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The views, opinions and/or findings contained in this report are those of the author(s) and should not contrued as an official Department of the Army position, policy or decision, unless so designated by other documentation.

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a. REPORT	b. ABSTRACT	c. THIS PAGE			William Kalkhoff
UU	UU	UU	UU		19b. TELEPHONE NUMBER 330-672-3712

RPPR Final Report
as of 22-Jun-2022

Agency Code: 21XD

Proposal Number: 69810LS **Agreement Number: W911NF-17-1-0456**
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Report Date: 31-May-2022 Date Received: 22-Jun-2022
Final Report for Period Beginning 11-Sep-2017 and Ending 31-May-2022
Title: Team Perception and Performance Under Threat
Begin Performance Period: 11-Sep-2017 **End Performance Period:** 31-May-2022
Report Term: 0-Other

Submitted By: William Kalkhoff Email: wkalkhof@kent.edu
Phone: (330) 672-3712

Distribution Statement: 1-Approved for public release; distribution is unlimited.

STEM Degrees: 0 **STEM Participants:**

Major Goals: In our last report, we reiterated that our laboratory had been shut down since March of 2020, and at the time of that report, we still had 14 experimental sessions left to complete. Our main goal was to finish those up (and thus the entire study) as soon as our lab reopened.

Accomplishments: We accomplished our goal. We completed all data collection in December of 2021 and thus finished the project.

Training Opportunities: We resumed data collection on October 8, 2021 after our lab was able to reopen, and data collection proceeded until the last experimental session was administered on December 10, 2021. The assistants who worked on the project were ones that were involved in data collection prior to the Covid shutdown, so there were no new training opportunities.

Results Dissemination: As mentioned in our last report, even though our laboratory was shut down up to submission of the last report, we began analyzing the behavioral for 66 (out of 80) teams for which we had complete data. To reiterate, we presented preliminary findings in October of 2020 at an online session of the ARO's Monthly Program Review/Seminar series on Innovations in Bioscience Sensing & Signaling:

Kalkhoff, Will and Joshua Pollock. 2020. "Team Perception & Performance Under Threat." Army Research Office, Life Sciences Division, Monthly Program Review/Seminar Series on Innovations in Bioscience Sensing & Signaling.

I will re-upload this.

At the moment we are completing analyses of the new behavioral data for the 14 groups that we finished up in December, and we are working our way through processing and analyzing the huge amount of physiological data (EEG, ECG, and GSR). Given the total number of teams (80), this is a painstaking process that will take us a few more months to complete. We hope to have a draft of a manuscript that includes all results by the end of the coming academic year.

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Honors and Awards: Dr. Kalkhoff signed two sponsored research agreements/contracts with external partners during the reporting period. Both projects are related to, and developed directly out of, our ARO-sponsored work (i. e., W911NF1710456). The two sponsored research agreements are:

Kalkhoff, Will (PI) and Joshua Pollock (Co-PI). “Can ‘The Last Maestro’ Reduce Stress and Aggressive Behavior Elicited by the Enactment of Simulated Violence.” Maestro Games, SPC. Funded at $103,565.20 for the period April 1, 2022-December 31, 2023.

Kalkhoff, Will (PI) and Joshua Pollock (Co-PI). “Evaluating the Comparative Effectiveness of the MILO Range Simulation Training System.” FAAC Incorporated, DBA MILO-LVC. Funded at $48,748 for the period October 15, 2021-October 15, 2022.

MILO provides simulation-based tactical training for law enforcement and military personnel worldwide. A study where Dr. Kalkhoff and his team used a MILO simulator was recently published in the Journal of Police and Criminal Psychology (https://link.springer.com/article/10.1007/s11896-022-09519-5). Dr. Kalkhoff's work with MILO was also featured on Kent State TV (https://www.youtube.com/watch?v=AseOilj7jk4). Maestro Games, SPC has partnered up with MILO to provide their device as a way of de-stressing officers who are going on duty. We will be testing that device in our lab to see how effective it is. It will be the most rigorous test of the device to date.

In addition to these major, project-related accomplishments, Dr. Kalkhoff completed his term as an NSF Sociology Advisory Panel member during the project period. He also recently completed his term as an Executive Committee member of the Brain Health Research Institute at Kent State University. He continues as an ongoing fellow of the Inter-University Seminar on Armed Forces in Society. He is also a returning guest editor for Advances in Group Processes (volume 40) and will likely come on as a series editor starting with volume 41. Finally, during the reporting period, along with Dr. Joy VerPlanck (Senior Insight Strategist, NeuroLeadership Institute) and Dr. David Rock (Co-Founder & CEO, NeuroLeadership Institute), Dr. Kalkhoff served as an panelist for an episode of Your Brain at Work LIVE focusing on "Power and Expectations: The Neuroscience of Group Dynamics" (https://www.youtube.com/watch?v=x4JczNbUtBk). He also served as an invited panelist for a session of the 2022 Neuroleadership Summit on "Breakthroughs: Allyship and Power: Propelling Equity."

Graduate research assistant, Haley Crews, received the Elaine Mai Schock Outstanding Master’s Student Award as well as a Graduate Student Senate Research Award. In addition, she was hand-picked by the governor of Ohio to serve as Graduate Student Trustee to the Kent State Board of Trustees. That is a major honor for a graduate student at Kent State.

Graduate research assistant, Chloe Miller, received a Research Award (Spring 2021) and an Outstanding Presenter Award (Spring 2022) from the Graduate Student Senate at Kent State University.

