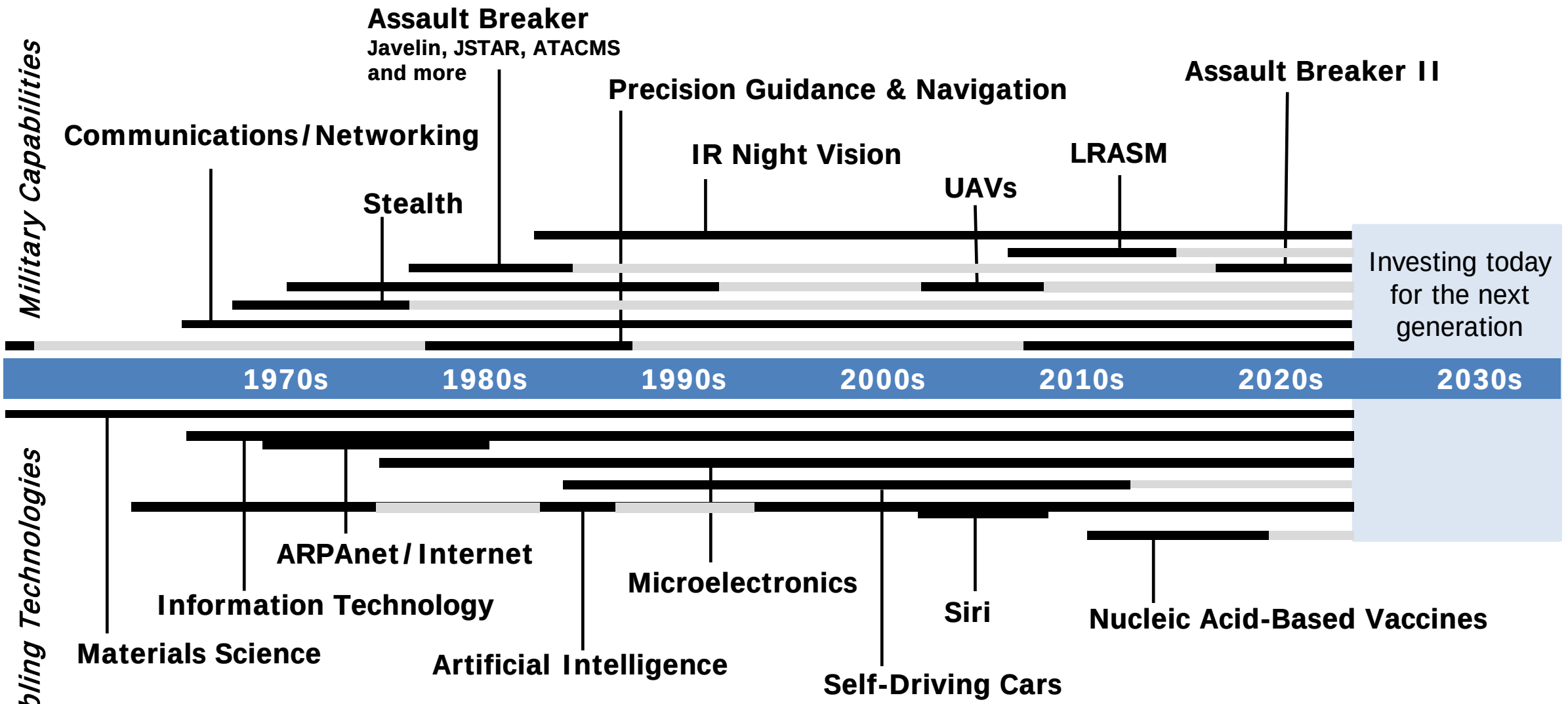
DARPA Overview

Dr. Jim Gimlett
Deputy Director
Defense Sciences Office (DSO)

RESTORE Proposers Day

March 14, 2025

Pivotal early investments that change what's possible



JSTAR: Joint Surveillance Target Attack Radar System
ATACMS: Army Tactical Missile System
LRASM: Long Range Anti-Ship Missile

DARPA technical offices

Defense Sciences Office

- Novel materials and structures
- Sensing and measurement
- Computation and processing
- Enabling operations
- Collective intelligence
- Emerging threats

Biological Technologies Office

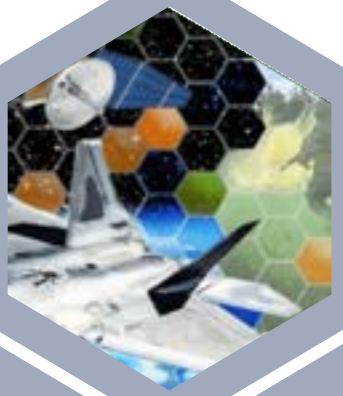
- Operational support capabilities
- Tactical warfighter care and functional restoration
- Strategic resilience and logistical security
- Sensing and responding to emerging threats

Information Innovation Office

- Proficient AI
- Advantage in cyber operations
- Confidence in the information domain
- Resilient, adaptable, and secure systems

Microsystems Technology Office

- Quantum, photonic, and organic circuits
- New microsystems manufacturing ecosystem
- Dual-use by design



Strategic Technology Office

- Advanced sensors and processing
- Battlefield effects
- Command, control, and communications
- Systems Warfare
- National Resilience

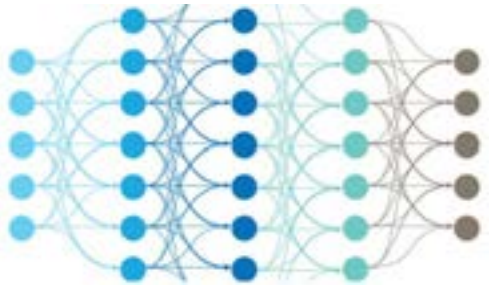
Tactical Technology Office

- Disruptive platforms and systems
- Reimagination of hardware design, development, test, manufacture and sustainment
- Focus on rapid, affordable, and scalable deployment

DSO Thrust Areas

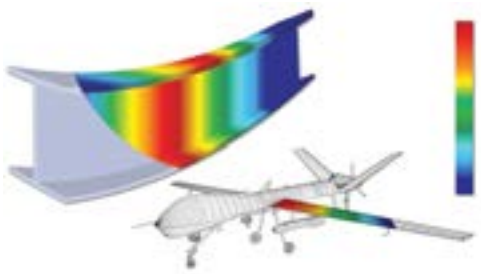
SENSING, MEASURING, & AFFECTING

Pushing to fundamental limits for orders-of-magnitude improvement in capabilities



MATH, COMPUTATION, & PROCESSING

Enabling quantum, and reimagining classical, computing for enhanced efficiency and new capabilities



MATERIALS, MANUFACTURING, & STRUCTURES

Breaking the tension between performance and efficiency for critical parts, energetics, superconductors, and propulsion

COMPLEX, DYNAMIC, & INTELLIGENT SYSTEMS

Foundations of intelligence for human-AI ecosystems and to enable warfighter capabilities

PROPELLING SCIENCE FROM BENCH TO BATTLEFIELD

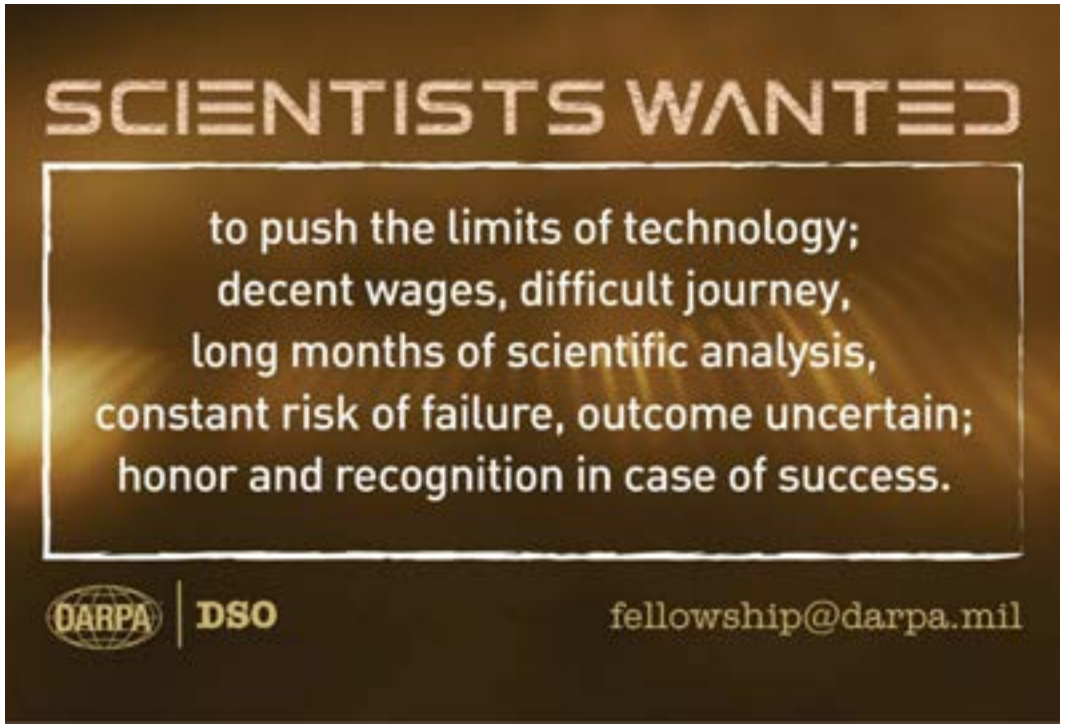
ARC and Fellows

Advanced Research Concepts (ARC)

- New process to quickly capture and rigorously evaluate many ideas
- Focus is on answering high risk/high-reward “what if?” questions

DARPA Innovation Fellowship

- 2-year Fellowship for early career scientists
- Build a long-term pool of diverse talent that can focus on national security



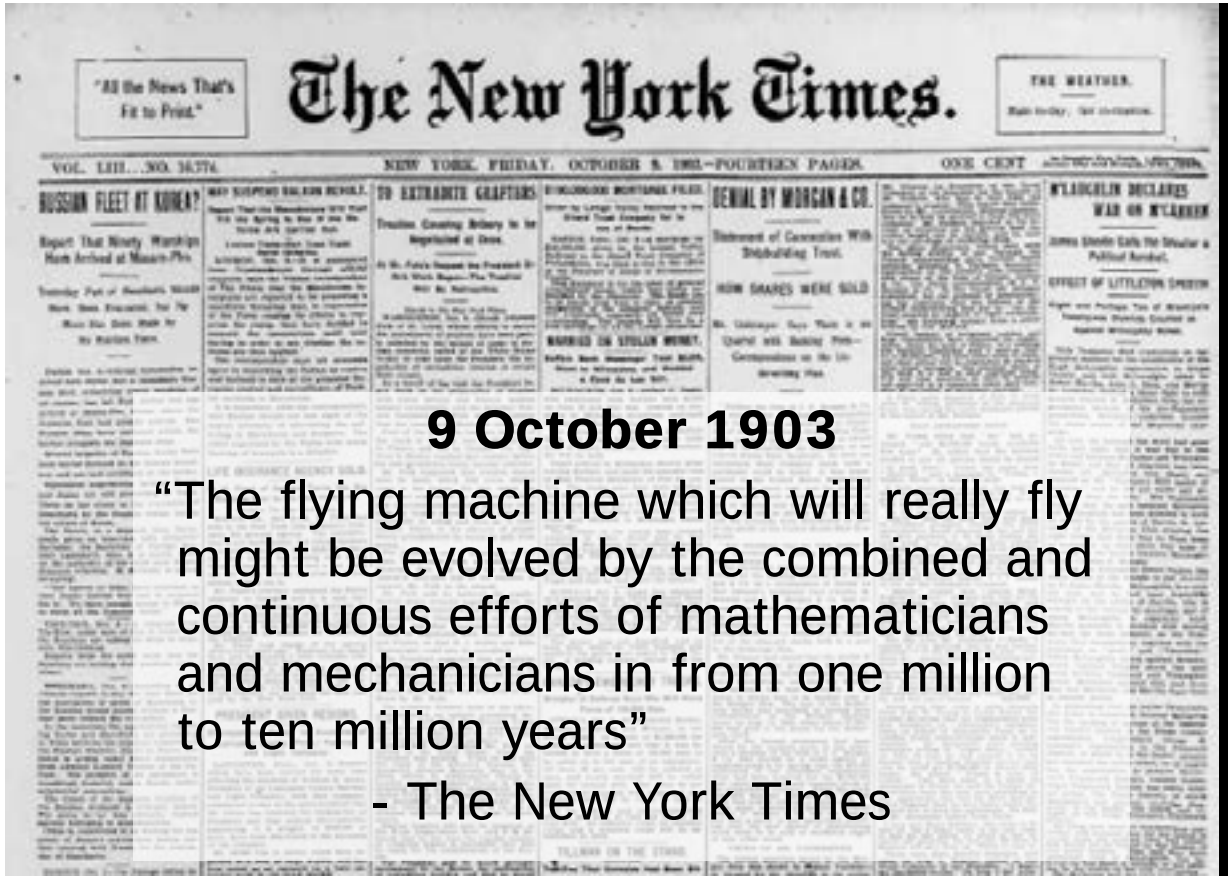
Breaking Down Barriers to Entry for Nontraditional Performers

DARPAConnect is designed to broaden DARPA's reach and stimulate **growth and collaboration** between DARPA, businesses, and academia.

- Regional and Virtual Events
- Networking Opportunities
- Training and Development
- Customized Support and Mentoring

DARPAConnect@darpa.mil

Evolutionary vs. Revolutionary R&D


"All the News That's Fit to Print."

The New York Times.

THE WEATHER.

VOL. LIII...NO. 16,774. NEW YORK, FRIDAY, OCTOBER 9, 1903—FOURTEEN PAGES. ONE CENT

RUSSIAN FLEET AT KOREA?

TO EXTRADITE GRAFTERS

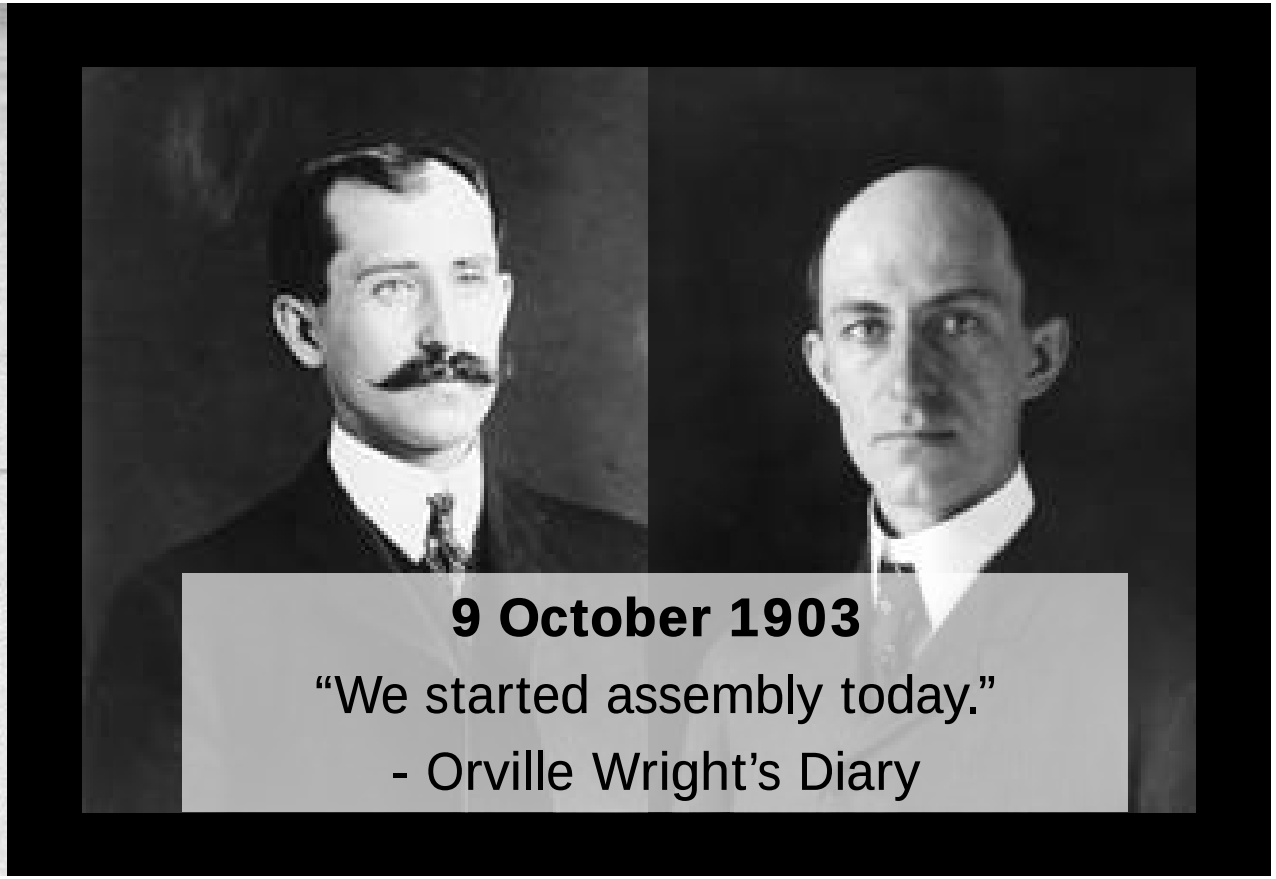
DENIAL BY MORGAN & CO.

