Sleep Deprivation Has Differential Sex-Specific Effects on Implicit Biases Toward Death and Suicide

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Disclosure Statement

COL William D. S. Killgore, USA (Ret.), Ph.D. has no conflicts to report.
Daniel B. Forger, Ph.D. has no conflicts to report.
Kimberly Henderson-Arredondo has no conflicts to report.
Jason Katz has no conflicts to report.
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The opinions, interpretations, conclusions, and recommendations in this presentation are solely of the authors and are not necessarily endorsed by the U.S. Army or Department of War (DoW)

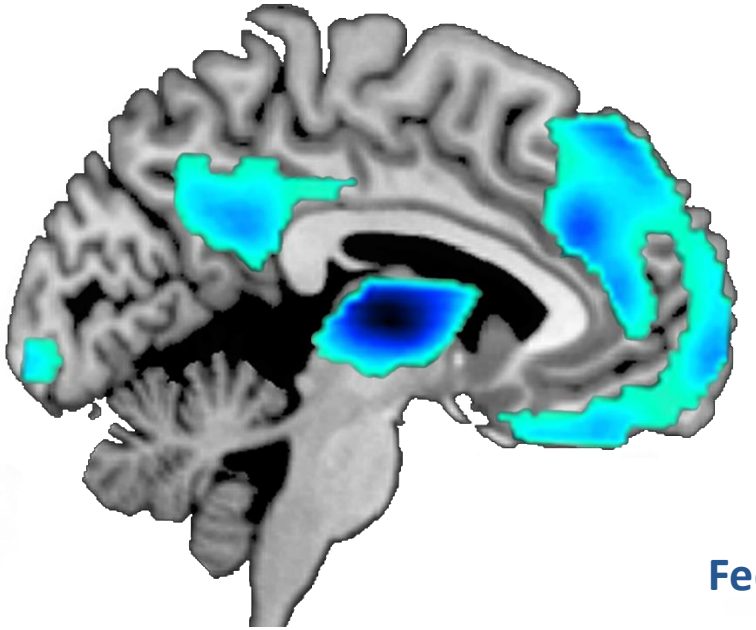
Poor Sleep is Common within the U.S. Military

42% of Service members routinely sleep ≤ 5 hr/night (Mysliwiec et al., Sleep, 2013)

Insomnia is may be up to 5x higher among military personnel compared to civilians (Capaldi et al., Military Mental Health, 2015)

Operational realities often require sustained periods of sleep deprivation (U.S. DoD, 2021; Good, Brager, Capaldi, & Mysliwiec, 2020)

Sleep Deprivation Affects Brain Functioning



Modified from Thomas et al. 2000, *J Sleep Res*

Self-Referential Processing

Emotion Regulation

Flexible Thinking

Moral Judgment (Killgore et al. 2007, Sleep).

Decision Making (Killgore et al. 2007, J Sleep Res).

Feedback Blunting (Whitney et al., 2015, Sleep).

Emotional Processing (Yoo et al., 2007, Current Biology).

Implicit Association Test (IAT)

- **Objective:** Measures subconscious bias and automatic mental associations that people may be unaware of or hide.
- **Method:** Rapidly sort words into changing pairs using a keyboard.
- **Metric:** Tracks reaction times in milliseconds; faster sorting reveals a stronger, more automatic mental link.
- **Insight:** Exposes cultural conditioning and split-second mental shortcuts, rather than conscious prejudice.