Protocol Activity Status:

Technology Transfer: Nothing to Report

PARTICIPANTS:

Participant Type: PD/PI
Participant: Will Kalkhoff
Person Months Worked: 12.00 **Funding Support:**
Project Contribution:
National Academy Member: N

Participant Type: Co PD/PI
Participant: Joshua Pollock
Person Months Worked: 12.00 **Funding Support:**
Project Contribution:
National Academy Member: N

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Participant Type: Graduate Student (research assistant)
Participant: Chloe Miller
Person Months Worked: 9.00 **Funding Support:**
Project Contribution:
National Academy Member: N

Participant Type: Graduate Student (research assistant)
Participant: Matthew Pfeiffer
Person Months Worked: 9.00 **Funding Support:**
Project Contribution:
National Academy Member: N

Participant Type: Graduate Student (research assistant)
Participant: Graem Sigelmier
Person Months Worked: 9.00 **Funding Support:**
Project Contribution:
National Academy Member: N

CONFERENCE PAPERS:

Publication Type: Conference Paper or Presentation **Publication Status:** 4-Under Review
Conference Name: ARO Life Sciences Division Program Review
Date Received: 21-Aug-2018 Conference Date: 08-Jan-2018 Date Published:
Conference Location: Cocoa Beach, FL
Paper Title: Neurodynamics of Status
Authors: Will Kalkhoff, David Melamed, Joshua Pollock
Acknowledged Federal Support: **Y**

Publication Type: Conference Paper or Presentation **Publication Status:** 0-Other
Conference Name: Army Research Office Life Sciences Division, Monthly Program Review/Seminar Series on Innovations in Bioscience Sensing and Signaling
Date Received: 21-Jun-2022 Conference Date: 14-Oct-2021 Date Published:
Conference Location: Online
Paper Title: Team Perception & Performance under Threat
Authors: Dr. Will Kalkhoff, Dr. Joshua Pollock
Acknowledged Federal Support: **Y**

RPPR Final Report
as of 22-Jun-2022

Partners

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I certify that the information in the report is complete and accurate:
Signature: Will Kalkhoff
Signature Date: 6/22/22 12:40PM

Army Research Office Life Sciences Division
Monthly Program Review/Seminar Series on
Innovations in Bioscience Sensing and Signaling

Dr. Will Kalkhoff & Dr. Joshua Pollock
Electrophysiological Neuroscience Laboratory of Kent
Kent State University

"Team Perception & Performance under Threat"

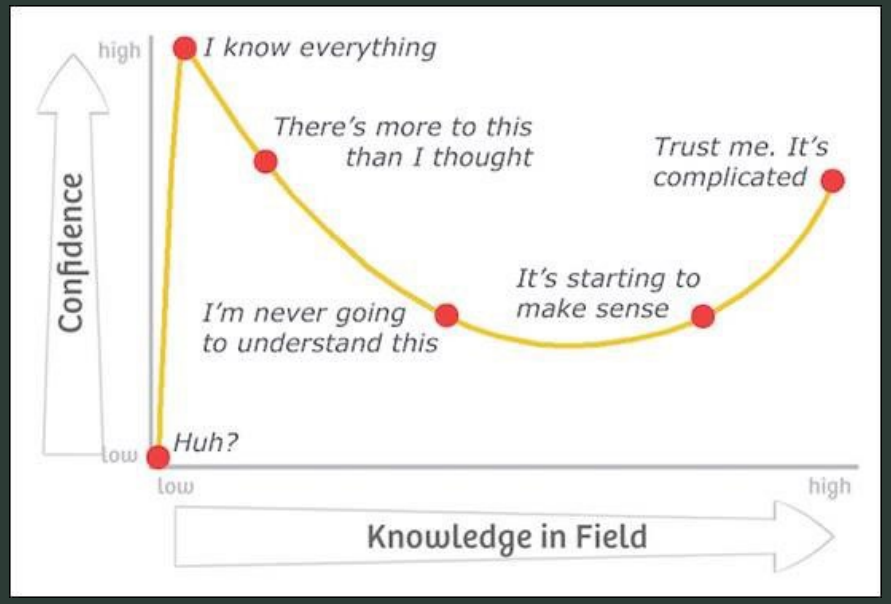
Program of Biosocial Research on Status Processes

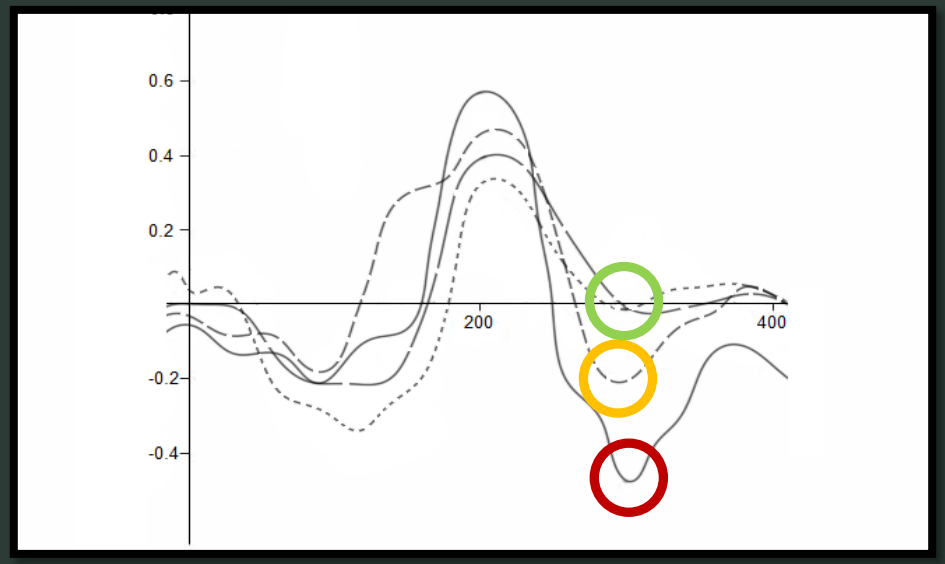
- Project I – “Neurodynamics of Status” (ARO 67034-LS)
- Project II – “Team Perception & Performance Under Threat” (ARO 69810-LS)
- Project II – “Teamwork and Decision-Making Under Threat: Implementing an Immersive Virtual Reality Environment” (ARO DURIP 75764-LS-RIP)

