



# **Psychophysiological Profiles of Sleep Deprivation and Stress during Marine Corps Training**

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**Research supported by the Defense Advanced Research Projects Agency (DARPA) program “Preventing Sleep Deprivation”, and by the Office of Naval Research. DARPA has approved this material for public release, distribution unlimited.**

**Technology development also funded by NIH.**

| Report Documentation Page                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                    |                                     |                                                           | Form Approved<br>OMB No. 0704-0188                  |                                 |
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| 1. REPORT DATE<br><b>2007</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                    | 2. REPORT TYPE                      |                                                           | 3. DATES COVERED<br><b>00-00-2007 to 00-00-2007</b> |                                 |
| 4. TITLE AND SUBTITLE<br><b>Psychophysiological Profits of Sleep Deprivation and Stress during Marine Corps Training</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                    |                                     |                                                           | 5a. CONTRACT NUMBER                                 |                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                           | 5b. GRANT NUMBER                                    |                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                           | 5c. PROGRAM ELEMENT NUMBER                          |                                 |
| 6. AUTHOR(S)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                    |                                     |                                                           | 5d. PROJECT NUMBER                                  |                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                           | 5e. TASK NUMBER                                     |                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                           | 5f. WORK UNIT NUMBER                                |                                 |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br><b>Advanced Brain Monitoring Inc,2237 Faraday Ave Ste 100,Carlsbad,CA,92008</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                    |                                     |                                                           | 8. PERFORMING ORGANIZATION REPORT NUMBER            |                                 |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                    |                                     |                                                           | 10. SPONSOR/MONITOR'S ACRONYM(S)                    |                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                           | 11. SPONSOR/MONITOR'S REPORT NUMBER(S)              |                                 |
| 12. DISTRIBUTION/AVAILABILITY STATEMENT<br><b>Approved for public release; distribution unlimited</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                    |                                     |                                                           |                                                     |                                 |
| 13. SUPPLEMENTARY NOTES<br><b>in Sleep30:A132</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                    |                                     |                                                           |                                                     |                                 |
| 14. ABSTRACT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                    |                                     |                                                           |                                                     |                                 |
| 15. SUBJECT TERMS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                    |                                     |                                                           |                                                     |                                 |
| 16. SECURITY CLASSIFICATION OF:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     | 17. LIMITATION OF ABSTRACT<br><b>Same as Report (SAR)</b> | 18. NUMBER OF PAGES<br><b>16</b>                    | 19a. NAME OF RESPONSIBLE PERSON |
| a. REPORT<br><b>unclassified</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | b. ABSTRACT<br><b>unclassified</b> | c. THIS PAGE<br><b>unclassified</b> |                                                           |                                                     |                                 |



# Introduction: Study Goals & Rationale

- Assess fatigue and stress and their effects on situation awareness and decision-making during 28-day USMC Mojave Viper training
- Evaluate utility of EEG, EKG, actigraphy in predicting performance deficits in an operational setting

## *Value to USMC*

*Better awareness of team capabilities*

*Improve safety and mission management*

*Fatigue management*



# Challenges of the operational environment

## **Mojave Viper training at 29 Palms**

- 28-day training event covering all USMC operations in desert & urban environments
- Final training prior to deployment in Iraq or Afghanistan

## **Main objectives**

1. Demonstrate that marines experience fatigue during training using objective measures.
2. Assess effects of fatigue and/or stress on performance during training.



## Methods: participants & measures

- N=17 platoon, squad & fire team leaders
- Continuous actigraphy throughout testing
- Baseline and repeated sessions (1/wk)
  - 30-minute EEG, EKG, 3-Choice Vigilance
  - Saliva cortisol levels
  - Subjective measures
    - POMS
    - Brief Fatigue Inventory
    - Perceived Stress Scale
    - Subjective Sleepiness Scale