Race

Gender

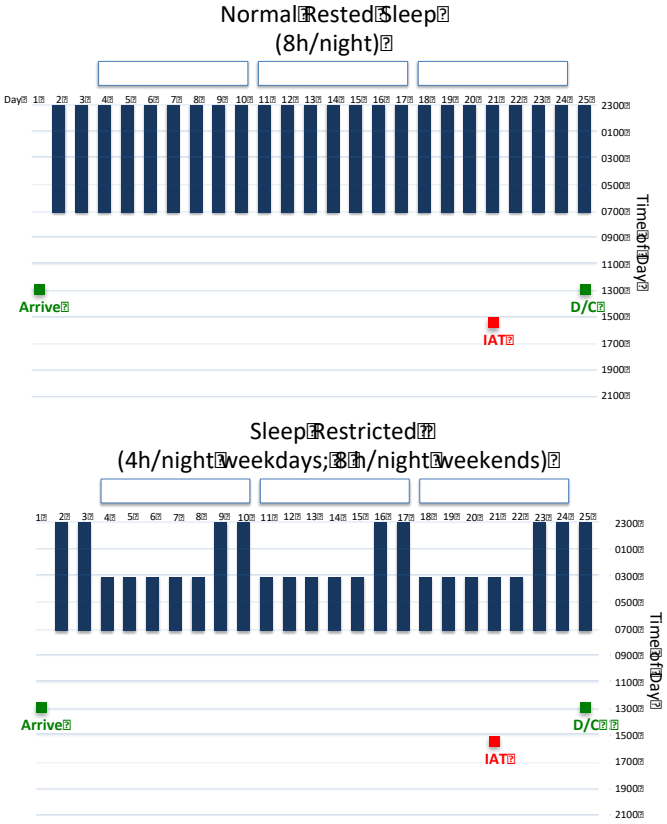
Sexuality

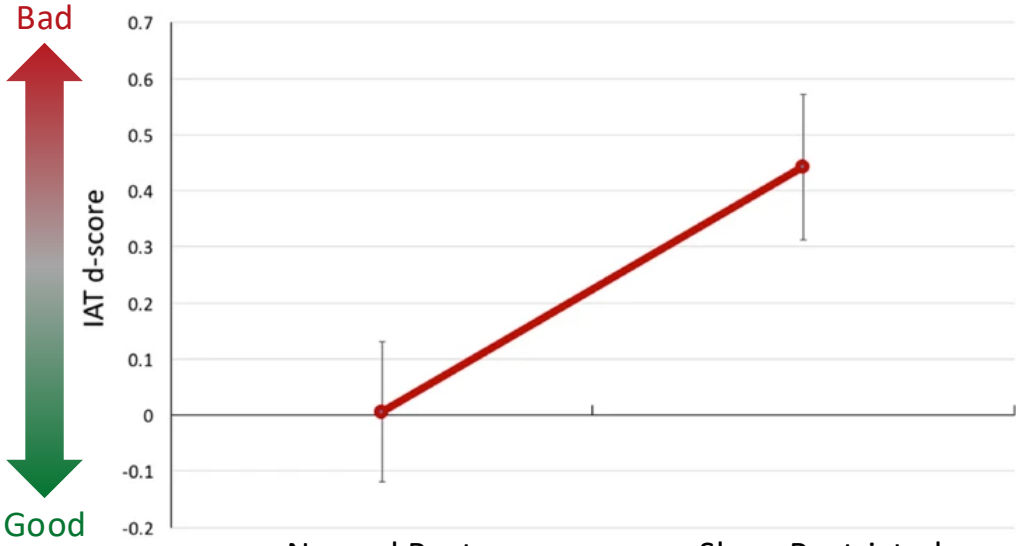
Weight

Suicidality

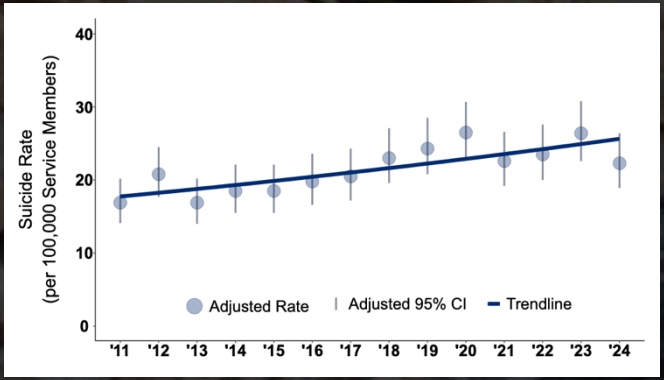
Arab-Muslim Name Bias

Sleep Restriction Increases Implicit Bias Against Arab Muslim Names





Suicide is a Major Health Concern in the Military



Suicide is the leading cause of death among U.S. military personnel, and the trend continues to rise (MHS, 2024; Kaplansky and Toussaint, 2024; MSMR, 2026).