Project I

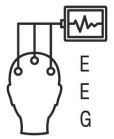
Neurodynamics of Status

- Confirm the role of (non-conscious) competency expectations and cognitive (un)certainty in the link between status and influence
- Status: completed (https://doi.org/10.1177/0190272519868988)





Experimental Design		Partner Behavior: Tends to **STAY** with initial answer	Partner Behavior: Tends to **CHANGE** initial answer
Participant Status	Higher	1	2
	Lower	3	4



EEG collected at frontal electrode sites revealed that the feedback-related negativity (FRN) event-related potential (ERP) indexed the degree of "expectancy violation" during an influence task

EEG spectral analysis revealed that power in the 8-12 Hz alpha band (an inverse measure of cognitive certainty) statistically mediated the relationship between status and influence rejection

And

For lower status participants, alpha power decreased between initial & final choices—i.e., they became more certain *after receiving input from a higher status, more competent partner*

The Upshot

- Project 1 confirmed the mediating role of (elusive) competency expectations and cognitive uncertainty in status processes
- Showed us that we can measure these things in real time during group tasks using EEG within an established experimental paradigm

Project II

"Team Perception & Performance Under Threat"

- Explore whether status processes work the same way during *threatening tasks*
- Status: preliminary behavioral analyses completed

Two-Person Teams Completed a Simulated Bomb Defusal Task

Not Actual Participants

The Team & Task

- Two-way audio communication from separate rooms
- Four separate bombs; 5 mins each; two puzzle modules per bomb
- $10 for each “success”; only $3 for a “failure”
- Subordinate Defuser provided w/a backup copy of the Reader’s defusal manual
- But, only the Reader has the “authority” to use the manual
- Defuser penalized up to $5 for using the backup ($2.50 per puzzle on each bomb)
- EEG, ECG, and voice recorded throughout

EXPERIMENTAL DESIGN

Between-Subjects Factor

Goal: 80 teams of undergraduate Ss (N=160)

Relative Competence

1. Neither Trained
2. Only Defuser Trained ("office w/out knowledge")
3. Only Reader Trained
4. Both Trained

Threat Level:

- High Threat (difficult)
- Low Threat (easy)

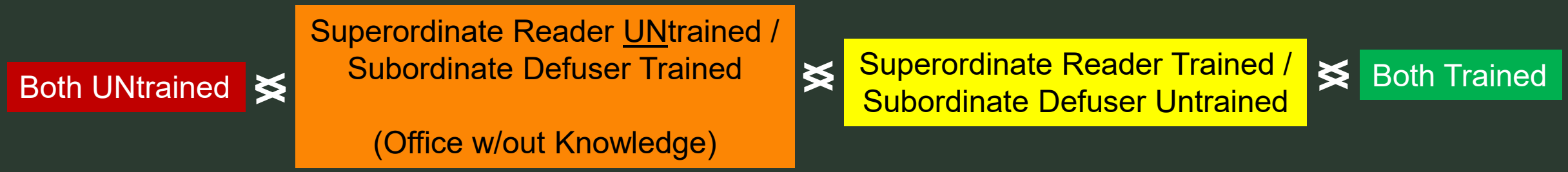
Audio Enhancement:

- High Threat (difficult)
  - Enhanced
  - Not Enhanced
- Low Threat (easy)
  - Enhanced
  - Not Enhanced