M'LAUGHLIN DECLARES WAR ON M'CARREN

9 October 1903

"The flying machine which will really fly might be evolved by the combined and continuous efforts of mathematicians and mechanicians in from one million to ten million years"

- The New York Times



9 October 1903

"We started assembly today."

- Orville Wright's Diary

www.darpa.mil

www.darpa.mil/dso

Sign up for DSO news updates to receive notification on new opportunities

Reengineering Enabling Sleep Transitions in Operationally Restrictive Environments (RESTORE)

Greg Witkop, M.D.
Program Manager, Defense Sciences Office

RESTORE Proposers Day

March 14, 2025

Translation AND - *NOT* OR - Transformation
"Science progresses in two fundamental and equally valuable ways." (NSB-07-32)

"The vast majority of scientific understanding advances incrementally, with new projects building upon the results of previous studies or testing long-standing hypotheses and theories." (NSB-07-32)

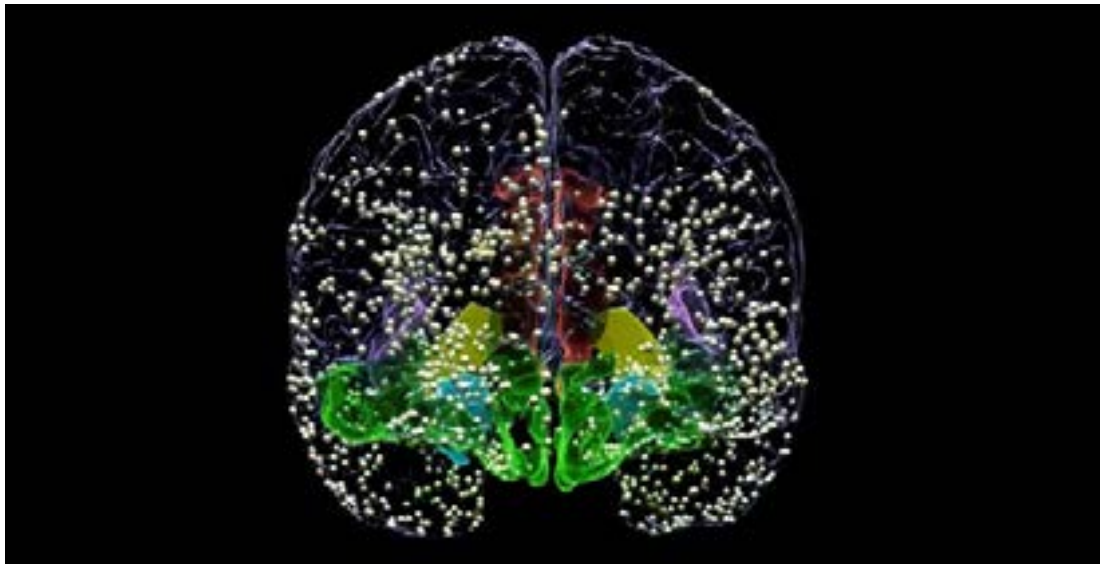
BRAIN: Brain Research Through Advancing Innovative Neurotechnologies
MD: Maryland
NIH: National Institutes of Health
NSB: National Science Board

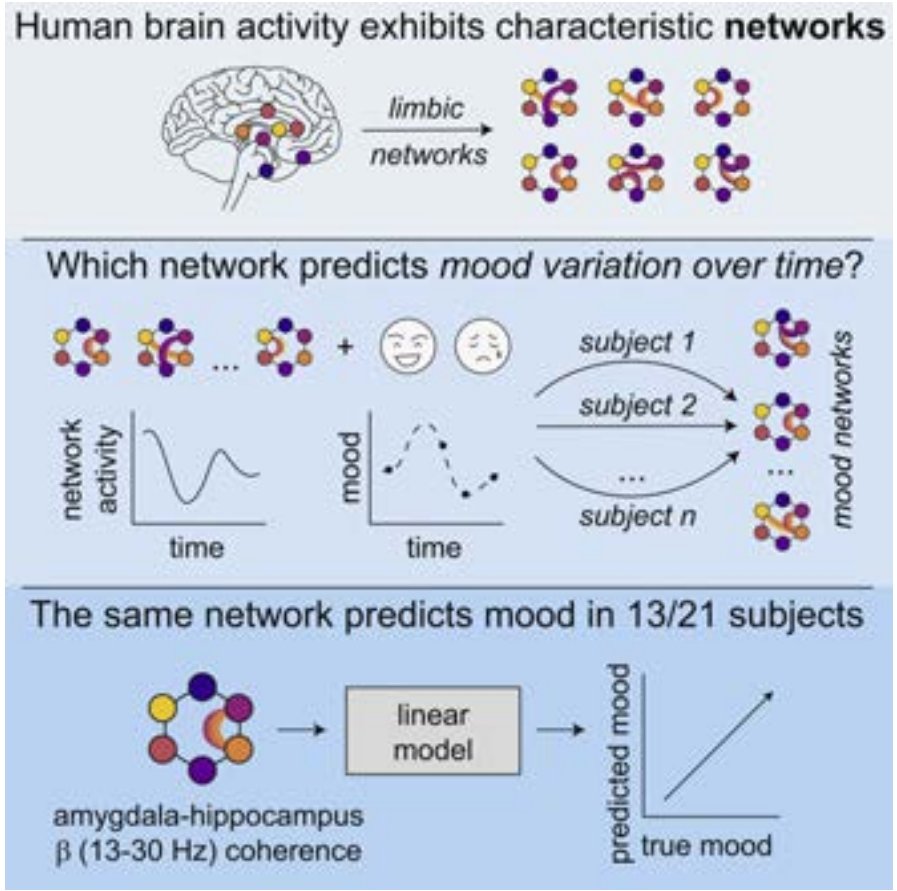
Transformation
“Science progresses in two fundamental and equally valuable ways.” (NSB-07-32)

“Less frequently, scientific understanding advances dramatically, through the application of radically different approaches or interpretations that result in the creation of new paradigms or new scientific fields.”(NSB-07-32)

DARPA 2014

Systems-Based Neurotechnology for Emerging Therapies (SUBNETS) program

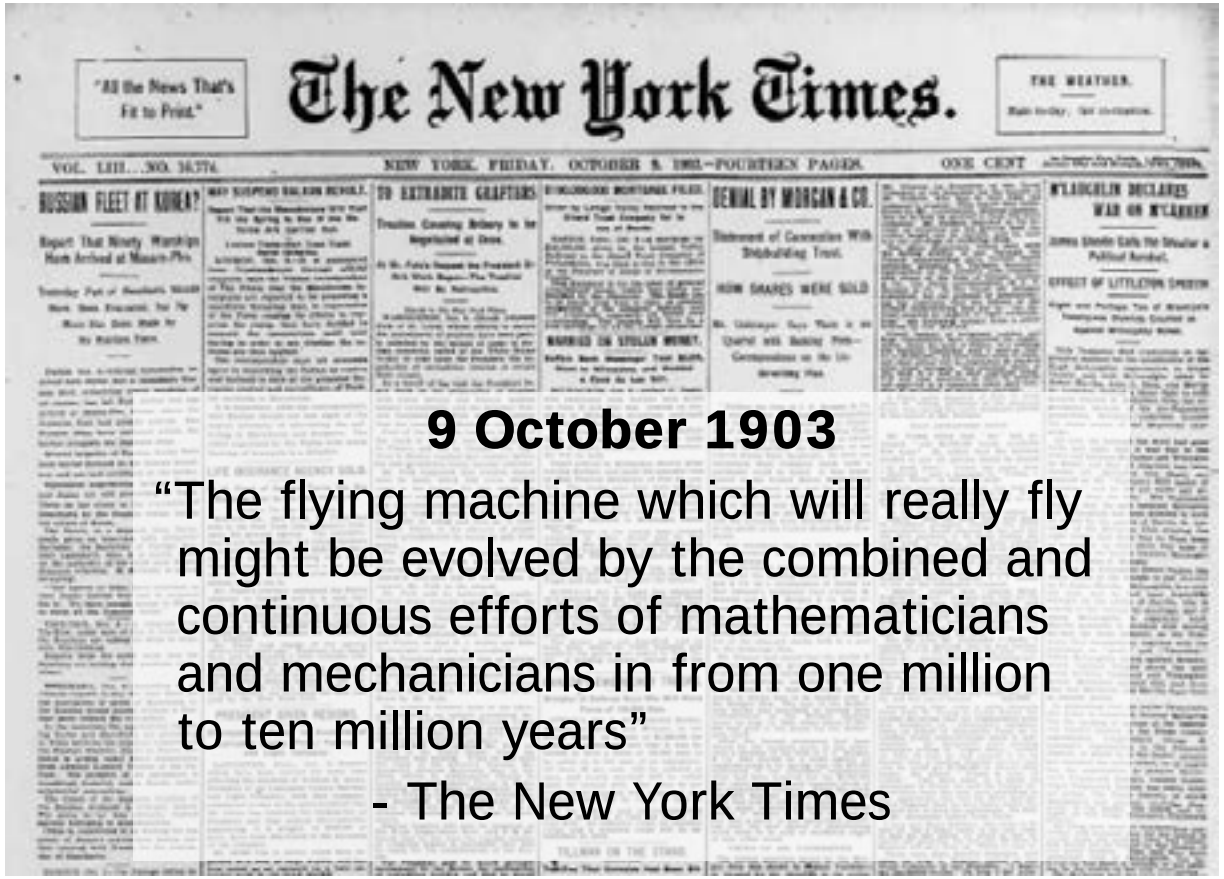




Kirkby, Luongo, Lee et al. (2018)

DARPA: Defense Advanced Research Projects Agency
Hz: hertz
NSB: National Science Board

While Less Common; Transformation is Possible


"All the News That's Fit to Print."

The New York Times.

THE WEATHER.

VOL. LIII...NO. 16,774. NEW YORK, FRIDAY, OCTOBER 9, 1903—FOURTEEN PAGES. ONE CENT

RUSSIAN FLEET AT KOREA?

Report That Ninety Warships Have Arrived at Masan-Pho

TO EXTRADITE GRAFTERS

DENIAL BY MORGAN & CO.

Statement of Connection With Shipbuilding Trust.

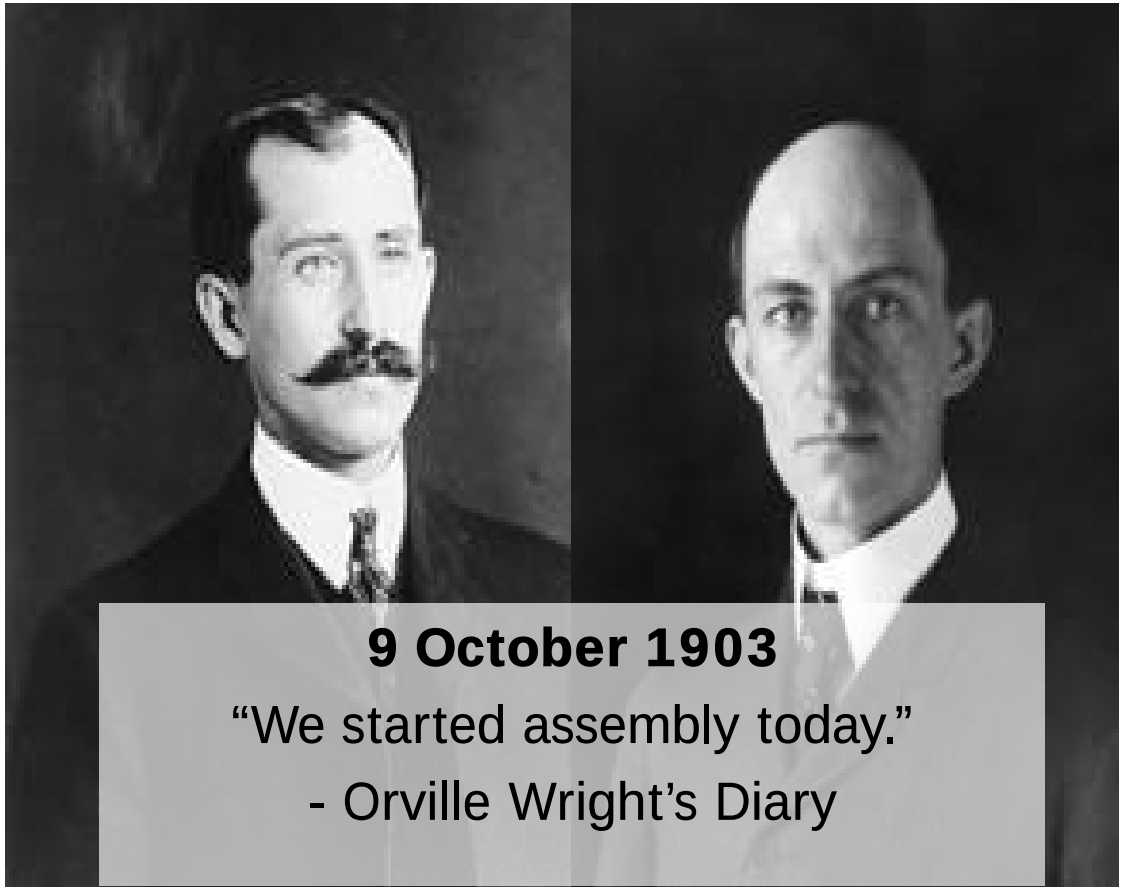
HOW SHARES WERE SOLD

M'LAUGHLIN DECLARES WAR ON M'CLELLAN

9 October 1903

"The flying machine which will really fly might be evolved by the combined and continuous efforts of mathematicians and mechanicians in from one million to ten million years"

- The New York Times



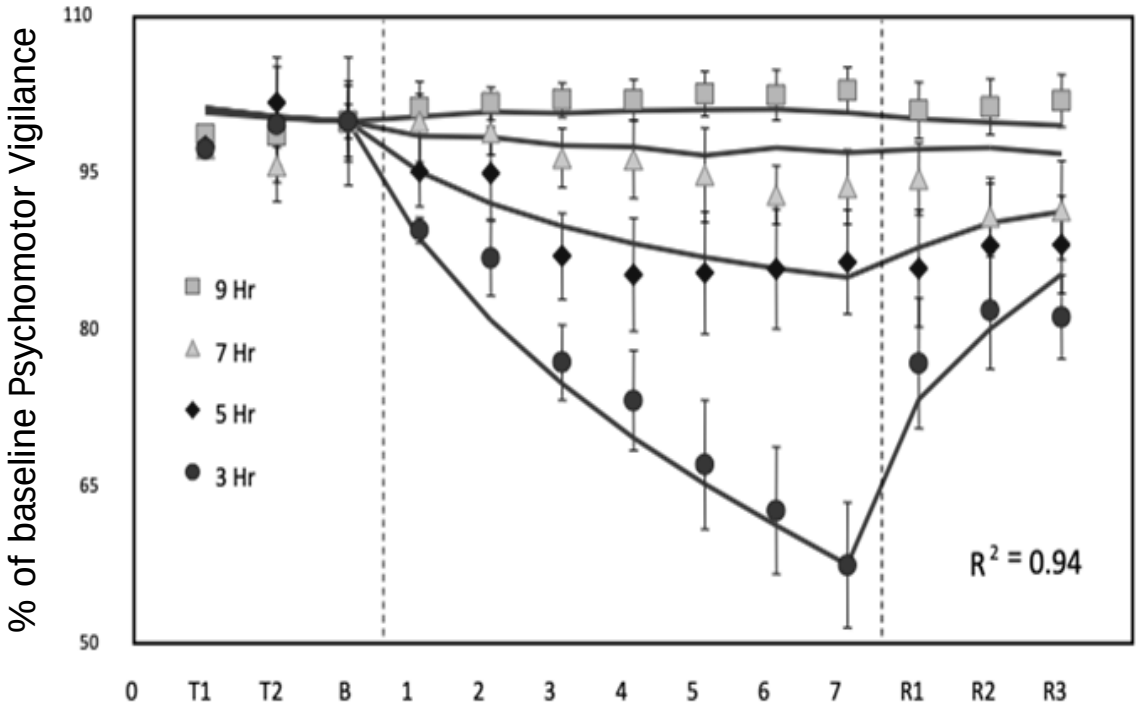
9 October 1903

"We started assembly today."

