Cyber Operations Stress Survey (COSS):

Studying fatigue, frustration, and cognitive workload in cybersecurity operations

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AGENDA

- Motivation
- Stress
- Developing the Cyber Operations Stress Survey (COSS)
- Case Study at NSA
- Lessons Learned and Conclusions
- Questions


MOTIVATION

TACTICAL CYBER OPERATIONS

Planned, structured set of activities with a specific goal in mind

- Speed and precision
- Highly trained workforce
- High-risk, high-reward work
- Ex: CTF, penetration testing



STRESS AND CYBER



STRESS HAS EFFECTS ON…

FATIGUE	Physical and mental feeling of tiredness
FRUSTRATION	Anxiety and annoyance over lack of control
COGNITIVE WORKLOAD	Amount of mental effort needed to use memory

RELATED WORK

- Demanding jobs require attention, memory, and visual perception [7]
- High workload increases likelihood of errors, decreases performance [14]
- Burnout linked to mental exhaustion from stress [21]
- Shift work and hours worked contributed to high stress and burnout in cyber warfare operators [3]
- Vigilance for (simulated) cyber events consistent with air traffic control [20]
- Stress from urgency to respond and hyper vigilance involved from not wanting to reveal position or strategy [8]

STUDYING CYBER STRESS

- Small, inaccessible study population
- Sensitive work environments
- Few validated research methods

CYBER OPERATIONS STRESS SURVEY

- Subjective measure of stress
- Summative assessment
- Well-validated models
- Minimally invasive, *in situ* experience sampling

FATIGUE

Samn-Perelli Fatigue Scale

Fatigue: How awake or tired are you before the operation?



Fully alert, wide awake.	Very responsive, but not at peak.	Okay, somewhat fresh	A little tired, less than fresh.	Moderately tired, let down.	Extremely tired, very difficult to concentrate.	Exhausted, unable to function effectively

FRUSTRATION & COGNITIVE WORK

NASA Task Load Index (TLX)



Mental Demand: How mentally demanding was the operation?

Physical Demand: How physically demanding was the operation?

Time Demand: How hurried or rushed was the pace of the operation?

Overall Performance: How successful were you in accomplishing what you were asked to do?

Frustration Level: How insecure, discouraged, irritated, stressed, and annoyed were you?

Effort: How hard did you have to work to accomplish your level of performance?

BASELINE

Normalizing Individual Differences

Fatigue: How awake or tired are you **before the operation**?



Fully alert, wide awake. | Very responsive, but not at peak. | Okay, somewhat fresh | A little tired, less than fresh. | Moderately tired, let down. | Extremely tired, very difficult to concentrate. | Exhausted, unable to function effectively

Fatigue: How awake or tired are you **after the operation**?



Fully alert, wide awake. | Very responsive, but not at peak. | Okay, somewhat fresh | A little tired, less than fresh. | Moderately tired, let down. | Extremely tired, very difficult to concentrate. | Exhausted, unable to function effectively

BASELINE

Normalizing Individual Differences

Frustration Level: How insecure, discouraged, irritated, stressed, and annoyed **are you**?



Very Low Very High

Frustration Level: How insecure, discouraged, irritated, stressed, and annoyed **were you**?



Very Low Very High

OTHER MEASURES

Background

- Years experience
- Other duties as assigned

Personal

- Last day off
- Shift schedule
- Caffeine intake

Operation

- Operation type
- Team synergy
- Accomplish goal?

Cyber Operations Stress Survey

PRE-OP: Complete this part before you start the operation

Name or Participant ID:	Date:
What time did you arrive at the office today?	When was your last operation?

Operation type or goal:

Study-specific questions can be added as needed…

Fatigue: How awake or tired are you before the operation?

Fully alert, wide awake.	Very responsive, but not at peak.	Okay, somewhat fresh.	A little tired, less than fresh.	Moderately tired, let down.	Extremely tired, very difficult to concentrate.	Exhausted, unable to function effectively.

Frustration Level: How insecure, discouraged, irritated, stressed, and annoyed are you right now?

Very Low — Very High

★ Complete this section only if you have never completed a version of this survey before:

Job Role
How long have you worked in this job?
What are your other work duties or responsibilities?

Operation start time:

Complete the back page after the operation is complete →

Cyber Operations Stress Survey

POST-OP: Complete this part after you complete the operation

Operation end time:

Fatigue: How awake or tired are you after the operation?

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Mental Demand: How mentally demanding was the operation?