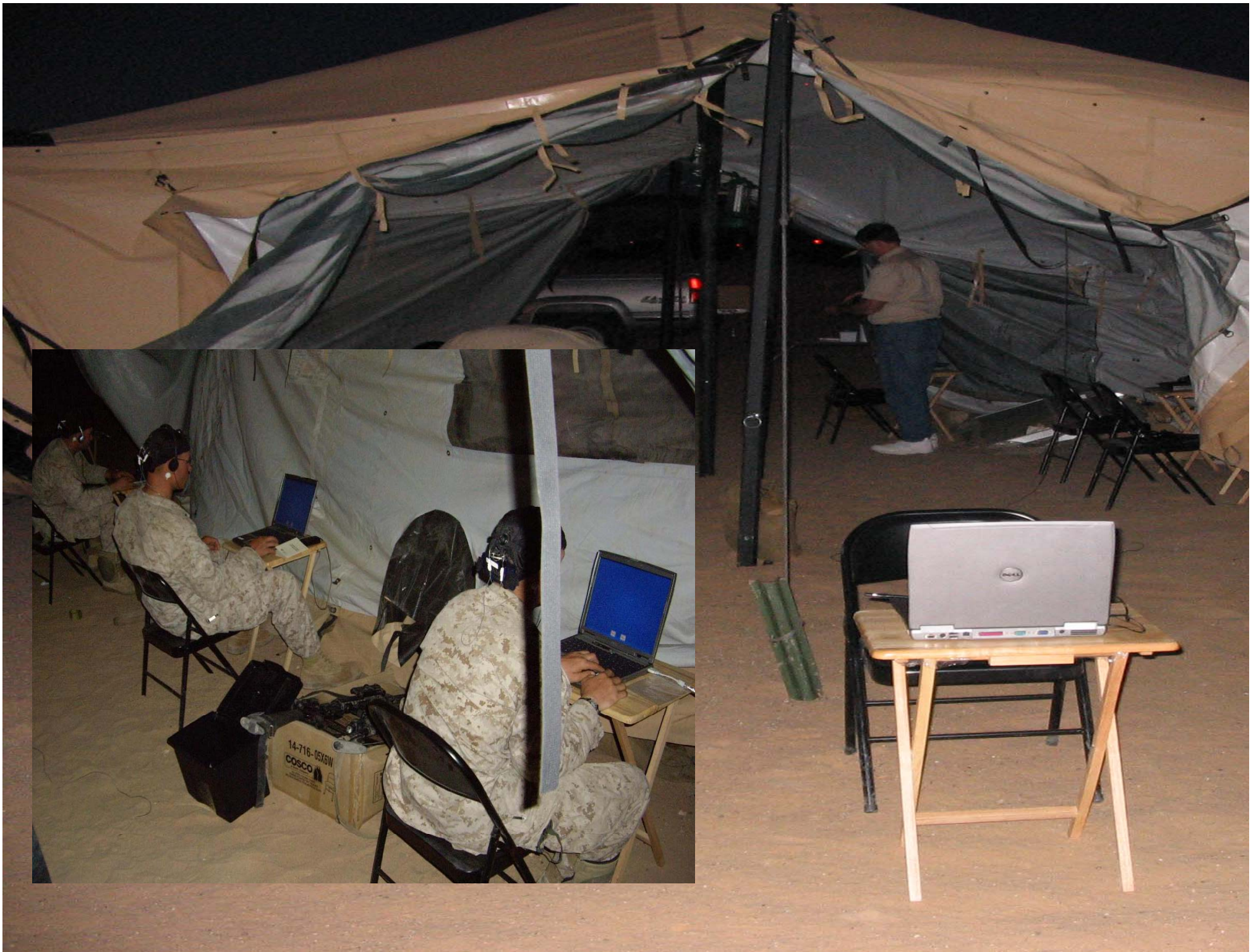


# Mobile Wireless EEG System



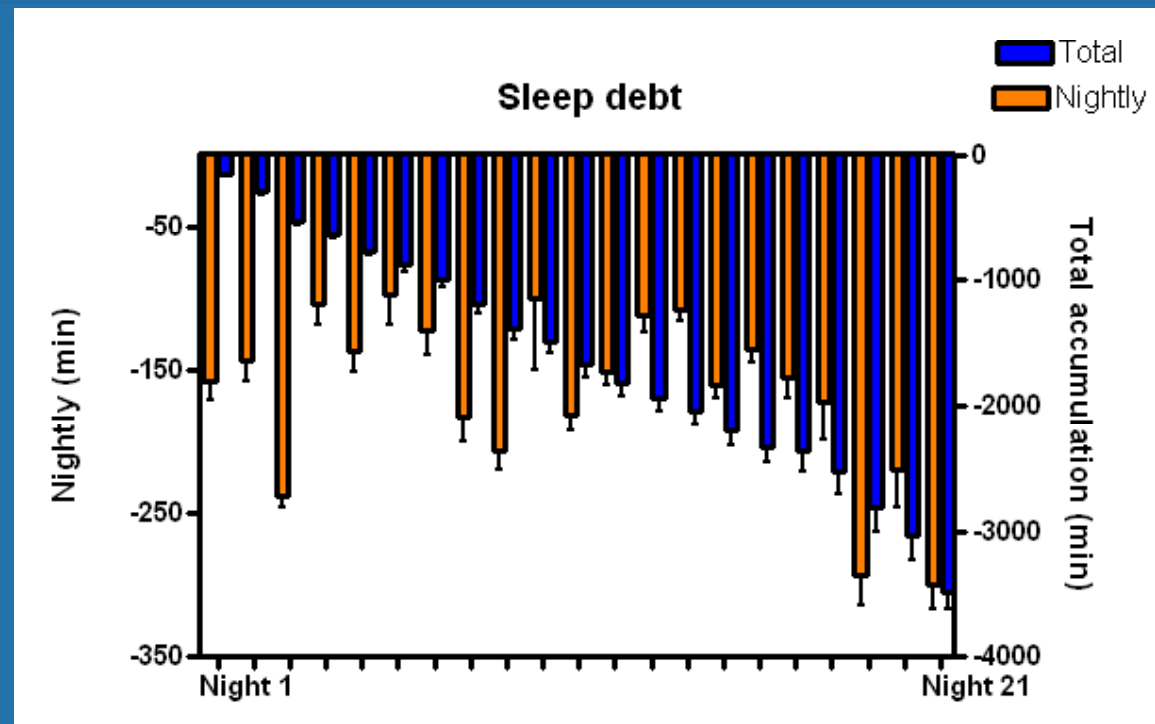
No-prep sensors  
Battery-powered  
Automate artifact  
detect / decon

- EEG sensors at Fz, Cz, POz referenced to linked mastoids, bipolar Fz-PO and Cz-PO
- EKG sensors on collarbone & lower rib