Suicide rates for men are almost 3x greater than for women (Men 28.2 and Women 10.3 per 100,000 person years) (MSMR, 2026).

The IAT reveals death/suicide bias (Nock et al., 2010, Psychological Sci).

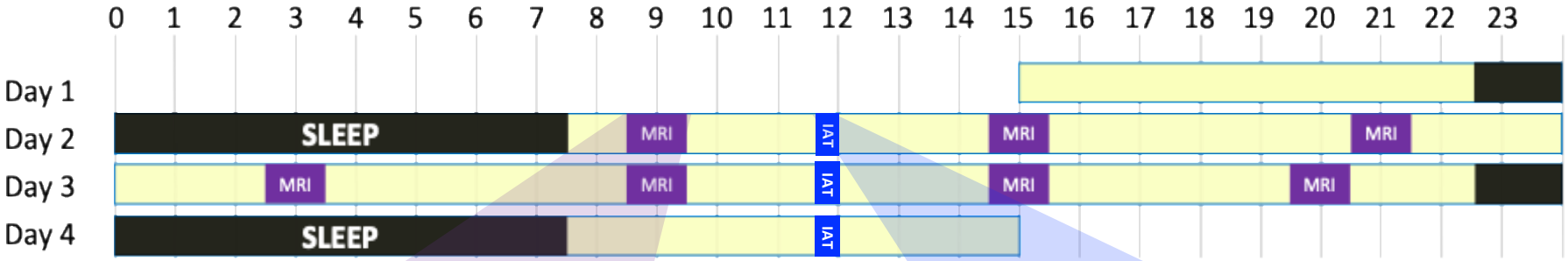
Is it affected by: 1) sleep deprivation, and 2) does it differ between men and women?

Death/Suicide IAT

Participants

	Males	Females	Total
N	9	9	18
Age	24.1 (SD = 6.1)	23.3 (SD = 3.6)	23.7 (SD = 4.9)
Education	14.1 (SD = 2.0)	14.9 (SD = 2.8)	14.5 (SD = 2.4)
BDI	5.4 (SD = 7.3) Range = 1 – 24	3.2 (SD = 2.7) Range = 0 – 8	4.3 (SD = 5.5) Range = 0 – 24
BDI Item 9 (suicide ideation)	0.11 (SD = 0.3) Range = 0 – 1	0 (SD = 0) Range = 0	0.06 (SD = 0.24) Range = 0 – 1

Sleep Deprivation Protocol

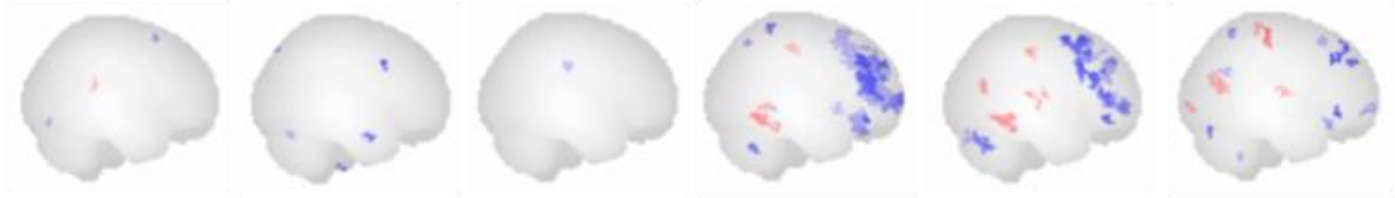


MRI Sessions

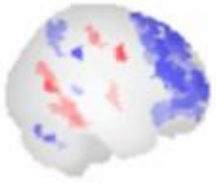
IAT Sessions

Study Design

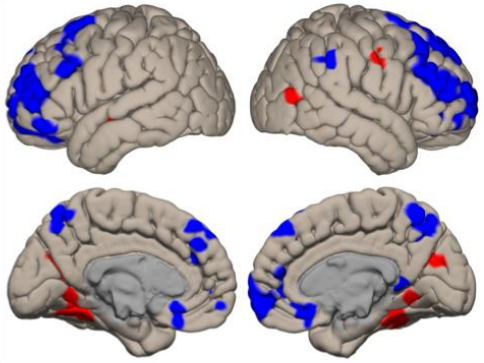
1500 > Base | 2100 > Base | 0300 > Base | 0900 > Base | 1500 > Base | 2100 > Base