Very Low — Very High

Physical Demand: How physically demanding was the operation?

Very Low — Very High

Time Demand: How hurried or rushed was the pace of the operation?

Very Low — Very High

Overall Performance: How successful were you in accomplishing what you were asked to do?

Very Low — Very High

Frustration Level: How insecure, discouraged, irritated, stressed, and annoyed were you?

Very Low — Very High

Effort: How hard did you have to work to accomplish your level of performance?

Very Low — Very High

Team Synergy: How well did your team work together?

Very Low — Very High

Did you complete your objective?	☐ Yes	☐ No

Is there anything else you would like to tell us?

STUDY EXECUTION



CASE STUDY

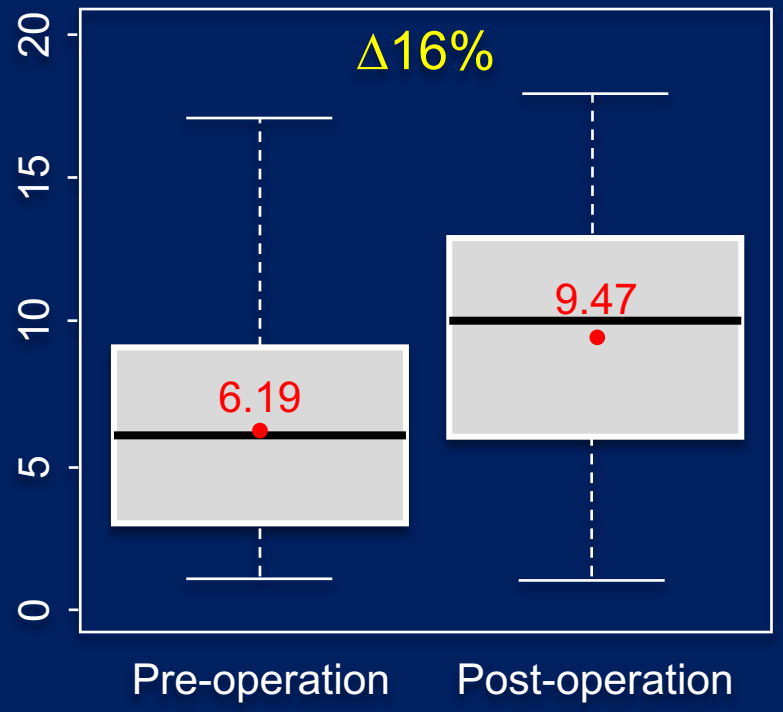
4 NSA Locations

126 Tactical Cyber Operators

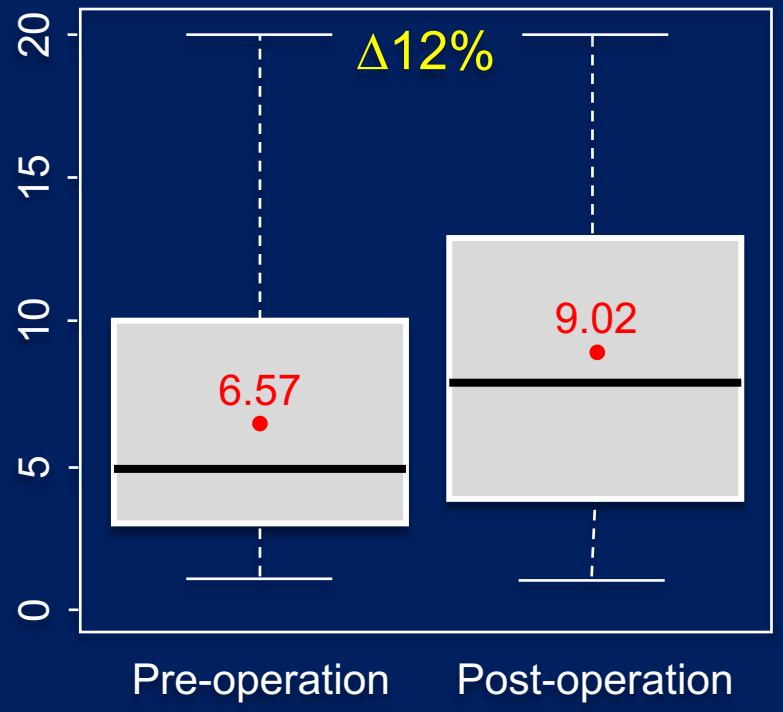
361 Operation Surveys

Both CIV and MIL*

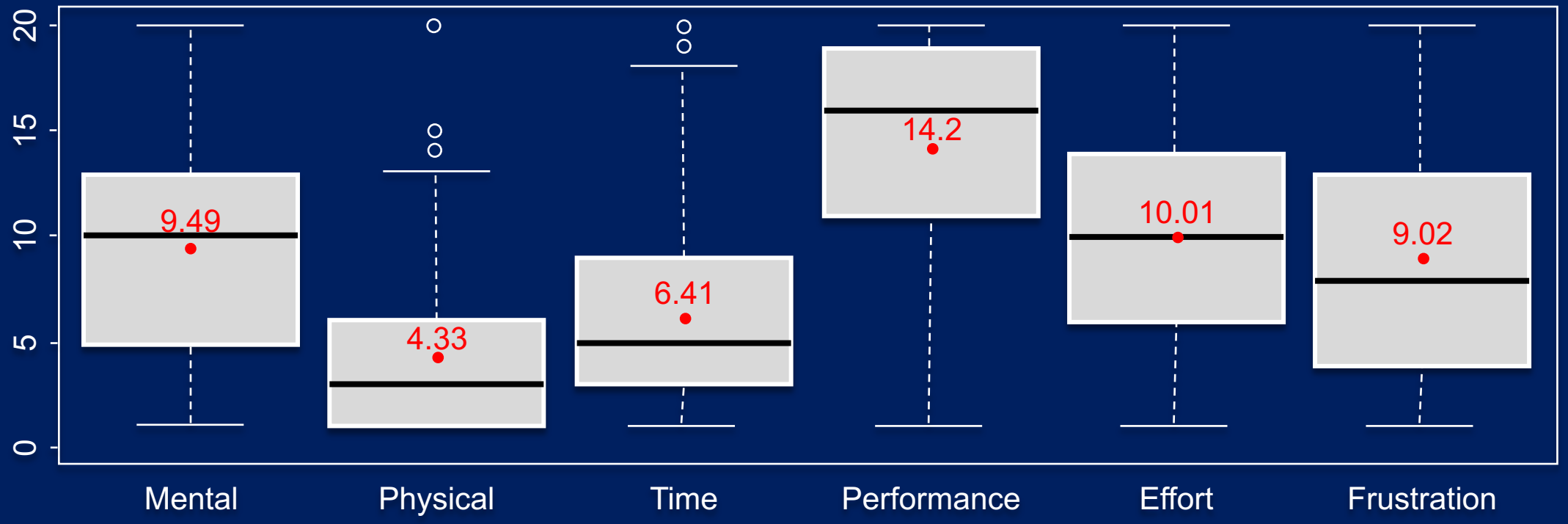
RESULTS: Fatigue



RESULTS: Frustration



RESULTS: Cognitive Workload



RTLX = 44.5 (SD = 28.1)

INTERNAL VALIDITY

Cognitive Stress Factors		N	Df	F	p
Fatigue	Pre-operation	357	3	0.53	.644
	Post-operation	356	3	0.46	.714
Frustration	Pre-operation	335	3	0.78	.503
	Post-operation	357	3	0.72	.541