- Orville Wright's Diary

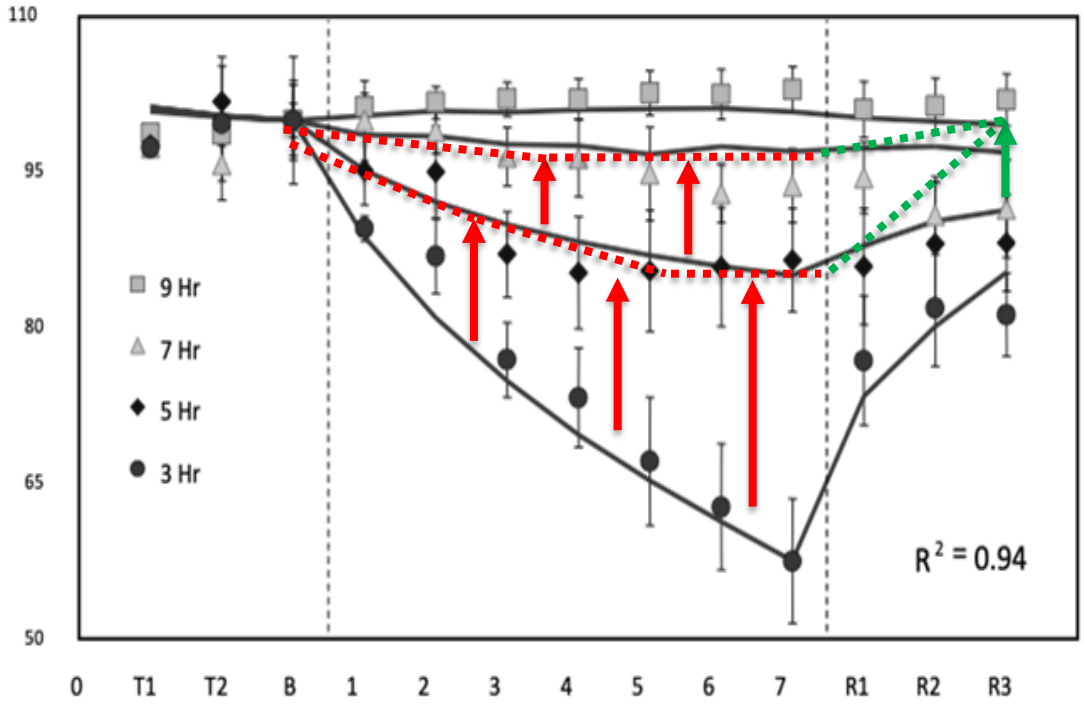
Program : Flattening the Belenky Curve

Current response to sleep restriction



Belenky, et al. 2003

RESTORE goal



RESTORE will transform our ability to maintain performance / health on less sleep and more rapidly recover from sleep loss

Clarification

In the event of a BAA posting, if there is any discrepancy between what is presented today and the BAA, the BAA takes precedence

Opening Comments

- The Proposers Day briefing is intended to provide an orientation to the RESTORE Broad Area Announcement and is solely for information purposes
- The solicitation supersedes anything presented or said by DARPA at the Proposers Day
- Examples in this briefing (e.g., technologies, use cases) are chosen for ease of illustration only and do not constitute endorsement of any particular approach
- Interested performers are expected to be able to articulate a clear and compelling vision for their technology, proposed course of research, and transition potential
- Teaming is important! Today is a great opportunity for networking
- We need your help to make this program a success!

Teaming is important

- To fully address the BAA, you may need to team with other entities
- Each team should submit a unified proposal under a single prime
- This BAA is open to educational institutions, government labs, and/or private companies
- Foreign entities may join a team or submit as the PI
- Even if you are a member of a team, you may still join any number of other proposal teams or form your own and submit a proposal as PI
  - Note: no person or organization may be a performer on more than one *awarded* TA effort, either as a prime or subcontractor
- You must find your collaborators on your own, but today is a great opportunity for networking!
- Note that the cost volume for each subcontract must be at the same level of details as for the prime

RESTORE: Sleep optimization to prepare, protect, and heal

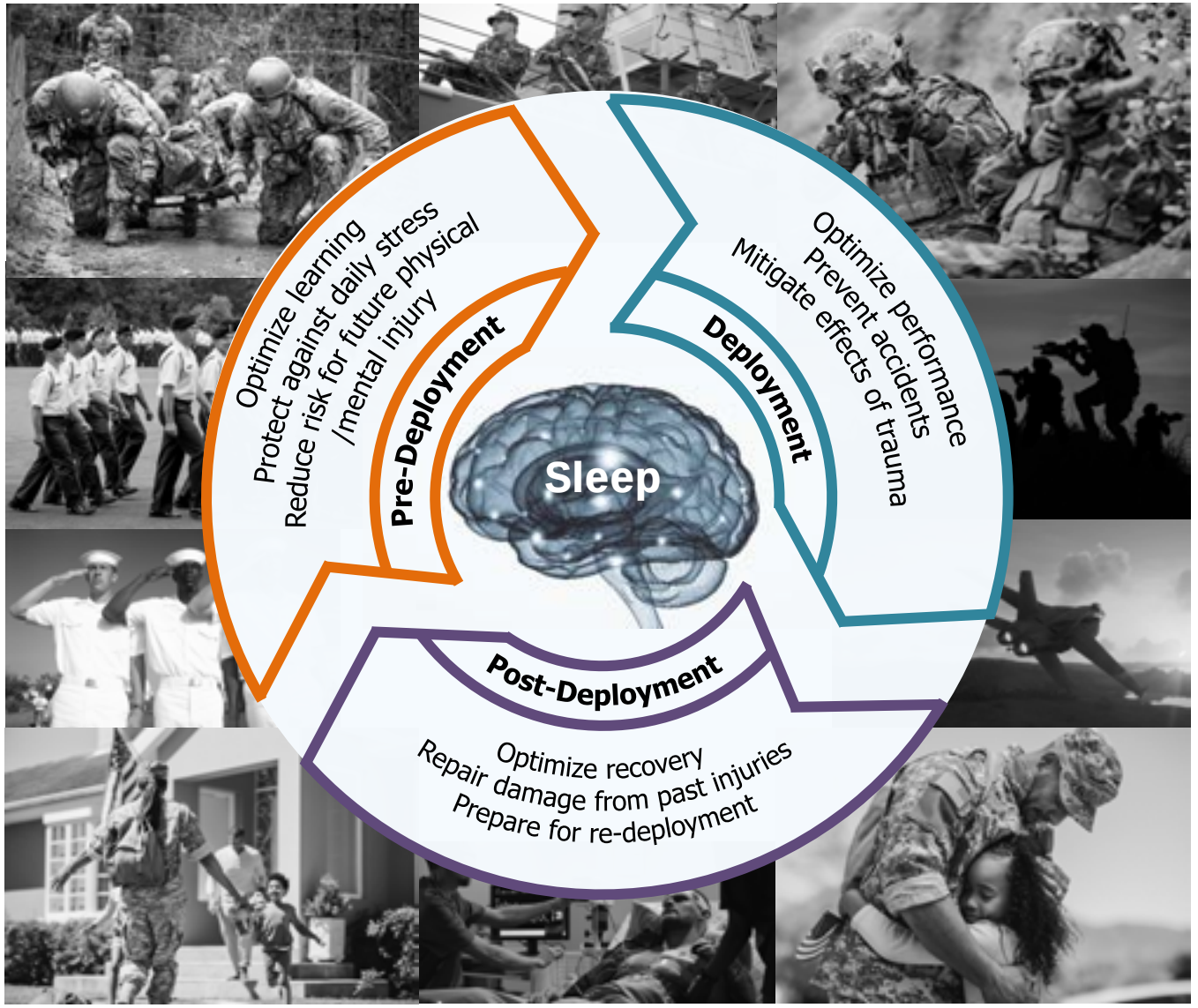
"Sleep may be the most important biological factor that determines Service member health and combat readiness" - DoD Report to the Congressional Armed Services Committees (2021)

Sleep rebalances the brain and body

- Release hormones to promote recovery
- Consolidate neuroplastic brain changes
- Improves cognitive functioning
- Supports adaptation to stress and trauma

Sleep optimizes performance and health

- Alertness and reaction time
- Judgement and decision making
- Learning and Memory
- Emotional Regulation
- Psychological Resilience



Military operational tempo disrupts sleep creating warfighter health and readiness vulnerabilities

Risks of Disrupted Sleep

Health

70% of service members (vs. 28% of civilians) are clinically sleep deprived (<6 hours of sleep per night) Good et al. (2020)

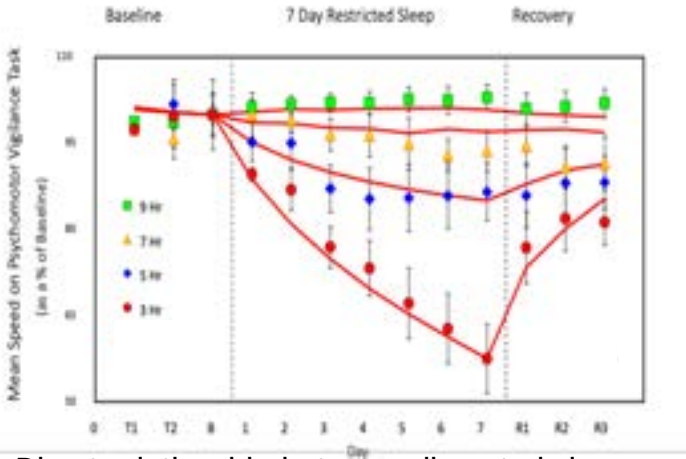
Pre-deployment deprivation:

- 1.8x increased risk of *post-deployment* TBI Luxton et al. (2011)
- 2.8x increased risk of *post-deployment* suicide Wang et al. (2018)
- 3.1x increased risk of *post-deployment* PTSD Wang et al. (2018)

Readiness

< 3 hours of sleep common in combat (Weeks, 2010)

- Identification and accuracy decreases 2.2x
- Increases hallucinations (no target) by 1.6x (WRAIR, 2023)

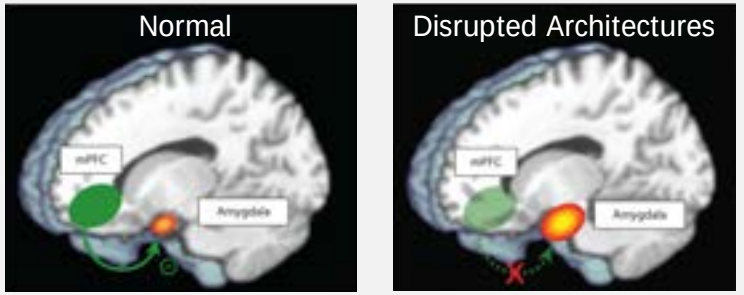


Direct relationship between disrupted sleep architectures and cognitive impairment (Belenky et al., 2003)

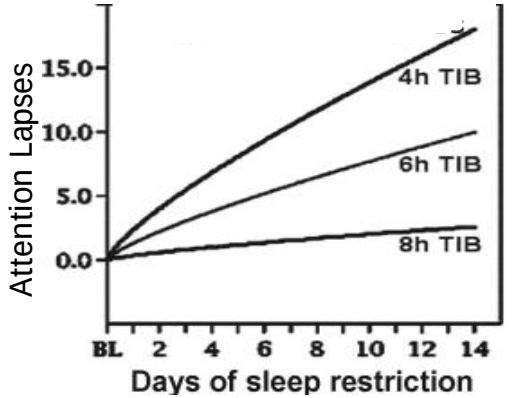
Biomarkers of Disrupted Sleep

Neuroimaging

Decreased activity in the areas responsible for cognitive function and increased activity in fear/ panic areas



Cognitive Testing



Banks & Dinges (2007)

Increased errors in health and readiness testing (attention and focus)

Disrupted sleep damages the brain causing cognitive impairment and, potentially, mental illness

BL: baseline
mPFC: medial prefrontal cortex
PTSD: post-traumatic stress disorder
TBI: traumatic brain injury
TIB: time in bed
WRAIR: Walter Reid Army Institute of Research

Current solutions – wakefulness at the expense of restorative sleep

Pharmacology

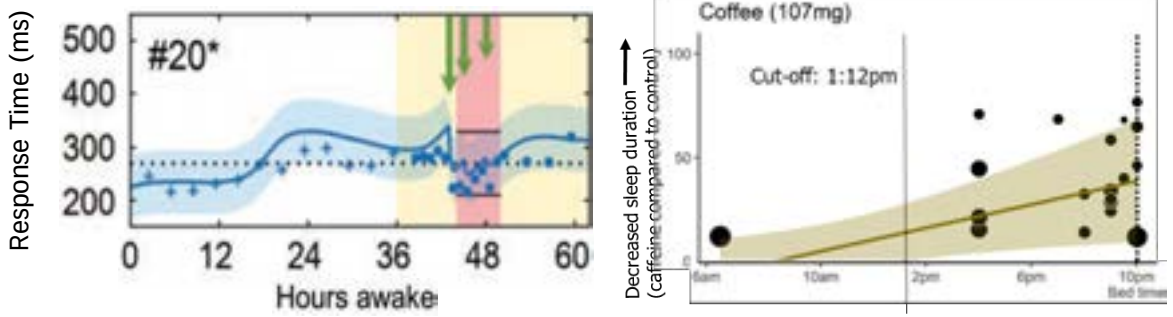
Caffeine

Side effects: Anxiety, dizziness, headaches

Amphetamines

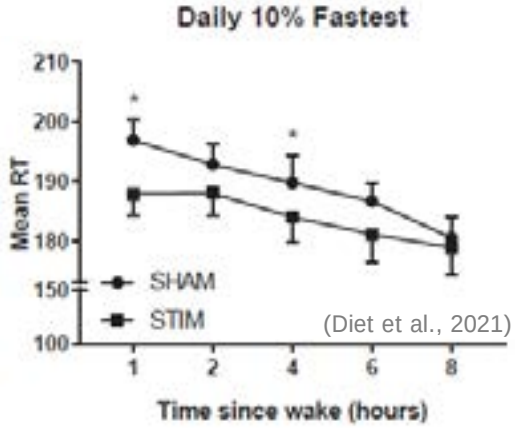
Decrease brain network connections while increasing risk of abuse and dependence (Manconi et al., 2023)