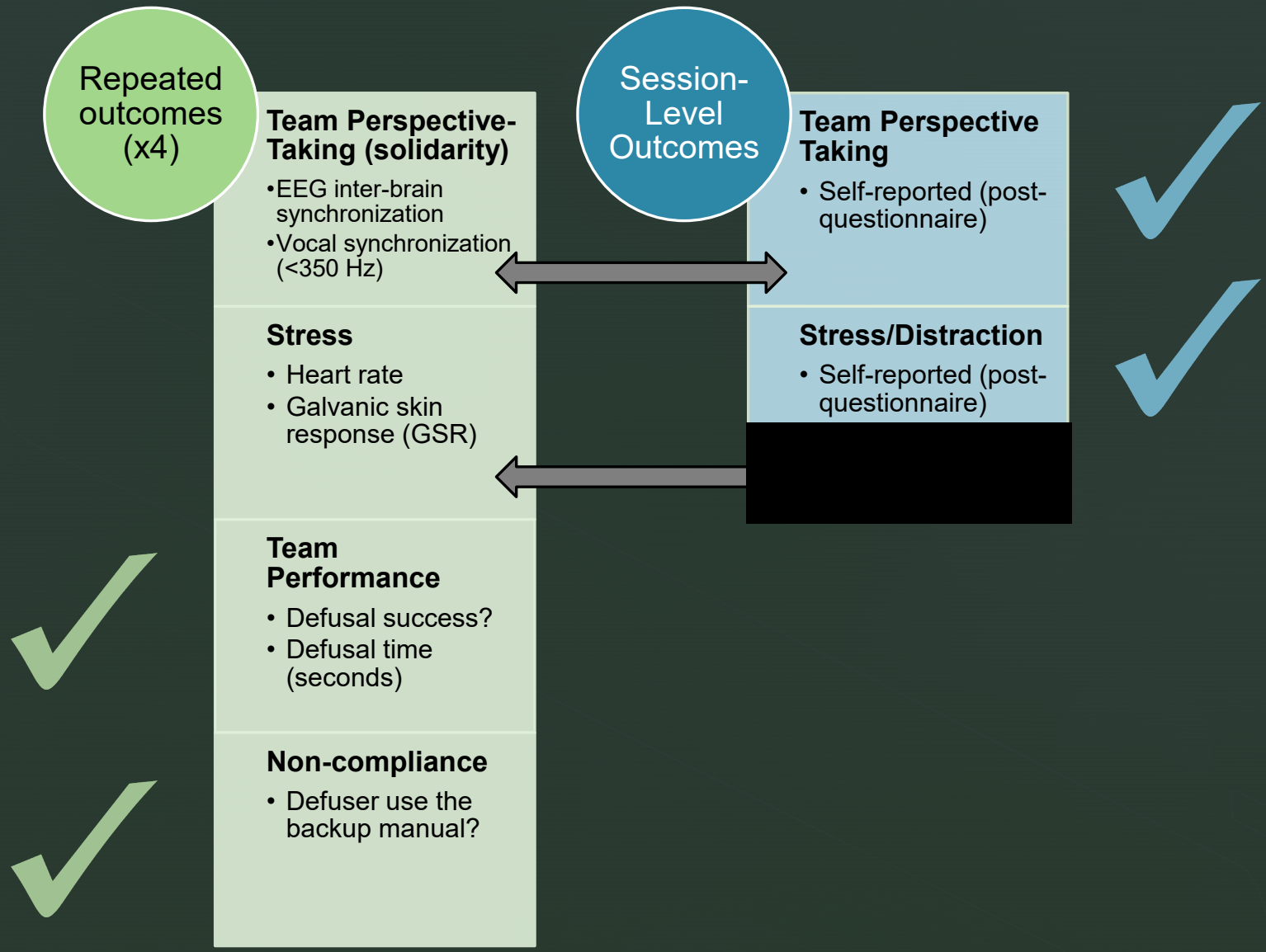
Within-Subjects Factors

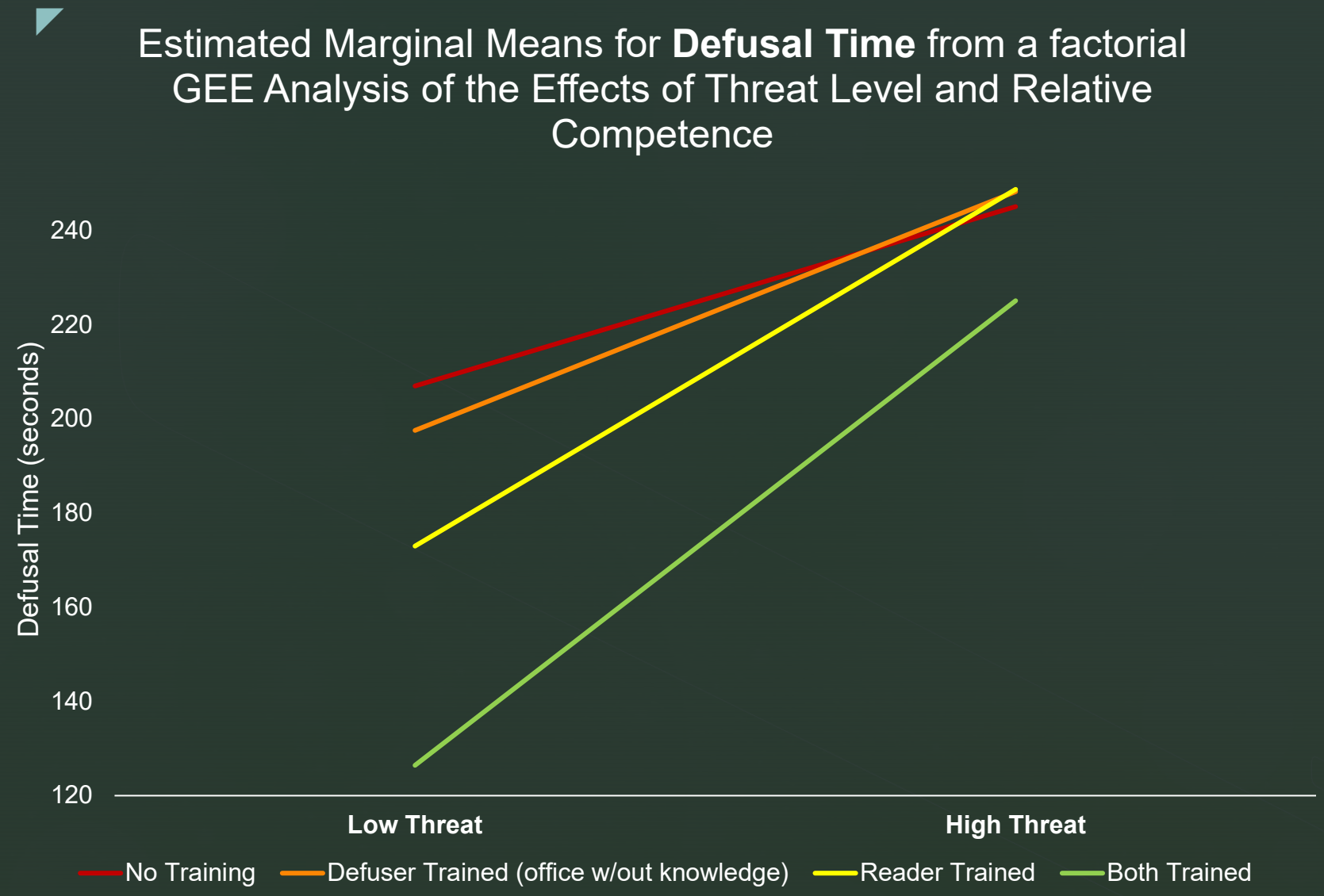
Basic Questions

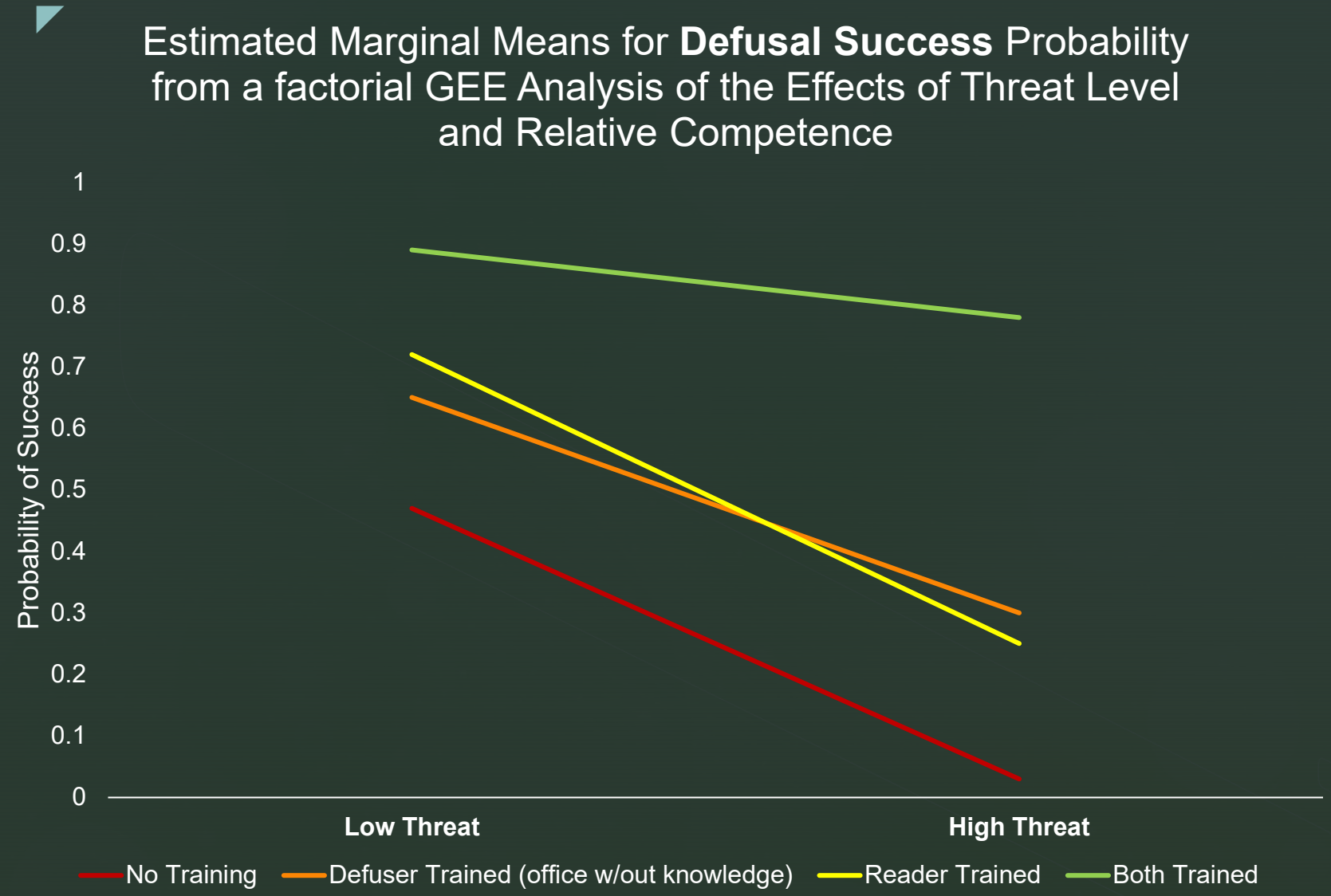
- Does status organization have comparable benefits for team functioning in both low- and high-threat contexts?
- Does status organization reduce non-compliance (by subordinate defusers)?
  - "Office without knowledge" problem (trained defuser; untrained reader)
- Does our audio filtering method improve team functioning?
  - Does it do so comparably across levels of threat and status configurations?