Cognitive Workload	Mental demand	356	3	1.62	.184
	Physical demand	356	3	0.06	.982
	Time pressure	356	3	2.12	.097
	Performance	352	3	0.60	.615
	Effort	356	3	0.14	.936

INTERNAL VALIDITY

	Mental	Physical	Time	Performance	Effort	Frustration
Physical	.479*					
Time	.547*	.541*				
Performance	-.034	-.012	-.022			
Effort	.686*	.486*	.509*	-.009		
Frustration	.468*	.334*	.429*	-.315*	.469*	

* $p < .001$

EXTERNAL VALIDITY

Study	RTLX	SD
COSS	44.55	28.1
Incident Response (Champion et al.)	56.94	21.4
Cyber Defense (Greenlee et al.)	51.94	14.2
Incident Escalation (Greenlee et al.)	40.04	11.6

LESSONS LEARNED

Participant Motivation

- Negative attitudes
- Value of sharing results
- Friendly ‘competition’

Contextual Factors

- Caffeine intake
- Team synergy

Limitations

- Subjective/self-report
- Affected by external factors

CONCLUSIONS

COSS is an effective research instrument

Human resiliency compliments technology resiliency

Consider objective data for detection and prediction

Potential for real-time analysis and automated risk assessments

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Very Low — Very High



Significantly dropped after the operation!

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