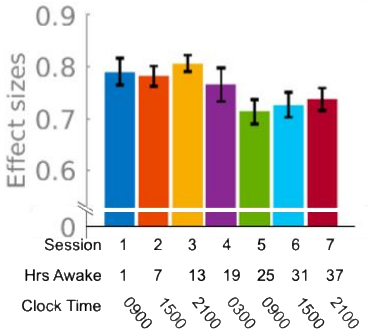


Total Homeostatic Effect



$$fALFF = \frac{ALFF}{\text{Total Power in ALL Frequency Bands}}$$



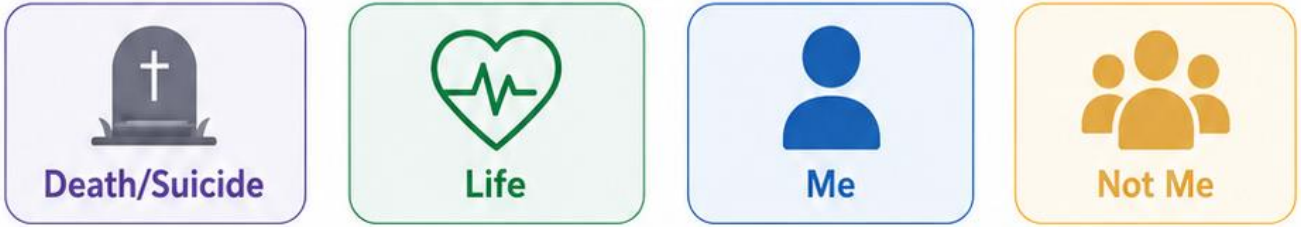


Peak p < .001, Cluster p < .05, FDR corrected

Death/Suicide IAT

1. Sort words quickly

Participants rapidly classify words into four categories:



2. Complete two key pairings

Faster responses suggest a stronger automatic association.