- System proved durable in field environment
  - ✓ Marines quickly learned to self-apply
  - ✓ No issues with comfort or usability





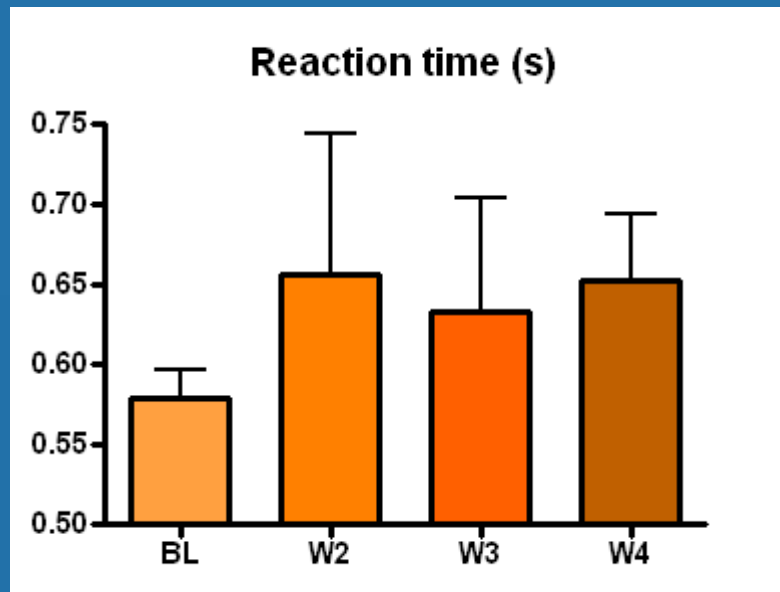
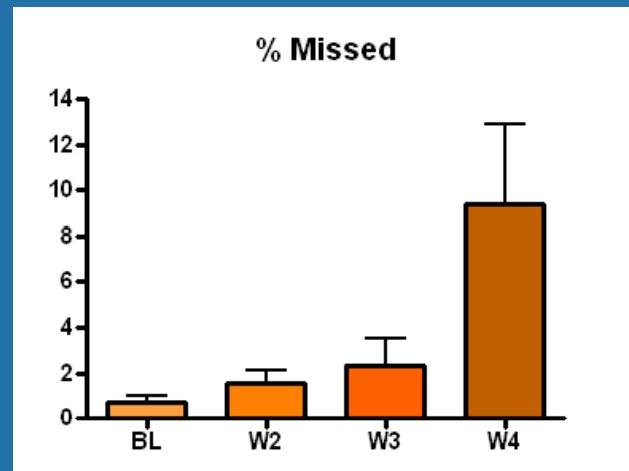
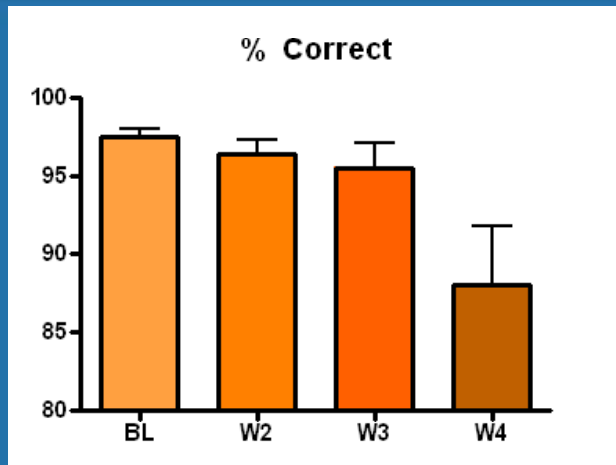
# Results: Actigraphy- Sleep Debt