WRAIR BeAlert App



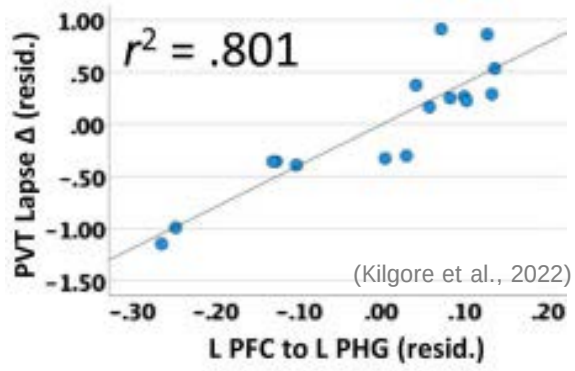
Caffeine disrupts restorative sleep architectures (Grimaldi et al., 2020)

Neurostimulation



(Diet et al., 2021)

Acoustic stimulation of slow wave sleep increases cognitive performance by 5% (25% improvement needed for significant behavioral response)



(Kilgore et al., 2022)

Blue light increased connectivity between brain areas for cognitive control (L PFC) and attention (L PHG) resulting in fewer lapses)

Wakefulness approaches disrupt complete restorative sleep necessary to repair the brain

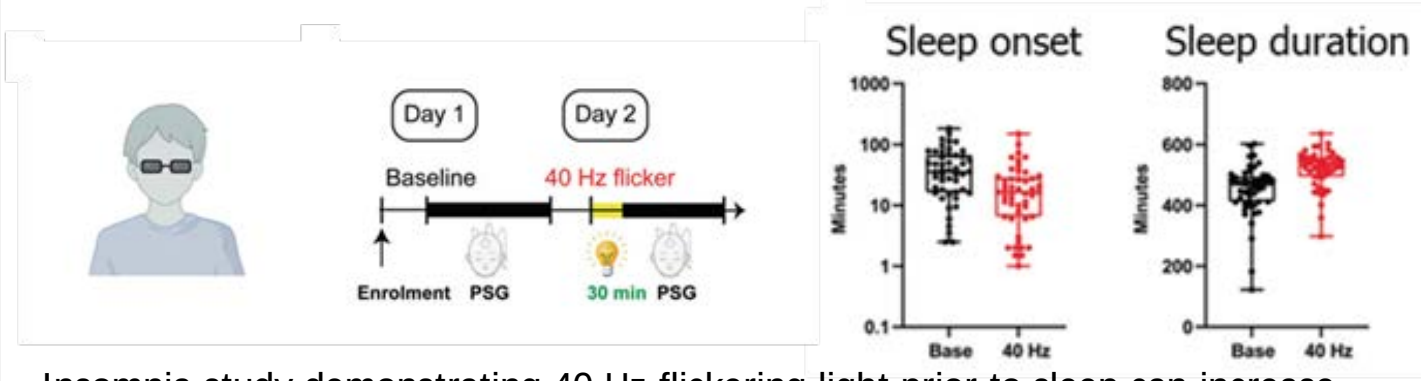
L PFC: left prefontal cortex
L PHG: left parahippocampal gyrus
mg: milligram
ms: milliseconds
PVT: psychomotor vigilance task
RT: reaction time
WRAIR: Walter Reid Army Institute of Research

Sleep medicine interventions focus on extending duration of sleep

NIH recommendations

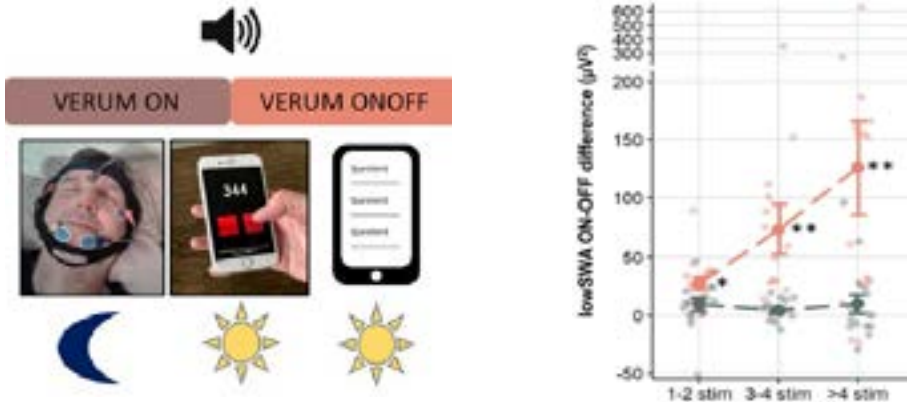
- Sleep "hygiene" for 7-9 hours of sleep
- Cognitive Behavioral Therapy-Insomnia (CBT-I)
- Pharmacology - most not approved for military use due to side effects and risks of abuse
- Impractical for warfighters in theater

Recent efforts to develop drug free methods to induce sleep



Insomnia study demonstrating 40 Hz flickering light prior to sleep can increase onset and duration of sleep

Zhou et al. (2024)



Acoustic stimulation can increase onset of slow wave sleep ("deep sleep")

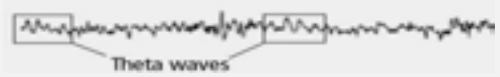
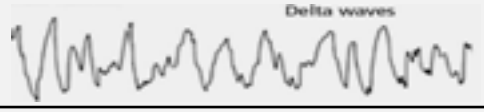
(Lustenberger et al., 2022)

These approaches assume routine 7-9 hours of sleep is possible

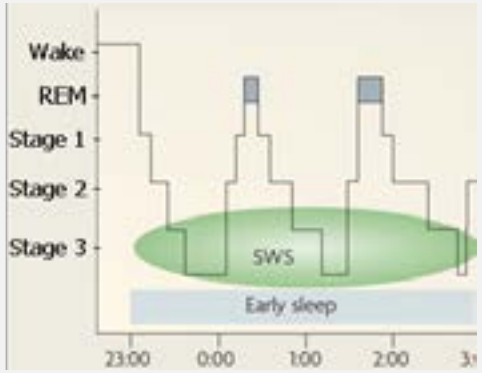
Hz: hertz
NIH: National Institutes for Health
PSG: polysomnography
stim: stimulation
SWA: slow wave activity
µV: microvolt

Restorative Sleep: Evolution's daily repair and optimization of brain and body function

Restorative Sleep

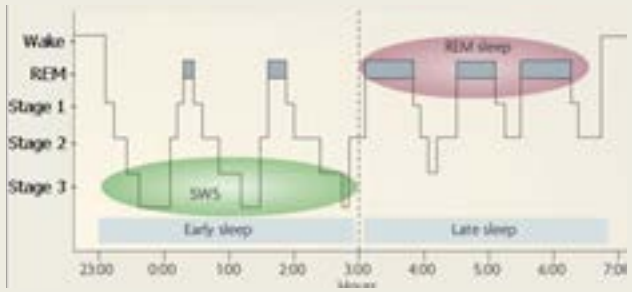
Sleep Architectures	Micro-architectures
Non-REM Sleep Stage 1	Theta waves (4-8 Hz) 
Non-REM Sleep Stage 2	Sleep spindles (12-14 Hz) 
Non-REM Sleep Stage 3	Delta/slow waves (1-4 Hz) Slow oscillations (0.5-1 Hz) 
REM sleep	Theta waves (4-8 Hz) 

Current: Single section interventions

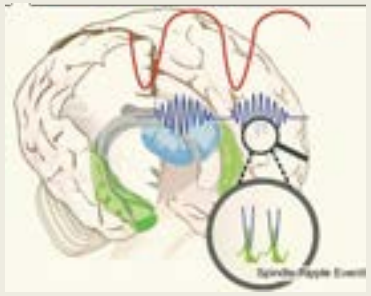


Partial architecture

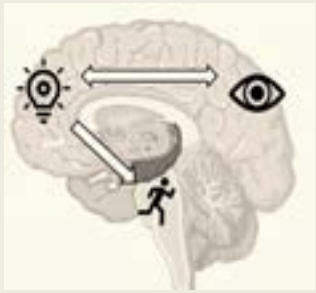
RESTORE – Orchestrating precision control of whole brain sleep architectures



Complete Architecture



Coupled Micro-Architectures



Synaptic Plasticity

Hypothesis: Orchestrating whole brain sleep architectures will repair damaged brain networks causing cognitive impairment

Hz: hertz
REM: rapid eye movement
SWS: slow wave sleep

RESTORE Definitions

Macro-architecture: The structural organization of sleep, including rapid eye movement (REM) and non-rapid eye movement (NREM)

Micro-architecture: The electrical signature of NREM sleep, characterized by distinct brainwave patterns such as slow waves, K-complexes, and sleep spindles

Out of Scope Activities

- Interventions to improve wakefulness/cognitive performance independent of improving sleep
- Study protocols that do not include human subjects, such as studies only including simulations, biophysical models, and animal models.
- Any proposal not clearly stating the specific strategies, techniques, and justifications for how proposed methods will successfully execute both of the program's key technical objectives.
- Proposals that develop general sleep interventions intended to support individuals in getting a full 7-8 hours of sleep without increasing the restorative effect of specific sleep micro-architectures or without the ability to increase restorative effects under conditions of restricted sleep.
- Proposals that focus extensively on developing novel neuroimaging, neurostimulation, or sleep intervention technologies (e.g., new pharmacological agents) without a clear justification for their necessity compared to existing techniques.
- Proposals that focus extensively on developing novel cognitive-behavioral tasks, clinical scales, or other such assessments, without a clear justification for their necessity compared to existing techniques (e.g., psychomotor vigilance, task switching, digit symbol substitution).
- Interventions that cannot be tested and demonstrated within the program's stated timelines, such that those that would require the need for safety studies prior to testing or those that are not able to receive FDA approval for clinical testing within program timelines.
- Proposals that rely on interventions that have not previously been shown capable of modulating sleep micro-architectures.
- Proposals that involve children and/or adolescents under 18 years old.

RESTORE Proposals

Successful proposals will succinctly and explicitly explain:

- The fundamental hypothesis to be tested, including the underlying assumptions and expected outcomes
- How results will change neuroscience understanding; specifically, how they will advance our knowledge of sleep and its relationship to cognitive performance, if the hypothesis is supported
- Evidence, data, projections, calculations, or theoretical explanations of how the proposed methods are capable of meeting the program's metrics. Proposals lacking such justifications are unlikely to be selected for award
- The potential implications of the proposed research for future work relating to sleep and cognitive function
- The theoretical neurobiological basis for the proposed interventions, including the underlying mechanisms
- Research design, including specific power analysis, to evaluate the effectiveness of the interventions
- Biomarkers that demonstrate a link between changes in brain activity and improvement in cognitive performance, and how these biomarkers will be measured and analyzed
- Specific plans, including cost and time estimates, to address the three key technical challenges outlined in the program description

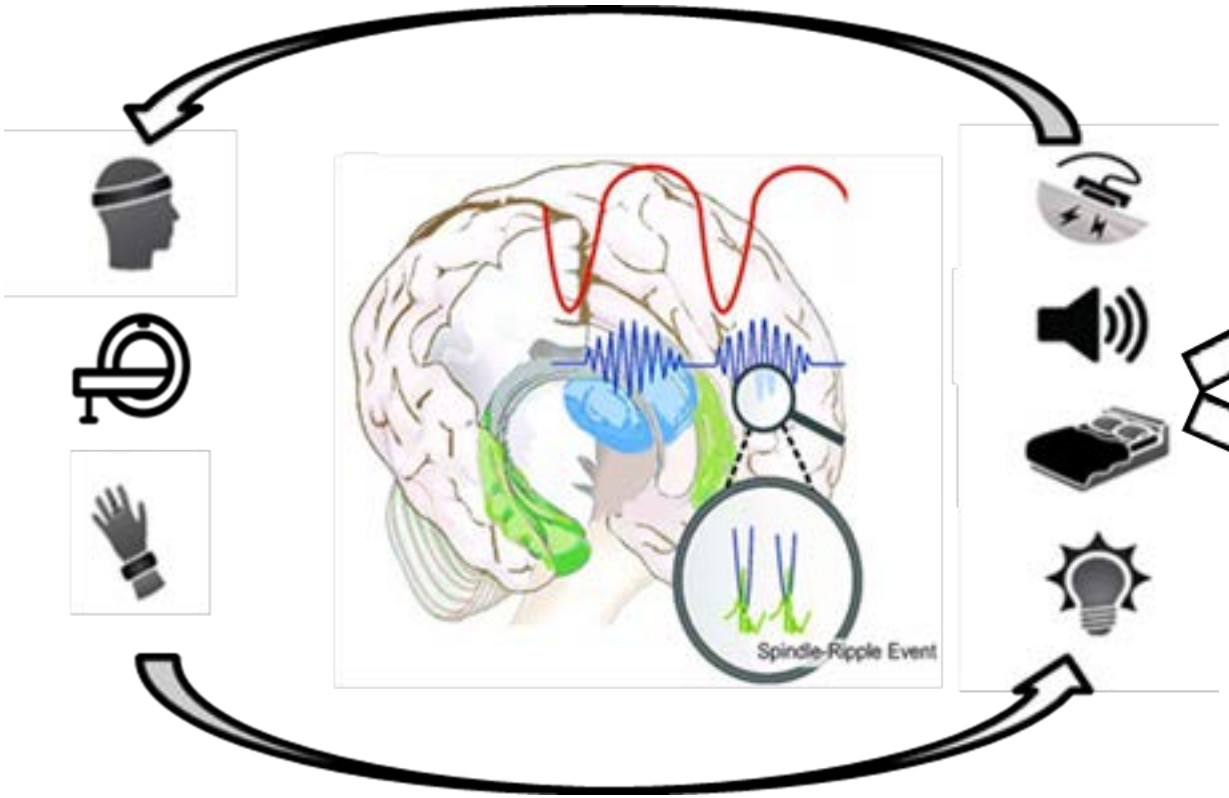
Successful proposals will not:

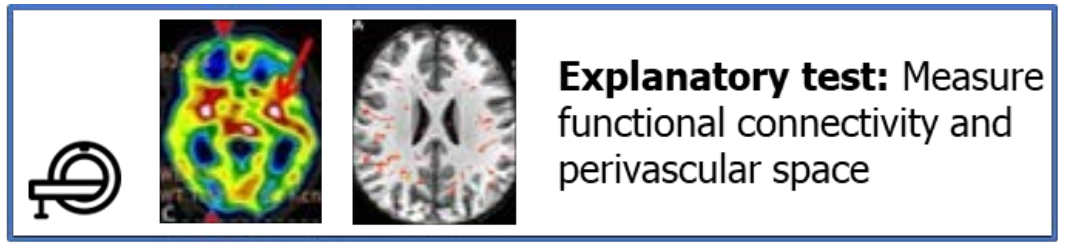
- Simply reiterate the justifications or background information provided in the BAA
- Require the development of new drugs or pharmacologic interventions
- Rely on existing pharmacologic interventions known to disrupt sleep, pose a risk of dependency or misuse, or increase performance risk if the individual is awakened prior to drug clearance

RESTORE will demonstrate potential to reduce cognitive impairment by controlling restorative sleep

Key Technical Objective 1:
Develop a multimodal system that enables the precision control and optimization of sleep macro- and micro-architectures

Key Technical Objective 2:
Evaluate changes in sleep macro- and micro-architectures and their mediating effects on pre- and postintervention brain activity, sleep and cognitive performance





Explanatory test: Measure functional connectivity and perivascular space

Primary Outcomes:
Cognitive performance

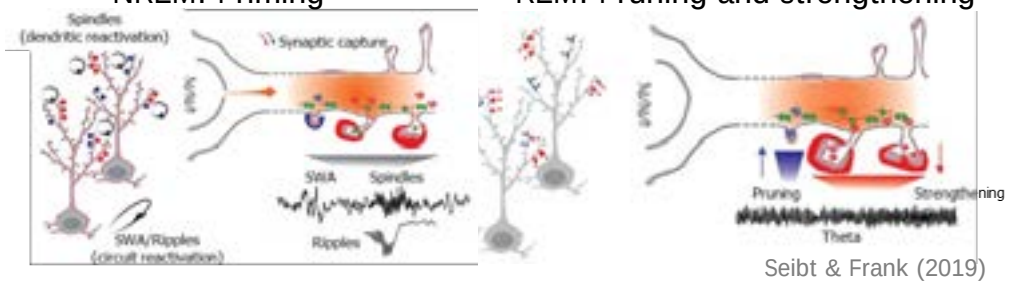
EEG: electroencephalogram

How does restorative sleep impact the brain?