Death/Suicide IAT

ME
or
LIFE

NOT ME
or
DEATH

My

Death/Suicide IAT

ME
or
LIFE

NOT ME
or
DEATH

Them

Death/Suicide IAT

ME
or
LIFE

NOT ME
or
DEATH

Die

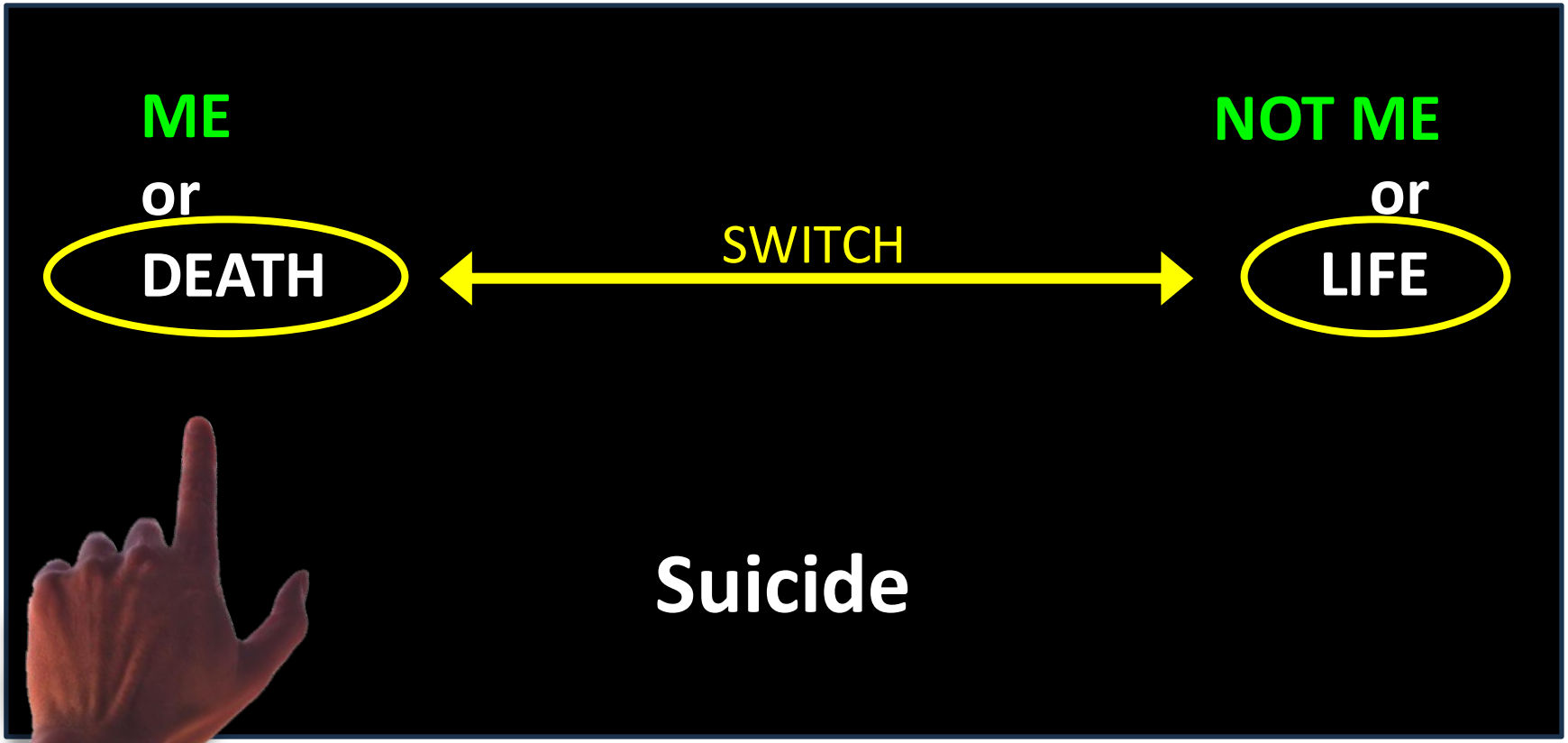
Death/Suicide IAT

ME
or
LIFE

NOT ME
or
DEATH

Live

Death/Suicide IAT



Death/Suicide IAT

ME
or
DEATH

NOT ME
or
LIFE

Survive

Death/Suicide IAT

ME
or
DEATH

NOT ME
or
LIFE

Myself

ME
or
DEATH

NOT ME
or
LIFE

Dead

D-IAT Analyses:

3. Compute the D-score

1 Clean the reaction-time data
Remove very slow trials (>10,000 ms), screen excessive fast responses, and apply an error penalty.

→ **2 Find the mean response time for each pairing**

→ **3 Standardize the difference**

$$D = \text{average}\left[\frac{\text{Mean Me+Life} - \text{Mean Me+Death}}{\text{pooled SD}}\right]$$

This combines the short and long test blocks.

4. Interpret the score

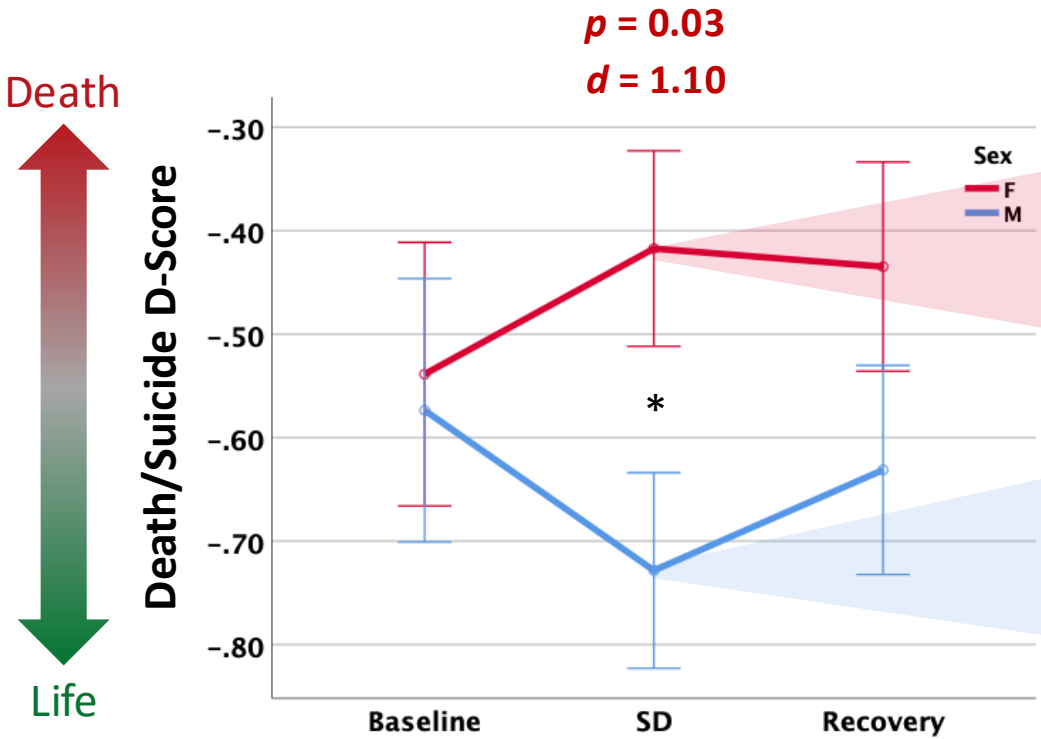
− Negative D
Faster for Me + Life
Stronger implicit self–life association