- Sleep debt calculated by subtracting recommended sleep period (8 h/ 480 min) from actual sleep minutes.
- By night 21, the marines average 58 hours of accumulated sleep debt



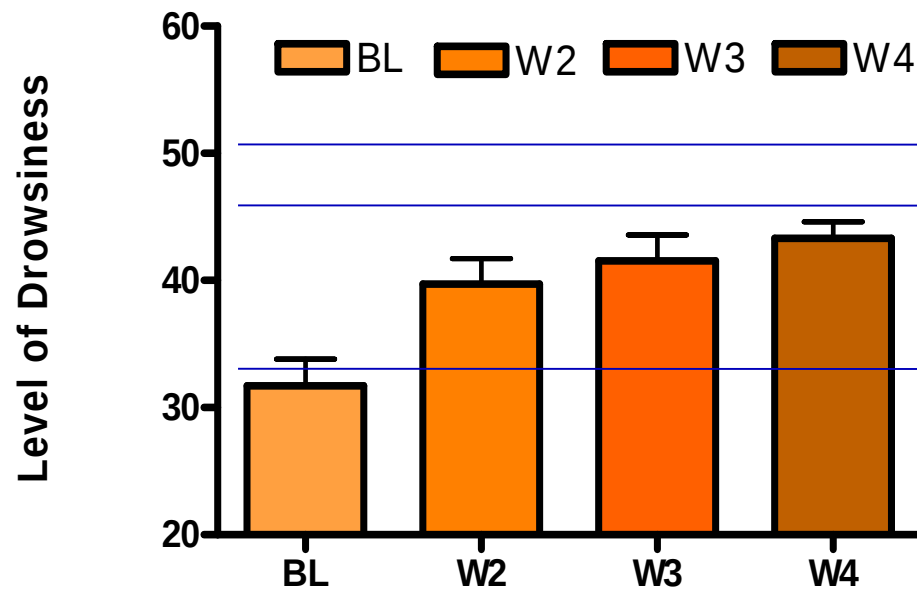
# Results: 3-Choice Vigilance Test



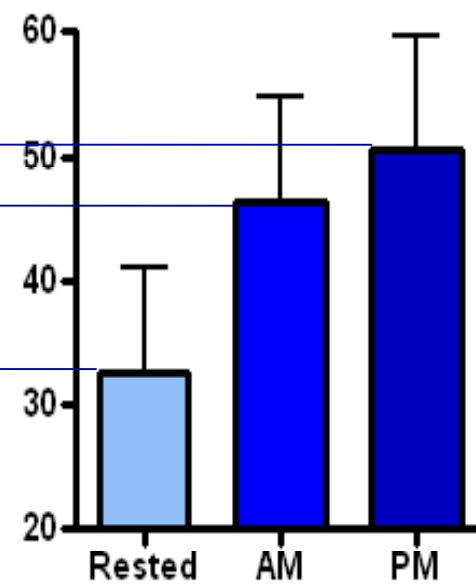


# Results: EEG-based Fatigue indications

Linear Drowsiness Scale



Anchoring LDS





# Results: Heart rate/variability

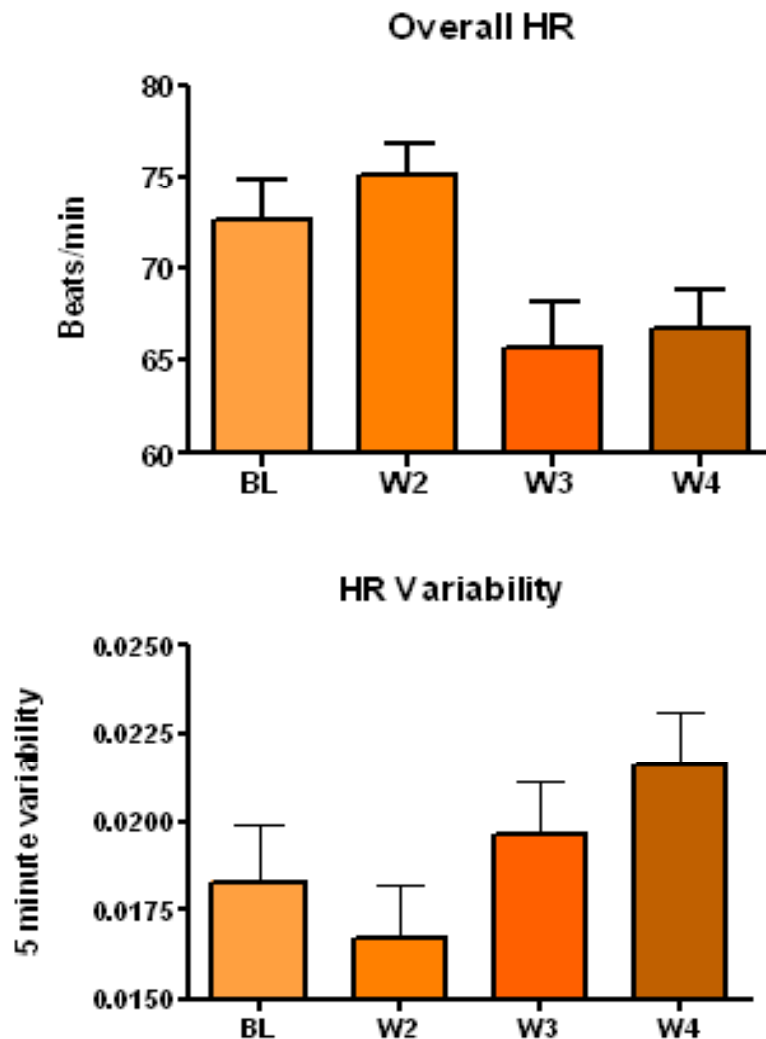