Synaptic plasticity

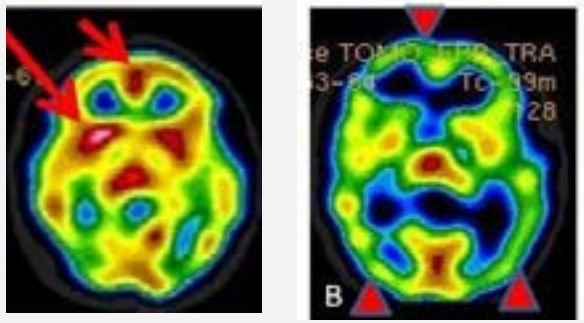
NREM: Priming

REM: Pruning and strengthening



Seibt & Frank (2019)

REM (theta) & NREM (SWA, spindles, ripples) architectures optimize anatomy and connectivity



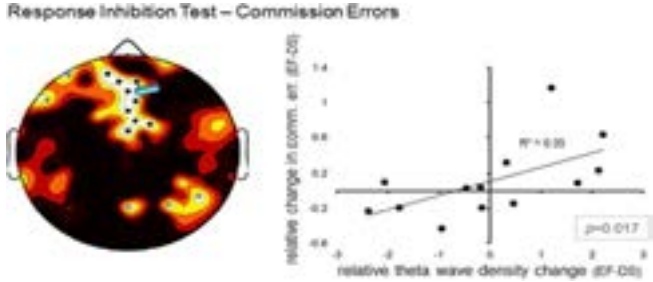
https://www.snmmi.org/

Disrupted sleep architectures decrease plasticity damaging brain connectivity associated with cognitive impairment

Restorative

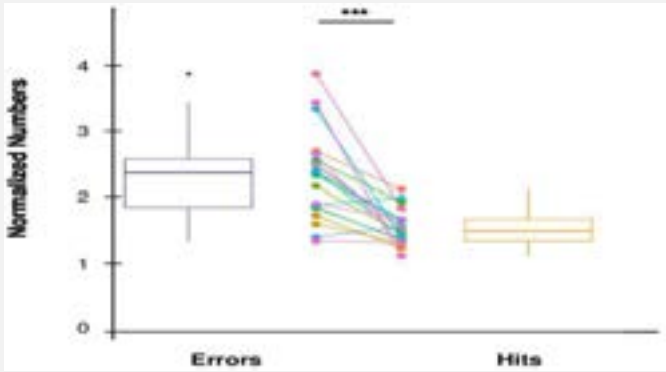
Disrupted

Local sleep during wakefulness



Bernardi et al., J Neurosci 2015

During sleep deprivation the local increase in theta waves detected with hdEEG correlates with impaired performance



Quercia et al., Front Human Neurosci 2018

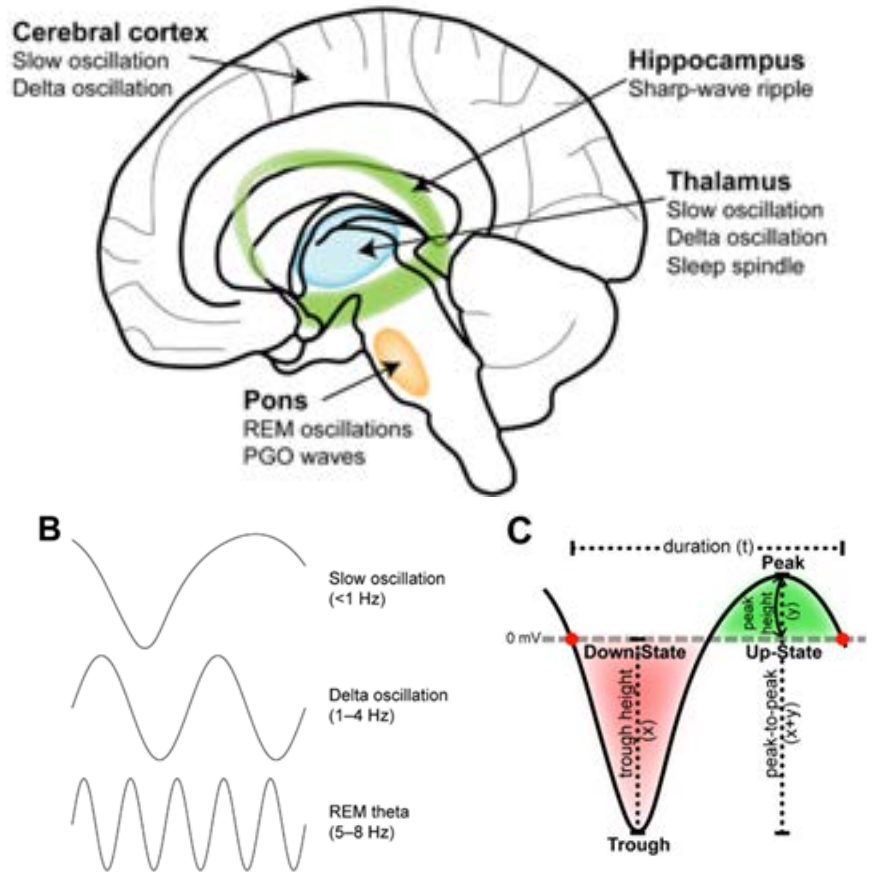
Even without sleep deprivation, local slow waves occur after intense learning and are associated with impaired performance

Restorative sleep repairs the brain daily to maintain cognitive performance

CSF: cerebral spinal fluid
Hz: hertz
hdEEG: high density electroencephalogram
NREM: non-REM sleep
REM: rapid eye movement sleep
SWA: slow wave activity

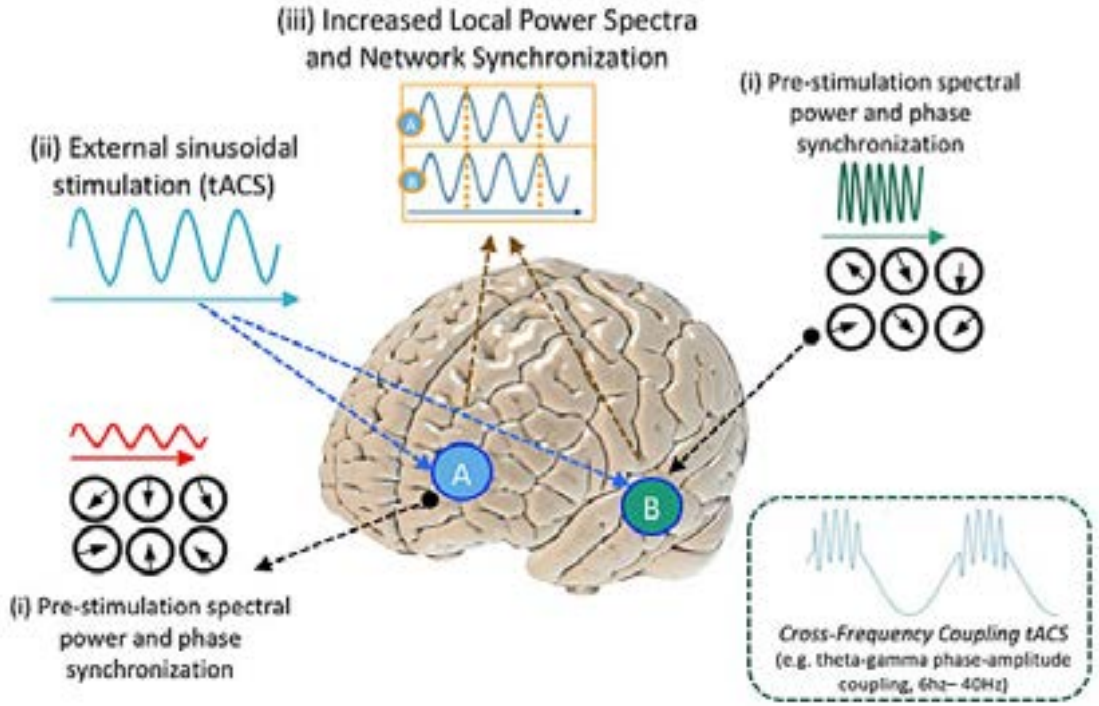
Key technical challenges in repairing disrupted sleep architectures

Orchestrate whole brain restorative sleep architectures



Brown et al., (2022)

Synergistic neuromodulation

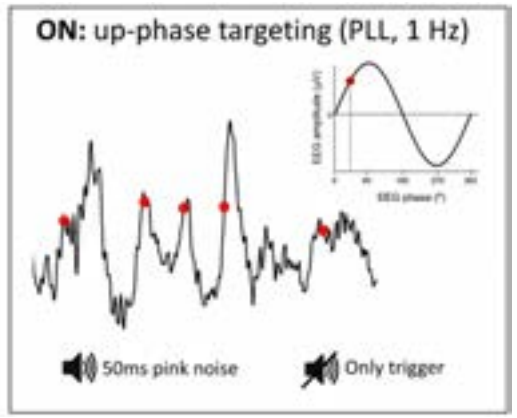


Menardi et al., (2022)

Hz: hertz
PGO: Ponto-Geniculo-Occipital
REM: rapid eye movement
tACS: transcranial alternating current stimulation

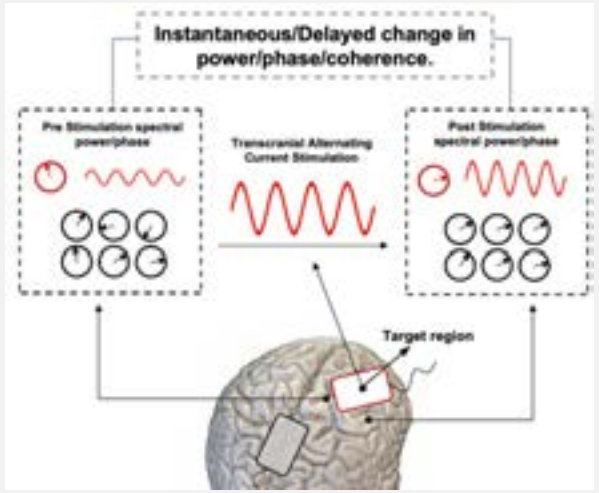
Evidence that orchestrating whole brain sleep architectures is possible

Mechanism of Action



Phase-locked-loop (PLL) acoustic stimulation to control sleep architecture in a closed-loop

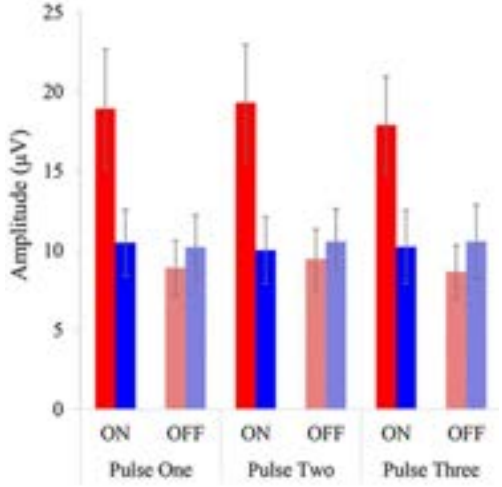
Lustenberger et al. (2022)



Neurostimulation (TES) aligns neuronal firing to control sleep architectures

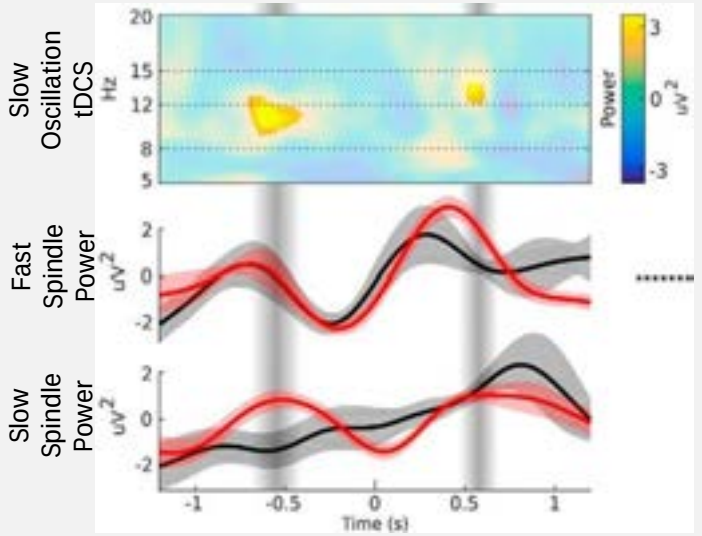
Romanella et al. (2020)

Impact on Sleep Architectures



Acoustic stimulation doubled magnitude (amplitude) of sleep slow waves

Papalambros et al. (2017)



Slow Wave TES can stimulate coupling of whole brain architectures

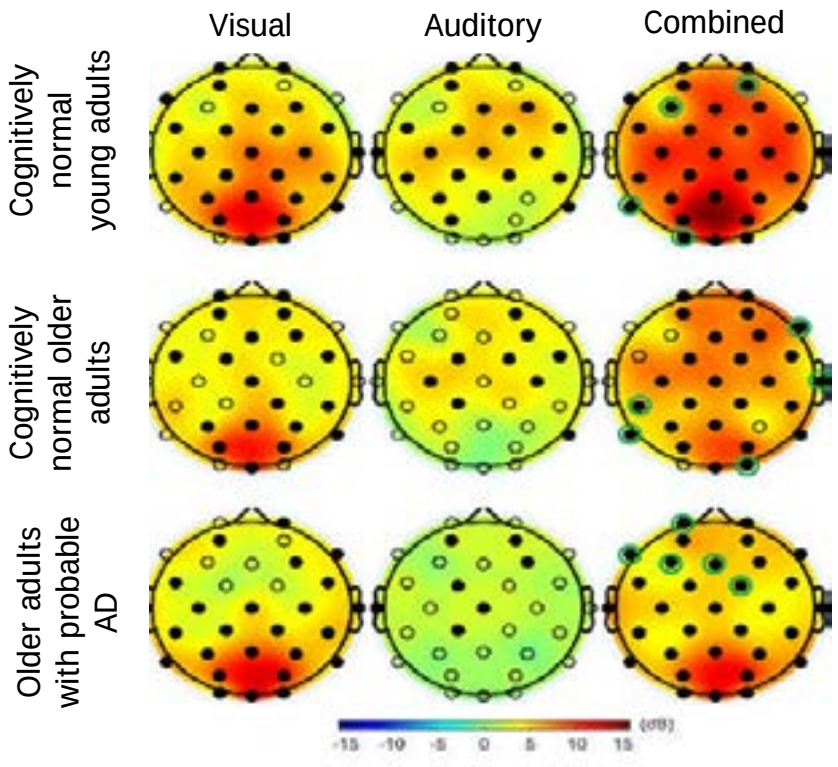
Ladenbauer et al. (2017)