0 Near 0
Little relative difference

+ Positive D
Faster for Me + Death/Suicide
Stronger implicit self–death association

0

Results:



During Sleep Deprivation

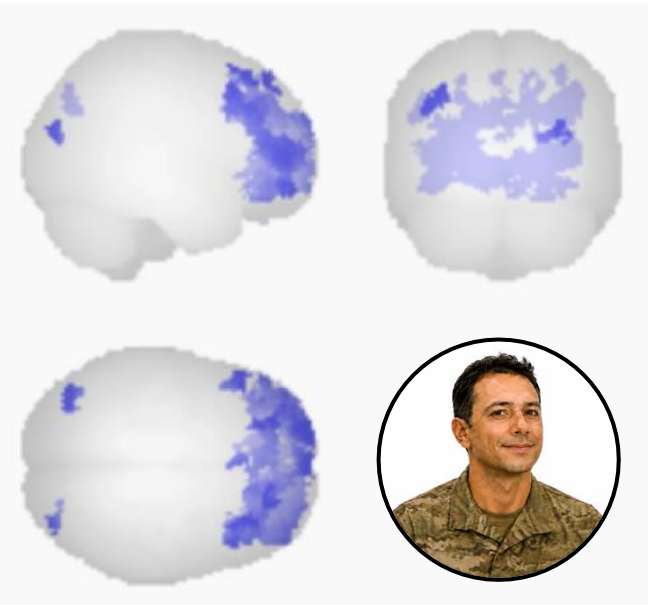
Moderate "Self-Life" association

Strong "Self-Life" association

Sex-Related Brain Responses to Sleep Deprivation

Females

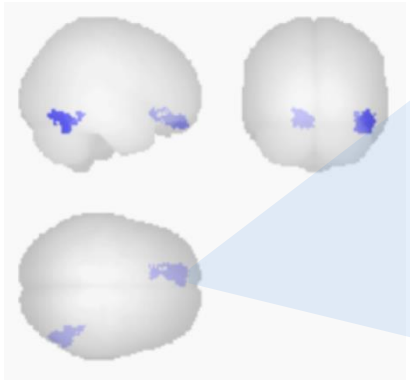
Males

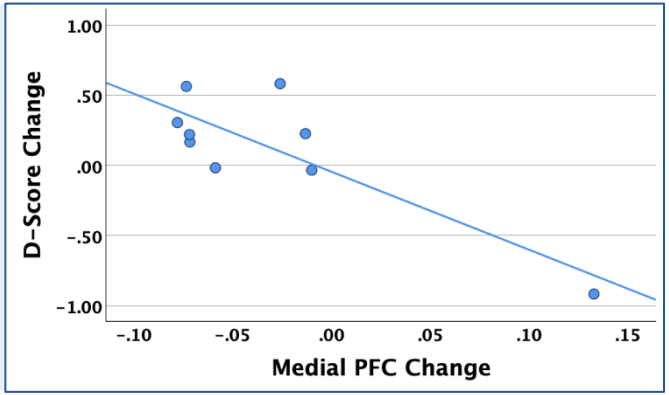


Peak p < .005, Cluster p < .05, FDR corrected