Outcomes


Repeated outcomes (x4)
Team Perspective-Taking (solidarity)
•EEG inter-brain synchronization
•Vocal synchronization (<350 Hz)
Stress
• Heart rate
• Galvanic skin response (GSR)
Team Performance
• Defusal success?
• Defusal time (seconds)
Non-compliance
• Defuser use the backup manual?
Session-Level Outcomes
Team Perspective Taking
• Self-reported (post-questionnaire)
Stress/Distraction
• Self-reported (post-questionnaire)


Estimated Marginal Means for **Defusal Time** from a factorial GEE Analysis of the Effects of Threat Level and Relative Competence
Defusal Time (seconds)
240
220
200
180
160
140
120
Low Threat
High Threat
No Training
Defuser Trained (office w/out knowledge)
Reader Trained
Both Trained

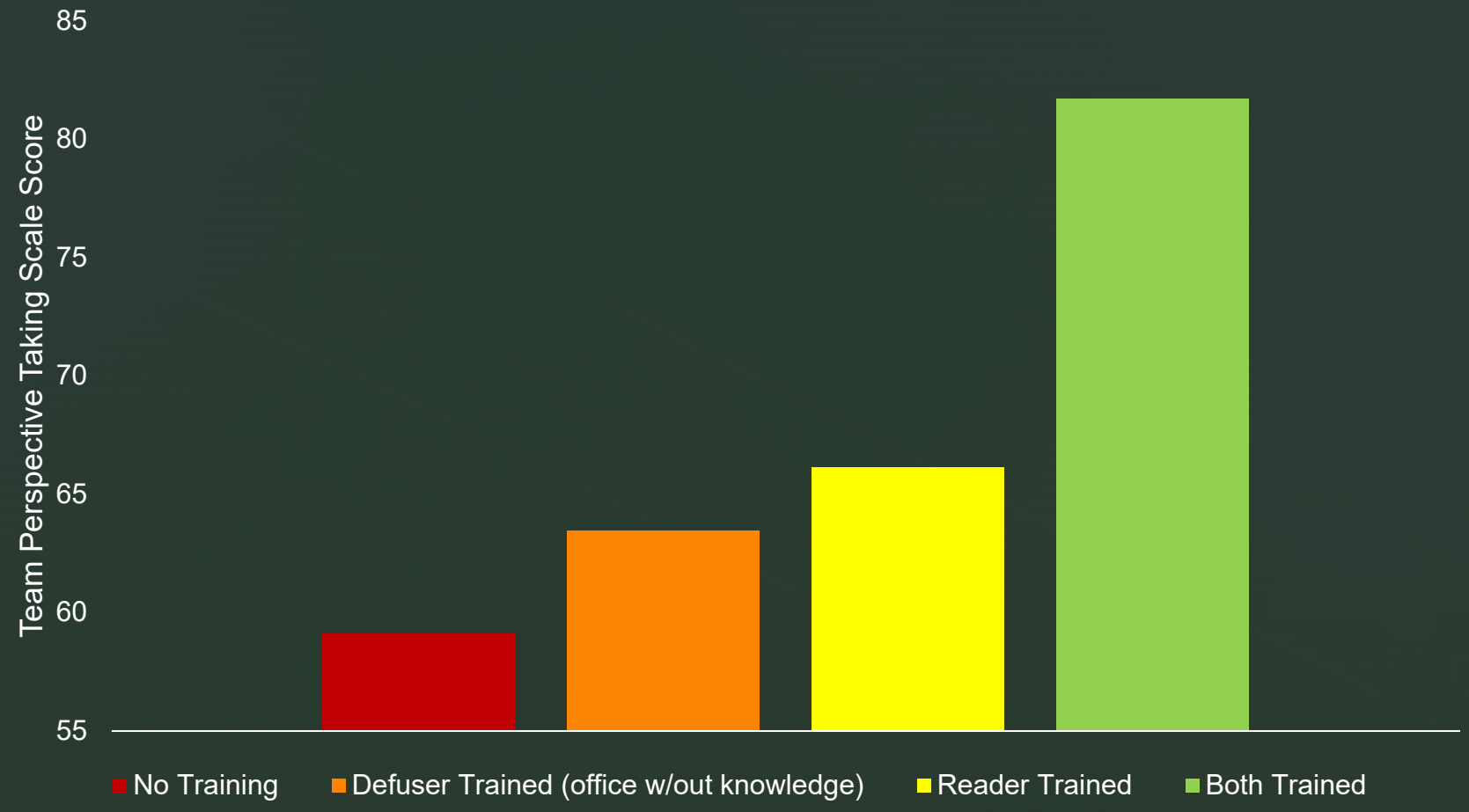

Estimated Marginal Means for **Defusal Success** Probability from a factorial GEE Analysis of the Effects of Threat Level and Relative Competence
Probability of Success
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Low Threat
High Threat
No Training
Defuser Trained (office w/out knowledge)
Reader Trained
Both Trained

Odds Ratios from a Firth Logistic Regression (Rare Event) Analysis of the Effect of Reader Competence on **Non-Compliance** (separately by threat)