Hz: hertz
s: seconds
μV: microvolt

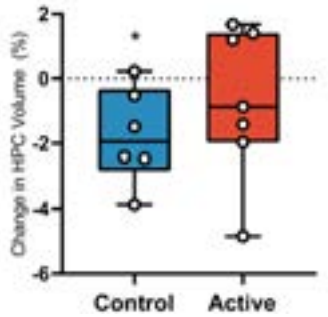
TES: transcranial electrical stimulation
tDCS: slow oscillatory transcranial direct current stimulation
TFR: time-frequency representation

Evidence that synergistic neuromodulation improves neurophysiology and cognitive performance

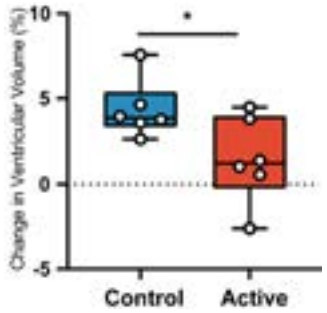
Visual and auditory neuromodulation using scalable technologies



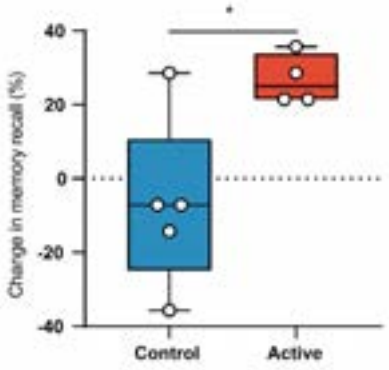
Hybrid stimulation increased brain activity more than single method stimulation



Synaptic Plasticity



Glymphatic Clearance



Cognitive Performance

Synergistic technologies improved physiology and cognitive impairment

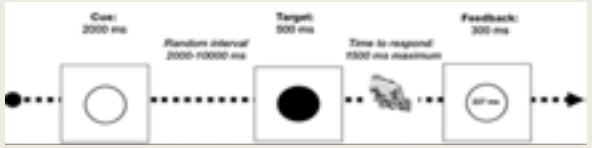
Phase 2 Clinical Trial, FDA Breakthrough Technology (Chan et al., 2022)

AD: Alzheimer's Disease
FDA: U.S. Food and Drug Administration
HPC: hippocampus

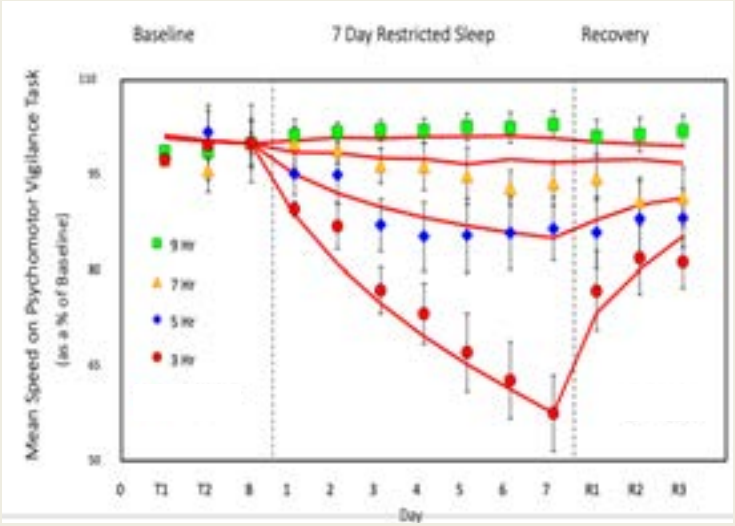
RESTORE Hypothesis: Orchestrating whole brain sleep architectures will overcome cognitive deficits of sleep deprivation

Risks of disrupted sleep (2003 - now)

Psychomotor Vigilance Task (PVT)



Press button when counter begins, repeat

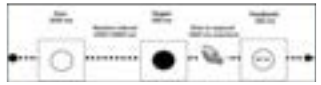


20+ years - No solution

RESTORE: Improved biomarker measurement of disrupted sleep

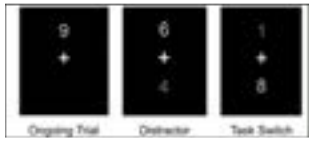
Cognitive testing of multiple performance domains

Psychomotor Vigilance Task (PVT)



Press button when counter begins, repeat

Task Switching

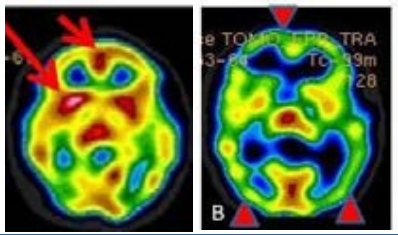


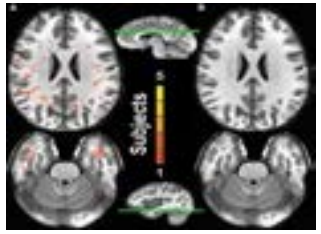
Switch between determining if target number is even-odd or >5

Digital Symbol Substitution Test

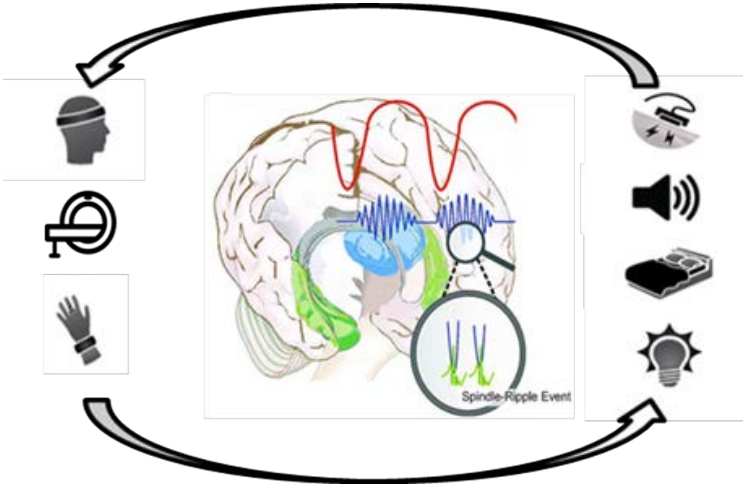
Match symbols to numbers according to given key

Neuroimaging of biomarkers to increase mechanistic understanding





RESTORE: Gold standard sleep restriction and intervention study



- Induce and measure cognitive impairment and brain dysfunction
- Conduct a sham-controlled intervention trial
- Evaluate prevention of cognitive impairment and brain dysfunction in sleep restricted state

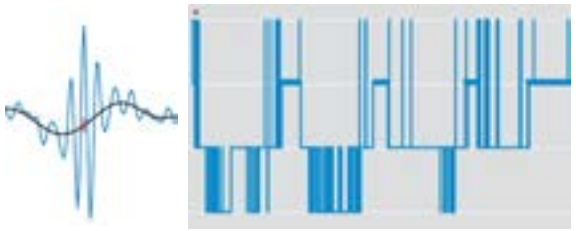
24-month MVP establishes basis for potential solutions to 20-year military challenge

MVP: mimimum viable program

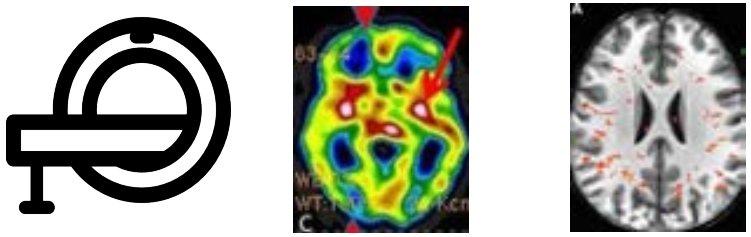
MVP metrics

MVP: Demonstrate 1) control of sleep architectures , 2) a statistically significant neurophysiological measure of brain restoration, and 3) improved cognitive outcomes		
Military Cognitive Performance Domains	**Test**	**Metric (3-hour sleep restriction)**
Attention* and Alertness* (sentry)	Psychomotor Vigilance Task Reaction time and lapses	25% improvement in cognitive performance
Monitoring* and Response Inhibition* (friendly fire/hostage rescue)	Task Switching Accuracy and response time	25% improvement in cognitive performance
Processing Speed* (navigation)	Digital Symbol Substitution Test Accuracy and response time	25% improvement in cognitive performance

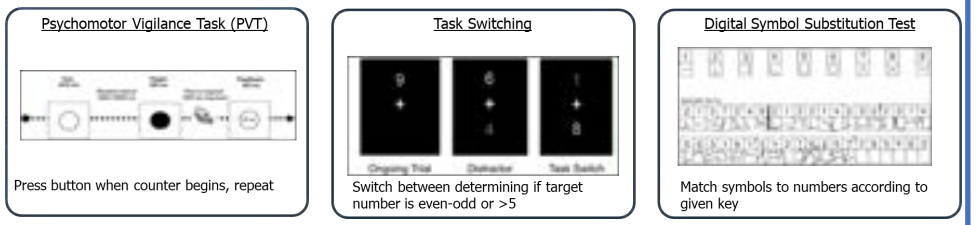
1) Sensors & decoders: Measure brain waves and identify architectures



2) Explanatory Tests: Link changes in brain physiology to sleep architectures and cognitive performance

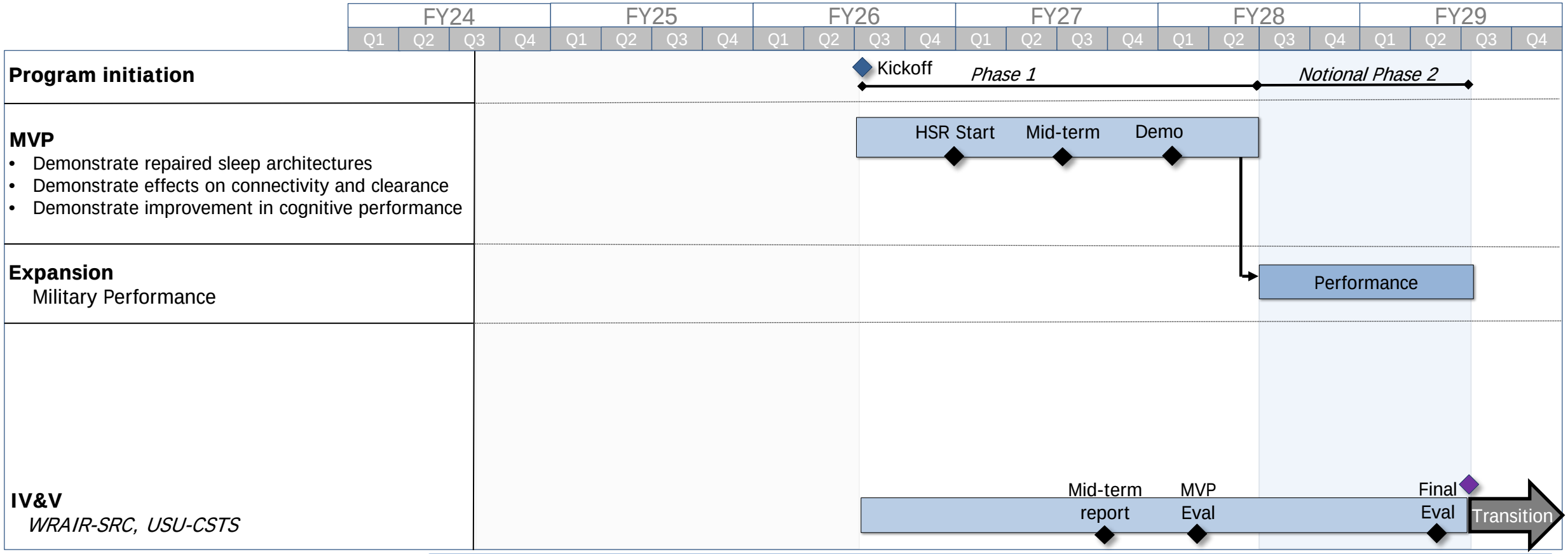


3) Primary Outcomes: Cognitive performance



*Military performance experts' consensus of critical components of cognitive performance (Albertelle, 2023)

RESTORE program plan



RESTORE Military MVP SMEs, Expansion Performers, and Transition Partners

Dr. Tracy Jill Doty, Chief of Sleep Research, WRAIR

COL Vin Capaldi, Chair of Psychiatry and Dir. of USU CSTS

Dr. Nita Shattuck, Professor of Operations Research Naval Postgraduate School

Dr. Rachel Markwald Director, Sleep Tactical Efficiency and Endurance Lab Warfighter Performance/NHRC

Dr. Erin Flynn-Evans Director, Fatigue Countermeasures Laboratory NASA Ames Research Center

Dr. Allison Brager, Deputy Chief Science Office, JFK Special Warfare Center

WRAIR-SRC: Walter Reed Army Institute of Research, Sleep Research Center
USU-CSTS: Uniformed Services University, Center for the Study of Traumatic Stress
HSR: Human Subjects Research
IV&V: Independent Verification & Validation

General guidance

- RESTORE aims to transform broad areas of the DoD Human Domain through applied research
- Achieving the RESTORE program goals will require tightly-integrated, multidisciplinary teams that can address both of the key R&D challenges

- RESTORE is comprised of two key Technical Objectives (TOs)
  - Each proposal should address **both** TOs
    - *DARPA will consider proposals that do not address both technical objectives as non-responsive and will not evaluate them*
  - Proposers should strive to provide a clear understanding of the cost, risk, and organizational expertise to be used within each proposed effort
  - Pay attention to “must” and “should” language in the BAA
  - Submitting a proposal abstract is **highly recommended**

Focus on multidisciplinary capabilities and teaming

Questions

- Please submit any questions to RESTORE@darpa.mil
- Answers to the questions will be provided later and posted to https://sam.gov/
- Select presentation materials will be made available after clearing public release