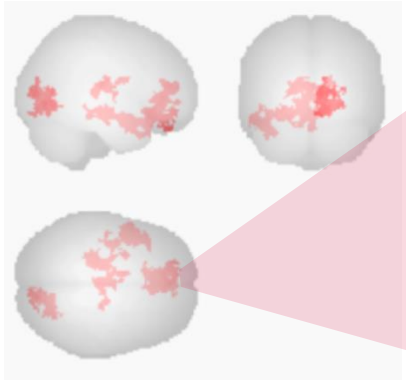
Correlation Between Changes in MPFC Activity and Changes in D-Score

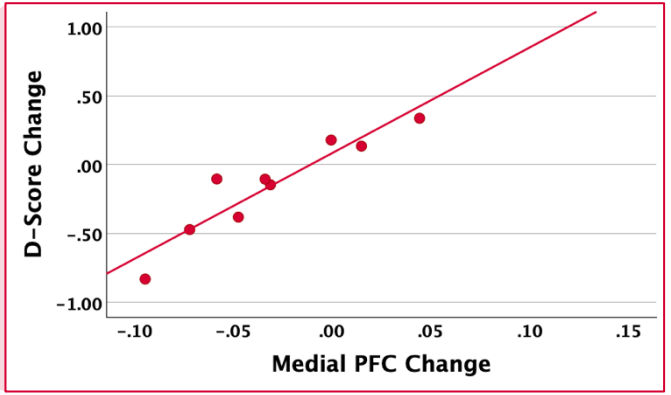
Females





Males





(peak < .05, size < .005)

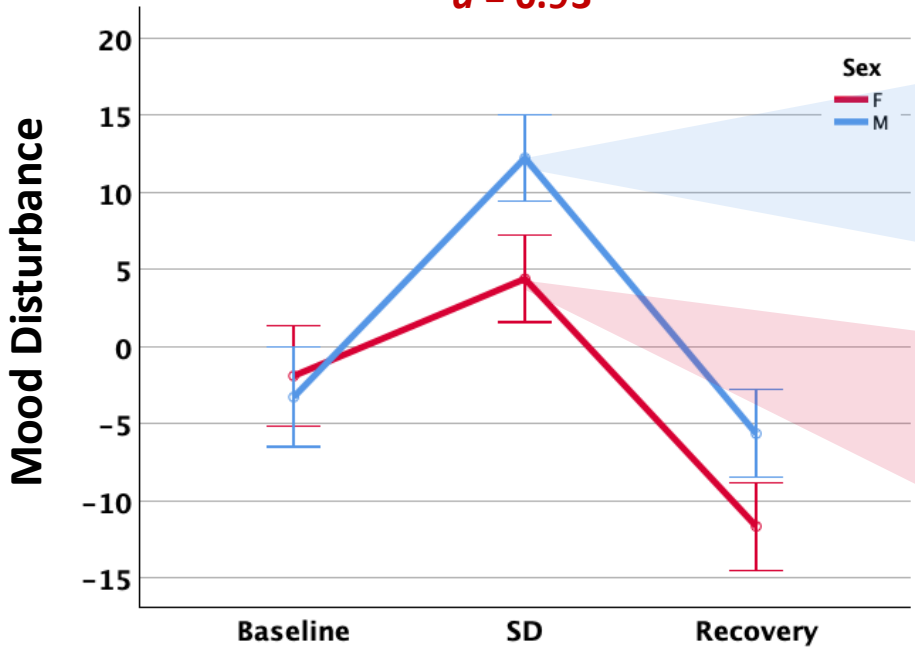
Results:

$p = 0.06$

$d = 0.93$

Worse

Better



During Sleep Deprivation

Strong Worsening Mood

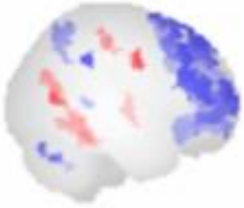
Mild Worsening Mood

Discussion

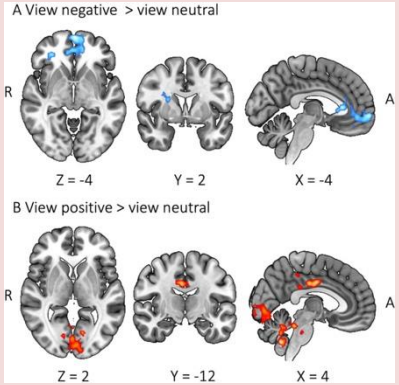
What does this suggest?

