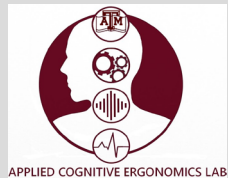
- The average score difference when performance was better in the intervention was **22.8** whereas the difference was **4.2** when the control was better.

Discussion

- Preliminary evidence shows that the **adaptive DST is effective**
 - Expect to see better results with a bigger sample size
 - Pairwise t-test:
 $p = 0.167$
cohen's $d = -0.545$
- Subliminal Perception?
 - 7/8 participants answered that they **did not notice the differences** in the displays between the two trials
- Future studies will integrate...
 - **Additional eye trackers** for other displays
 - AI/ML models to **monitor and predict** individual behaviors
 - **Physiological data** (e.g. heart rate) and **stress detection** technologies to better inform supervisors

Thank you

Stay connected with SERC Online:



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