Key upcoming dates

- Abstracts Due (optional): 21 March 2025 4:00 PM EST
- FAQ Submission Deadline: 22 April 2025 4:00 PM EST
- Full proposal Due Date: 19 May 2025
- Expected Start Date: January 2026

www.darpa.mil

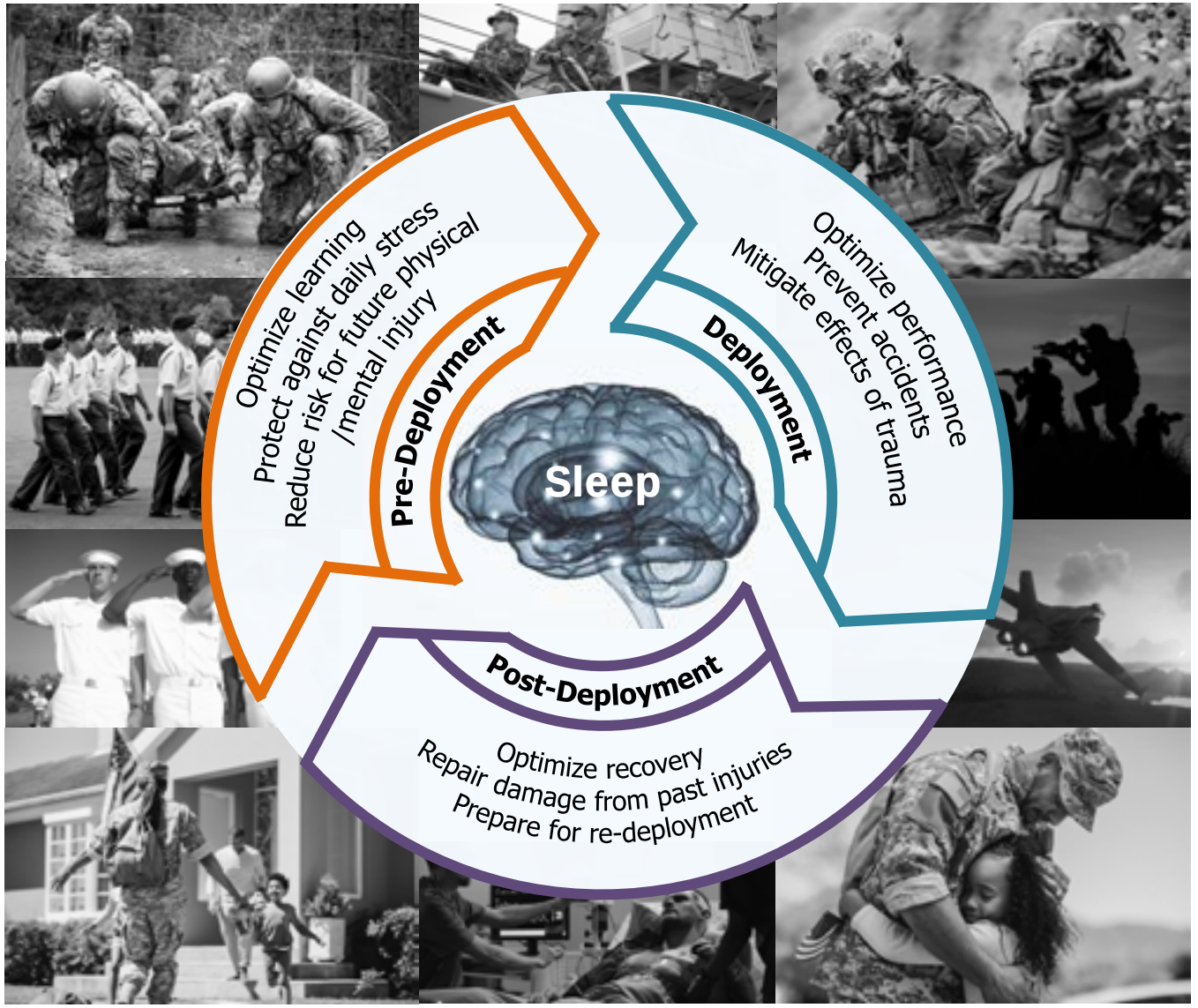
RESTORE: Sleep to prepare, protect, and heal

"Sleep may be the most important biological factor that determines Service member health and combat readiness"

DoD Report to the Congressional Armed Services Committees (2021)

Yet...

69-72% of soldiers are chronically sleep restricted (<6hrs), compared to 28% of civilians (Good, et al. 2020)



Warfighter sleep optimization throughout deployment cycle

"Sleep may be the most important biological factor that determines Service member health and combat readiness"

DoD Report to the Congressional Armed Services Committees (2021)

Yet...

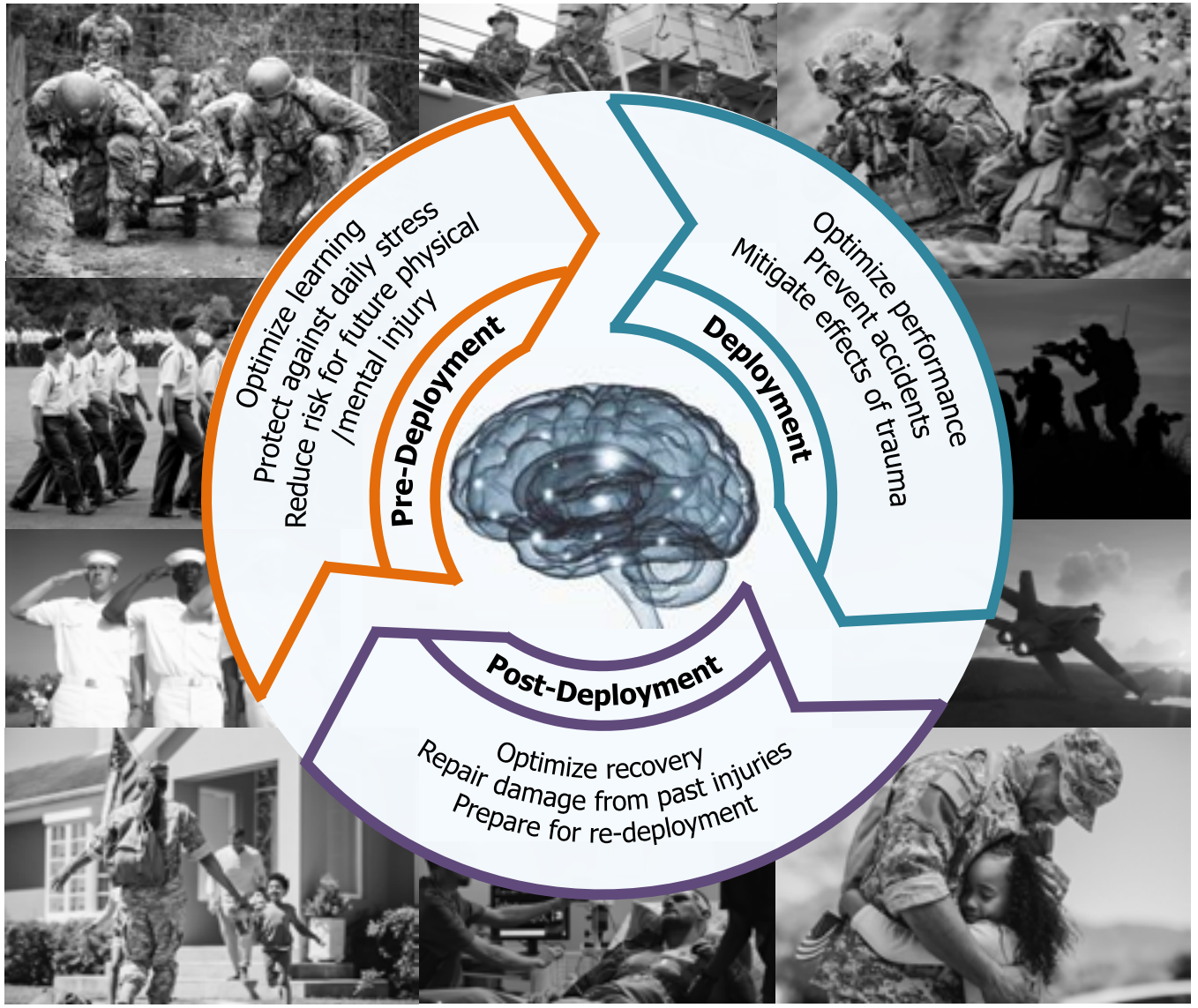
69-72% of soldiers are chronically sleep restricted (<6hrs), compared to 28% of civilians

Mental Health: < 6 hours sleep/night pre-deployment:

- Increases post-deployment TBI 1.8X, alcohol abuse 1.9X, suicide 3.8X, PTSD 4.7X (Good, et al. 2020)

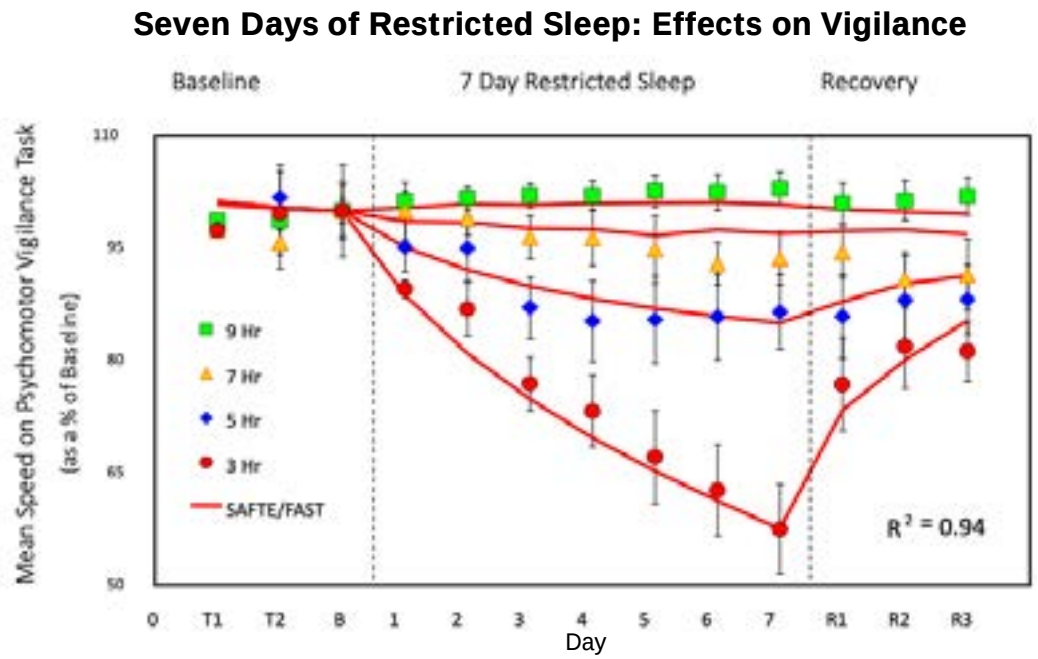
Performance: < 3 hours of sleep common in combat (Weeks, 2010)

- Identification and accuracy decreases 220%
- Increases false fires (no target) by 164% (WRAIR)



TBI: traumatic brain injury
PTSD: post-traumatic stress disorder

Poor sleep negatively impacts military performance



Belenky, et al. 2003

- 69-72% of Soldiers are chronically sleep restricted (< 6 hours per night) vs. 28% of civilians (Good, et al. 2020)
- </=3 hours sleep is common for combat operations & training, and 20-hour day-cycles are common for many military duties (Weeks et al., 2010)
- After 3 days of limited sleep, soldiers' ability to identify/shoot the enemy ↓220% and 164% ↑ shot at things that did not exist (WRAIR)
- During deployment, > 50% of accidents are caused by sleep and circadian disruptions (WRAIR)
- < 6 hours sleep/night pre-deployment leads to increased post-deployment TBI (1.8x), alcohol abuse (1.9x), suicide (3.8x), and PTSD (4.7x) (Good et al., 2020; Luxton et al. 2011; U.S. Department of Defense, 2021)

Hypothesis: Sleep and circadian rhythm disruption is causal rather than a secondary comorbid effect of psychopathology

Current Treatments

Cognitive Behavioral Therapy for Insomnia
(Muench et al., 2022)

+ 70-80% respond, ~50% reduction in symptom severity, long-term sustained effect
− 4-8 weeks for effectiveness
− Requires optimal sleep practices and settings not feasible for many military demands

Sleep promoting Rx **medications** (e.g., Ambien)

+ Improve sleep onset, wakenings, and duration
− Side effects: drowsiness, dizziness, headaches
− Risks: abuse, dependence, sleep disturbance

Wake-promoting Rx **medications** (e.g., Provigil)

+ Treat excessive sleepiness caused by SCDs
− Side effects include anxiety, dizziness, headaches
− Risks: abuse, dependence, sleep disturbance

Treat

Mitigate

Stimulants

+ Immediate effectiveness
− Can cause sleep disruptions
− Rx stimulants (e.g., Provigil) prohibited for most military uses due to risk of abuse
− Do not treat sleep disorders

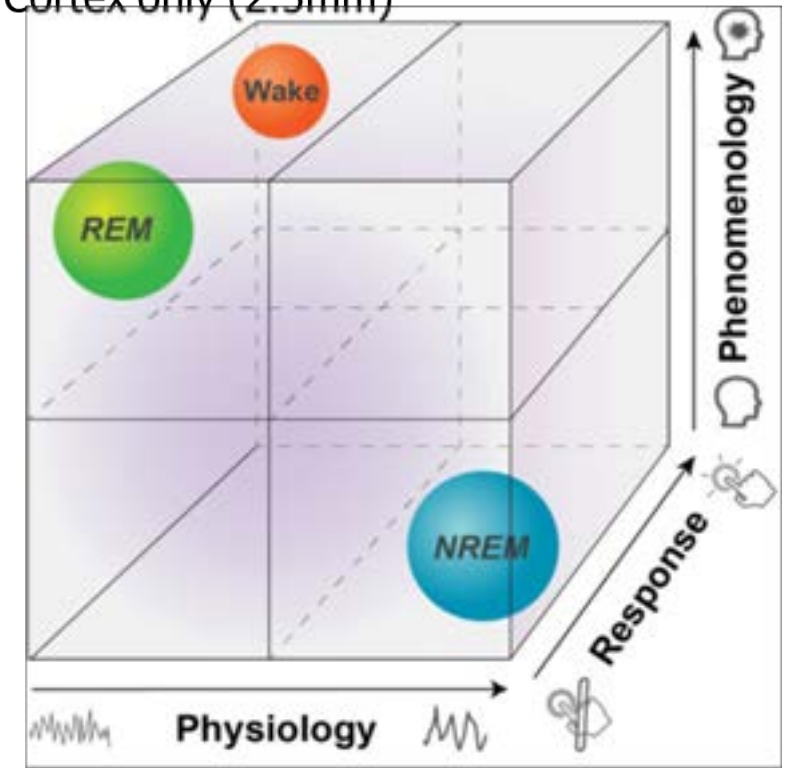
Tactical **napping**:

+ Improve alertness and fatigue
− Best results require dark and quiet location not available in many military deployment conditions
− Unknown ability to target restorative mechanisms

SCD: Sleep and circadian disruption

Restorative sleep via synchronized neural mechanisms

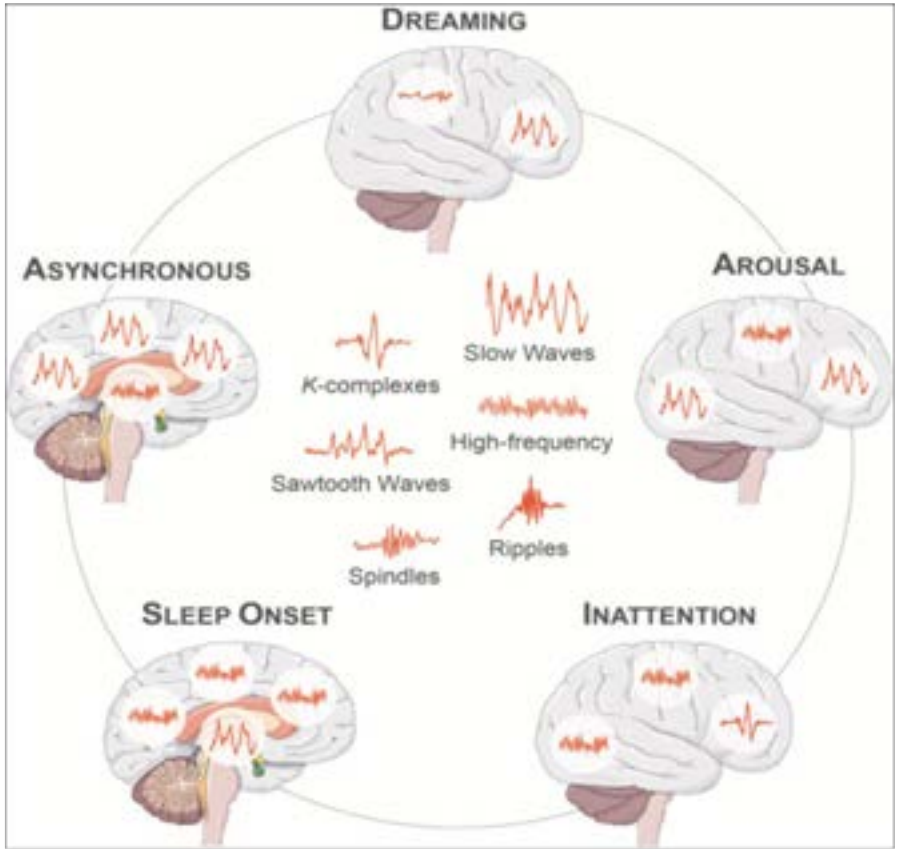
EEG-informed "Global" Sleep Models
Cortex only (2.5mm)