The medial prefrontal cortex is affected by sleep deprivation in both men and women, but the effects differ by sex

Consistent with other evidence of sex differences in functional organization of the emotional brain.

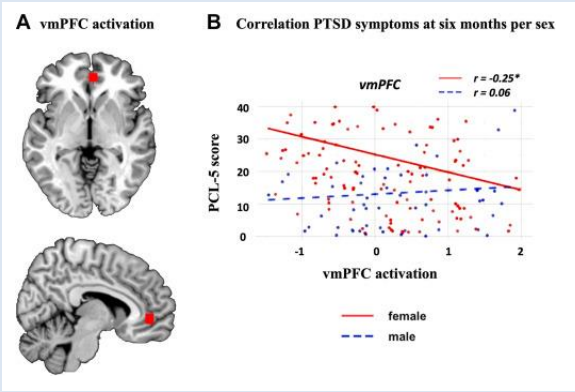


Brain activation differs between men and women during emotional processing



Min et al. (2023), *Brain Topogr.*

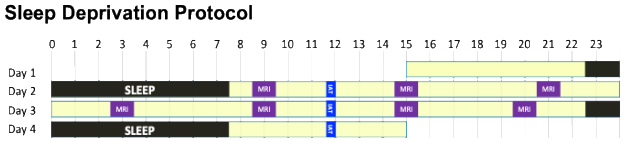
PFC activation predicts 6-month PTSD recovery for women but not men



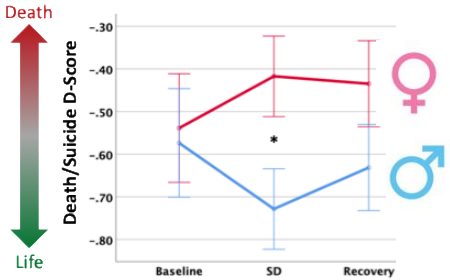
Borst et al. (2024), *Biol. Psychiatry: Cogn. Neurosci,. Neuroimaging*

Summary

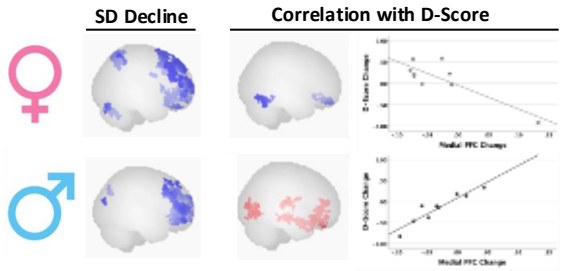
18 participants underwent 39-hours of sleep deprivation while completing MRI scans every 6-hours and D-IAT at baseline, 24-hours, and post-recovery.



While men and women were similar at baseline, women shifted toward greater implicit death/suicide bias while men shifted away from that bias when sleep deprived.



Although both sexes showed similar declines in mPFC brain activity with sleep deprivation, these declines were associated with opposite suicide bias patterns.



Conclusion

Sleep deprivation may represent a transient neurobehavioral risk state, affecting not only attention and operational performance, but also automatic cognitive associations related to death and suicide.

The effects of sleep loss on suicide-relevant cognition appear to differ by sex, with women showing a greater shift toward implicit death/suicide bias after 39 hours awake, despite no baseline sex differences.

Medial prefrontal dysfunction may be one mechanism linking sleep deprivation to suicide-relevant cognition, but the brain–behavior relationship appears sex-specific rather than uniform across men and women.

For military populations, these findings support sex-informed fatigue-risk models and reinforce sleep protection as a potentially important component of suicide-prevention and force-readiness efforts.

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