* p < .05
\+ p < .10

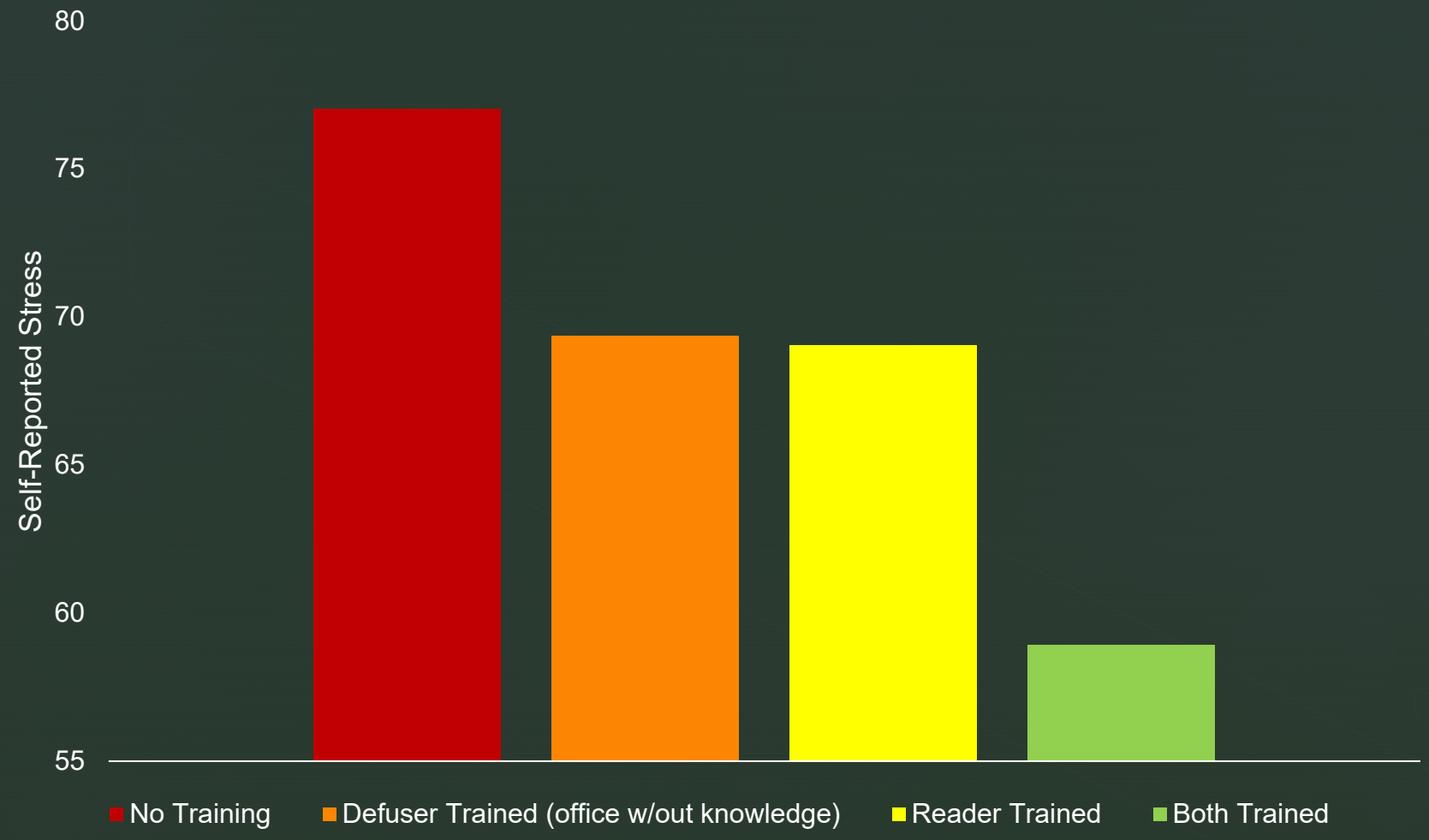
Both Trained is the reference category

Estimated Marginal Means for Self-Reported **Team Perspective-Taking** from a GEE Analysis of the Effect of Relative Competence



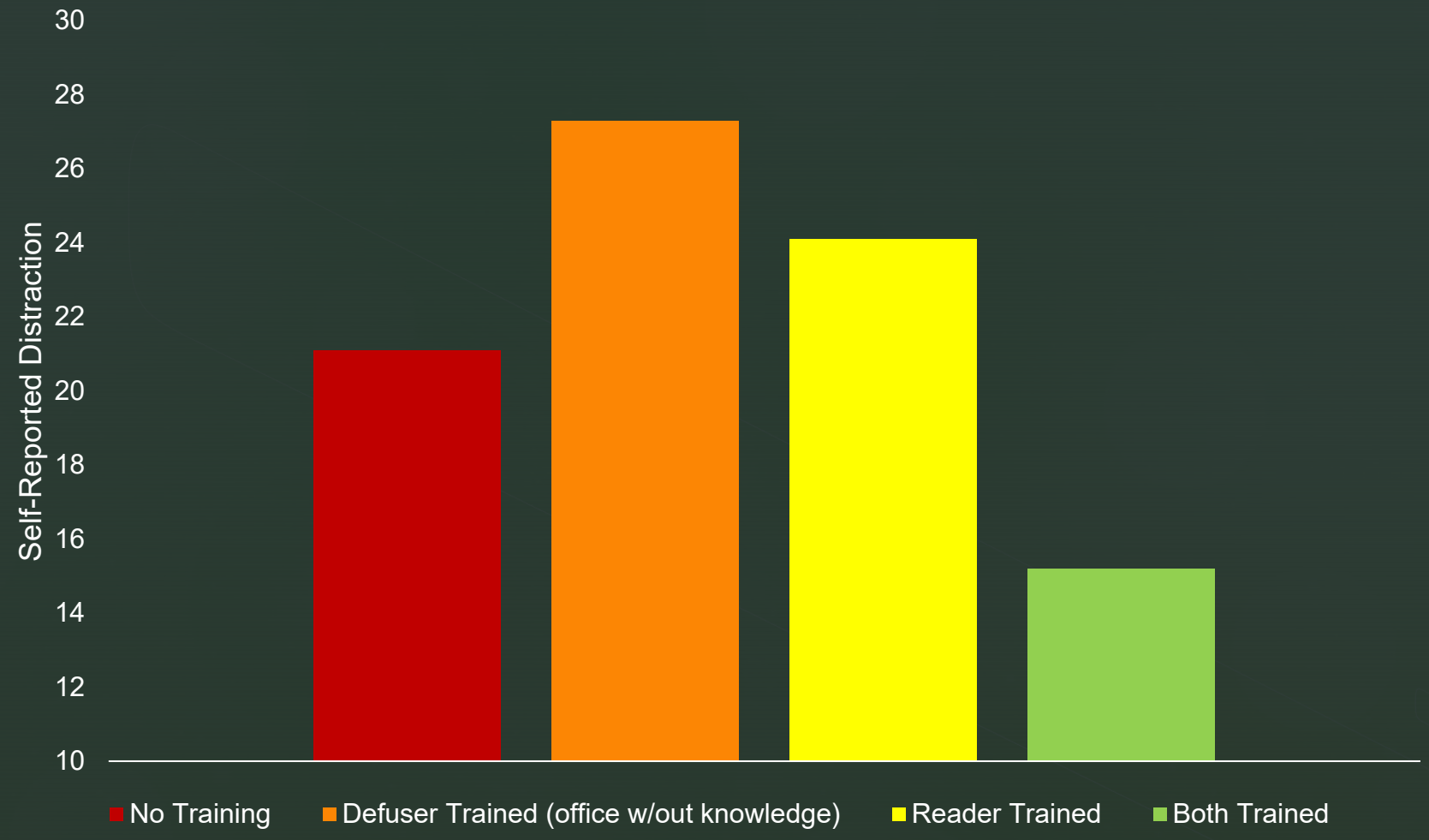
Linear contrast estimate (17.77) is significant at p=.000