REM EEG: low-amplitude, high-frequency desynchronized rhythms, atonia, rapid eye movements

NREM EEG: "slow" aka 1-4 Hz (delta) waves, K-complexes (high-amplitude delta waves) or sleep spindles (waxing-and-waving 11–16 Hz transient oscillation

Recent Intracranial EEG-informed "Local" Sleep Models



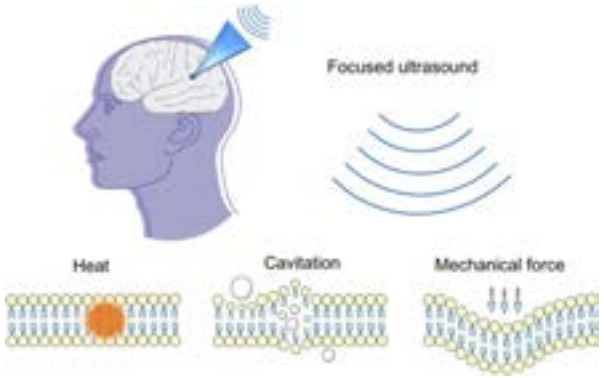
2

Andrillon and Oudiette (2023)

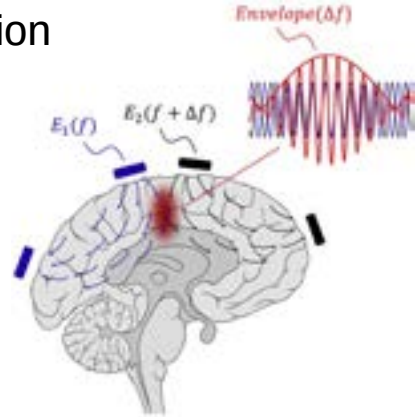
Recent technological advances create potential for closed loop, whole brain systems

Portable and durable hardware development

Non-invasive deep brain neuromodulation

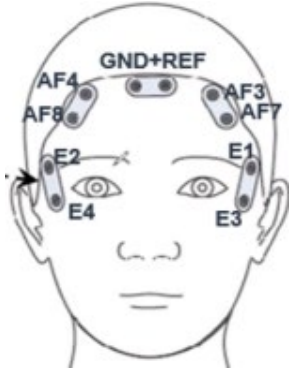


Low-Intensity Focused Ultrasound (LIFUS)

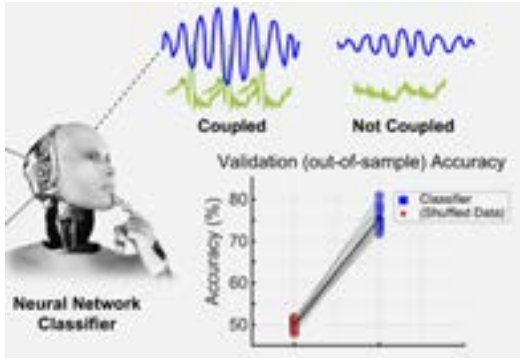


Transcranial Electrical Stimulation with Temporal Interference (TES-TI)

Automated decoding of sleep stage and restorative biomarkers



Wearable multi-modal sensors



Advanced decoders detect synchronized cortical-deep brain biomarkers

IV&V System Integrating Sleep Enhancement Modes

StARS | System to Augment Restorative Sleep

Effectors (Onboard, Connected, Wireless)

Auditory
- In-ear headphones (bluetooth, wireless, USB-C)
- Environmental speaker (onboard)

Thermal
- Dynamic cutaneous thermomodulator (mattress / pad)

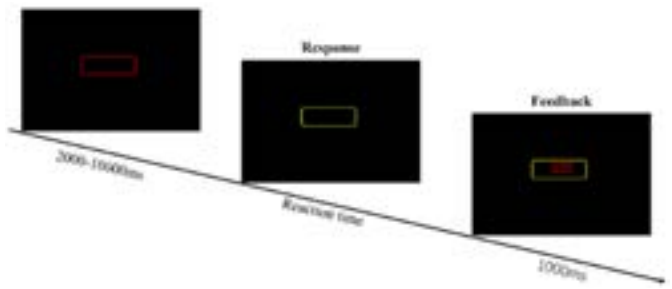
Electrical
- Transcranial electrical stimulation-ready

Environmental
- IoT connectivity (wireless, bluetooth)
- Visual stimulation with full-spectrum LED (onboard)

MVP Metrics – 25% decrease in cognitive impairment (PTSD / TBI) after 30 days of restorative sleep

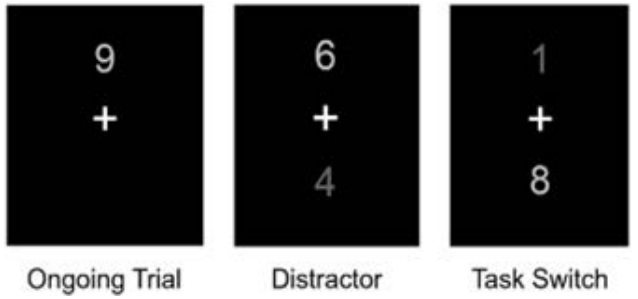
Military performance psychologists' consensus of critical components of cognitive performance:
Attention, Alertness, Response Inhibition, Processing Speed, Monitoring (Albertelle, 2023)

Psychomotor Vigilance Task (PVT)



Press button when counter begins, repeat

Task Switching



Switch between determining if target number is even-odd or >5

Digital Symbol Substitution Test

Match symbols to numbers according to given key

Attention and Alertness
Reaction Time & Lapses
Sentry

Response Inhibition and Monitoring
Reaction Time & Accuracy
Shoot / No Shoot
Hostage Rescue & Friendly Fire

Processing Speed
Reaction Time & Accuracy
Navigation

MVP: minimum viable program
PTSD: post-traumatic stress disorder
TBI: traumatic brain injury
DoD: Department of Defense
ms: millisecond

Broad Agency Announcement (BAA)
Reengineering Enabling Sleep Transitions in Operationally Restrictive Environments (RESTORE)
Doing Business with DARPA

Lydia Richards
Contracting / Grants / Agreements Officer
DARPA Contracts Management Office

February 4, 2025

RESTORE – Doing Business with DARPA

- Will be posted on SAM.gov and grants.gov websites
- This is a 24 months, single-phase program
- Multiple Awards are anticipated.
- Please pay attention to due dates in BAA and special instructions outlined in the new BAA Model format
- **Potential Award Instrument Types**:
  - Procurement contracts
  - Cooperative Agreements
  - Other Transaction (OT) for Prototype
  - OT for Research
- DARPA expects solutions to be either **fundamental** OR **non-fundamental research**

NOTE: If there is any discrepancy between what is presented today and the BAA, the BAA takes precedence.

Abstracts

- Abstracts are strongly encouraged, but not required.
  - **Attachment A: Abstract Summary Slide** (Required if submitting an Abstract)
  - **Attachment B: Abstract Instructions and Template** (Required if submitting an Abstract)
- The Program Manager will respond to each Abstract with feedback either encouraging or discouraging a full proposal submission.
- Proposers may submit a full proposal even if the Abstract is discouraged.

Full Proposal Tips

- Read the BAA carefully – **Non-conforming proposals may be rejected** without review.
- Please ensure review of eligibility and statutory requirements when requesting an **Other Transaction**
- **A full proposal must include 2 volumes**
  - ❑ **Procurement contracts OR OT-Ps:**
  1. **Technical Approach & Management (Volume I)**
     - o Proposal Summary Slide Template = Attachment C = **REQUIRED**
     - o Proposal Instructions and Volume I Template = Attachment D = **REQUIRED**
  2. **Cost Proposal (Volume II)** = **No page limit**
     - o Proposal Instructions and Volume II Template = Attachment E = **REQUIRED**
     - o MS Excel DARPA Standard Cost Proposal Spreadsheet = Attachment F = **REQUIRED**
  - ❑ **Cooperative Agreements or OT-Rs:**
  1. **Technical Approach & Management (Volume I):** Attachments C and D are **REQUIRED**
  2. **Cost Proposal (Volume II):** Attachment E is **REQUIRED and SF424 (R&R) Budget** form through Grants.gov

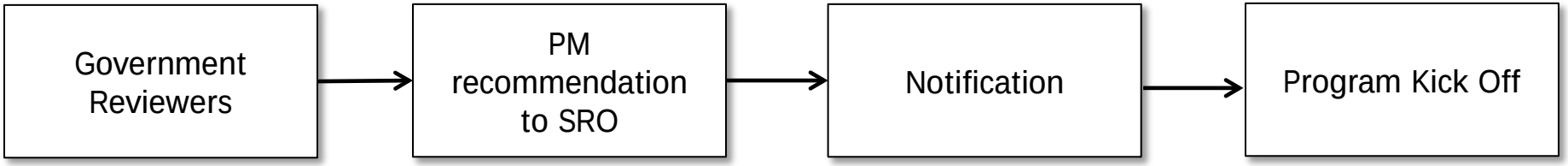
BAA Process: Teaming & Eligibility

- All responsible sources capable of satisfying the Government's needs may submit a proposal that shall be considered by DARPA.

- **FFRDCs, UARCs & National Labs:** subject to limitations
  - Federally Funded Research and Development Centers (FFRDCs), University Affiliated Research Centers (UARCs), and Government entities interested in participating in this opportunity or proposing to this BAA must first contact the point of contact listed in the Overview Information section prior to the Abstract due date to discuss eligibility.

- **Organizational Conflicts of Interest:**
  - DARPA policy: Without prior approval or a waiver from DARPA, in accordance with FAR 9.5, a contractor cannot simultaneously provide scientific, engineering, technical assistance (SETA) or similar support (A&AS) and also be a technical performer.
  - Must address in your proposal if providing SETA or similar support to any DARPA technical office(s) through an active contract or subcontract.

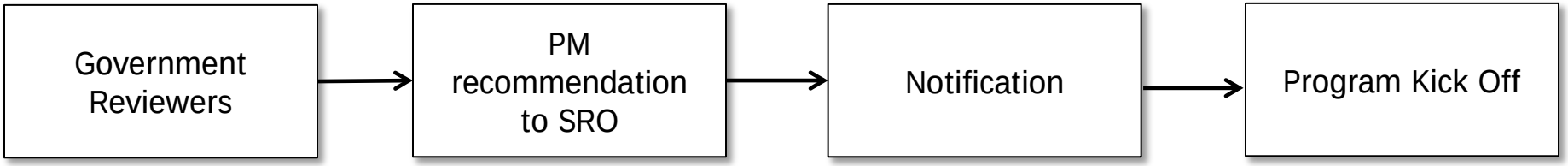
Full Proposal Review-Awards Process



- No common Statement of Work - Proposals are evaluated on individual merit and relevance as it relates to the stated research goals/objectives rather than against each other.
- Proposals are evaluated for strengths and weaknesses relative to the criteria published in the BAA, listed in ***descending order of importance***:

Refer to BAA for details regarding proposal evaluation

Full Proposal Review-Awards Process



- Government reserves the right to select for award all, some (partial selection), or none of the proposals received.
- Multiple awards are possible. The amount of resources made available under this BAA will depend on the quality of the proposals received and the availability of funds.
- **Contract negotiation timelines depend on each institution/organization's responsiveness to the proposal requirements in the BAA.**
- The contracting office will contact the selected performers and begin the contracting process.

Refer to BAA for details regarding proposal evaluation

Final Bits of Advice

Once it is published, read the BAA over and over again and follow all instructions carefully.

A conforming proposal addresses **all aspects** of the BAA

Pay attention to "**must**", "**should**", "**shall**", and "**all**" in the BAA

DO NOT try to **shoehorn ongoing, but not applicable, work into a BAA response**

DO NOT submit a **rewritten USDA, NIH or NSF abstract**

DO NOT propose to do anything that is **not directly relevant to the BAA**

DO NOT submit **an irrelevant or incomplete abstract** in the hope we'll fund it anyway

A proposal abstract is **STRONGLY RECOMMENDED,** but not required

Register for an account at the BAA Portal (https://baa.darpa.mil)

Human Subjects Research at DARPA

Component Office for Human Research Protections (COHRP)

Definition of Human Subjects Research in Federal and DoD Policies

The term “human subject” can be applied to research efforts that meet EITHER of the following criteria:

A living individual about whom an investigator (whether professional or student) conducting research:

- Obtains information or biospecimens through intervention or interaction with the individual, and uses, studies, or analyzes the information or biospecimens; or
- Obtains, uses, studies, analyzes, or generates identifiable private information, personally identifiable information, or identifiable biospecimens.

Human Subjects Research involves:

- Activities that include both a systematic investigation designed to develop or contribute to generalizable knowledge and involve a living individual about whom an investigator conducting research obtains information or biospecimens through intervention or interaction with the individual, or identifiable private information, or biospecimens.

Any DARPA-funded research which involves humans as defined on this page MUST be considered HSR.

Review of the Protocol

All DARPA human subjects research protocols must go through two reviews

1st review

Local Level (local IRB)

2nd review

DoD Human Research Protection Official/Office Review (administrative)

HSR approval Process

- Principal Investigator submits protocol to local IRB for review and approval
- HSR package is then submitted for DoD headquarter review and approval
  - Includes local IRB approval letter
  - Federal Wide Assurance (of institution performing research)
  - Informed Consent Document ***Make sure informed consent document includes statement that the research is being funded by DoD and thus the DoD has access to the data***
  - Recruiting Materials
  - Biosketches/CVs
  - Training Certifications
- DoD review authority, reviews the entire package
  - May go back to PI with comments/recommendations/changes
- Once DoD HRPO approval is obtained, HSR research can begin
- Note that protected populations (i.e. military, pregnant women, etc.) have special regulations that need to be followed. This includes such things as command level approval for recruitment of subjects (active duty military)

Note – DoD HRPO review and approval can take anywhere from 3-6 months. Do not delay in starting this process!

Helpful Hints/FAQs

- **If possible, submit an IRB approval letter and/or a Draft HSR Protocol with proposal.** Especially, in cases where humans are involved and you don't know that the work is really HSR. Having an IRB already look at it will help you and DARPA in moving forward faster.

- **If you do not have an internal IRB, you have one of three options**
  - Hire a commercial IRB
  - Work with the Contracting Agent to determine if they have an internal IRB that could assist
  - If work involves collaboration with other performers, considering using their IRB

- **If you have a contract involving subcontractors who are conducting HSR; they will also need to obtain HSR approval.** Any performer including subcontractors must receive HSR approval through the local IRB and the DoD HRPO office, before start of their research.

- **If you make changes to the statement of work, they also need to be approved.** If the changes are to the HSR portion of the work, the revisions will have to go through the local IRB for review, as well as DoD HRPO office for approval and concurrence.

Questions?

For questions pertaining to HSR in this program, please contact the DARPA PM/SETA team and they will route your questions to the DARPA COHRP