Estimated Marginal Means for Self-Reported **Stress** from a GEE Analysis of the Effect of Relative Competence



Linear contrast estimate (-12.22) is significant at p=.000

Estimated Marginal Means for Self-Reported **Distraction** from a GEE Analysis of the Effect of Relative Competence



Quadratic contrast estimate (.82) is significant at p=.035

The (Provisional) Upshot (So Far)

- Status-organizing effects may not be robust in extraordinary “high threat” contexts
  - Act, don’t think
  - Training is paramount
- The “office without knowledge” problem deserves more attention

Project III

“Teamwork and Decision-Making Under Threat: Implementing an Immersive Virtual Reality Environment”

- Replicate Project II in an immersive VR environment
- Status: completing lab construction/setup & project planning

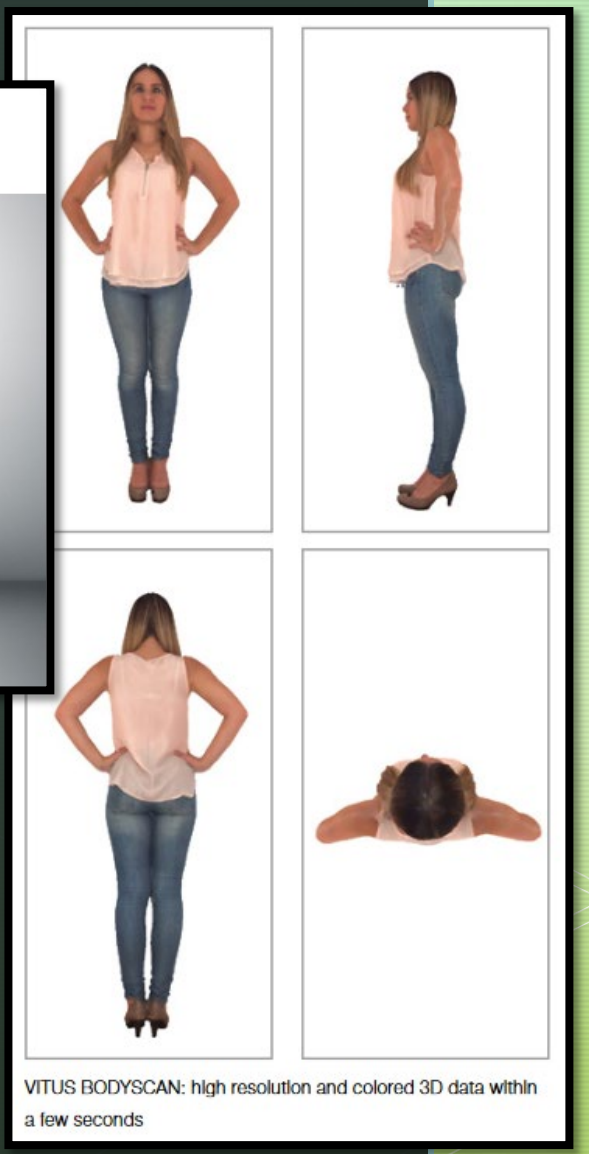
The ENLoK VR Lab

Varjo VR-2

Virtuix Omni

Vitronic Vitus Body Scan

Aim: build upon our state-of-the-art equipment and protocols to extend the bridge between the real world and laboratory settings



VITUS BODYSCAN: high resolution and colored 3D data within a few seconds

Thank you!

EEG Analysis

- Comparing neural synchrony around bomb defusal or failure between conditions
  - Investigating Alpha (Frontal) & Theta (Frontal Midline) Synchrony
    - Analyzed at bomb success/failure screen following each of the four bombs
    - Isolating areas of high synchrony during the task
- Comparing neural activity during and following each bomb between conditions
  - Recording and analyzing
    - Alpha Power
      - Frontal & Occipital
    - Beta Power
      - Central, Occipital & Frontal
    - Theta Power
      - Frontal & Midline

Physiological Analysis

- Recording and analyzing (comparing between conditions):
  - Heart Rate Variability
    - One measurement across all 4 bombs
      - HRV requires a longer window to record
  - Instantaneous Heart Rate
    - Heart Rate during Task
  - Galvanic Skin Response
    - Latency and amplitude of phasic bursts relative to the task
      - Event-Related Skin Conductance Response (ER-SCR)