## HR/HRV measures

Calculated on 5 min. windows during testing

HRV: coefficient of variation based on median

Mean HR significantly decreased at weeks 3 & 4

Mean HRV significantly increased at week 4





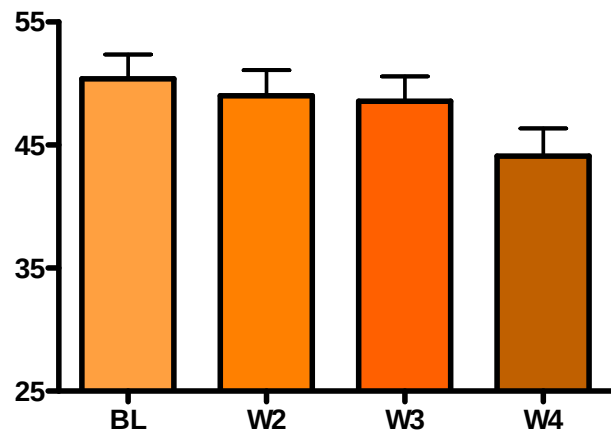
## Results: Subjective Measures

POMs Vigor significantly decreased at week 4.

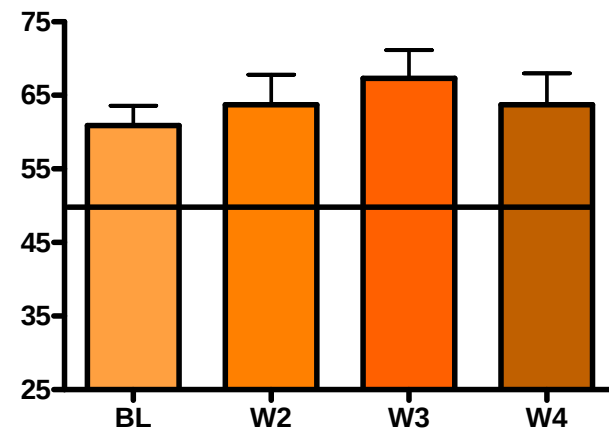
Marine anger levels were above normal on POMs.

*No changes observed in other subjective measures*

Vigor



Anger



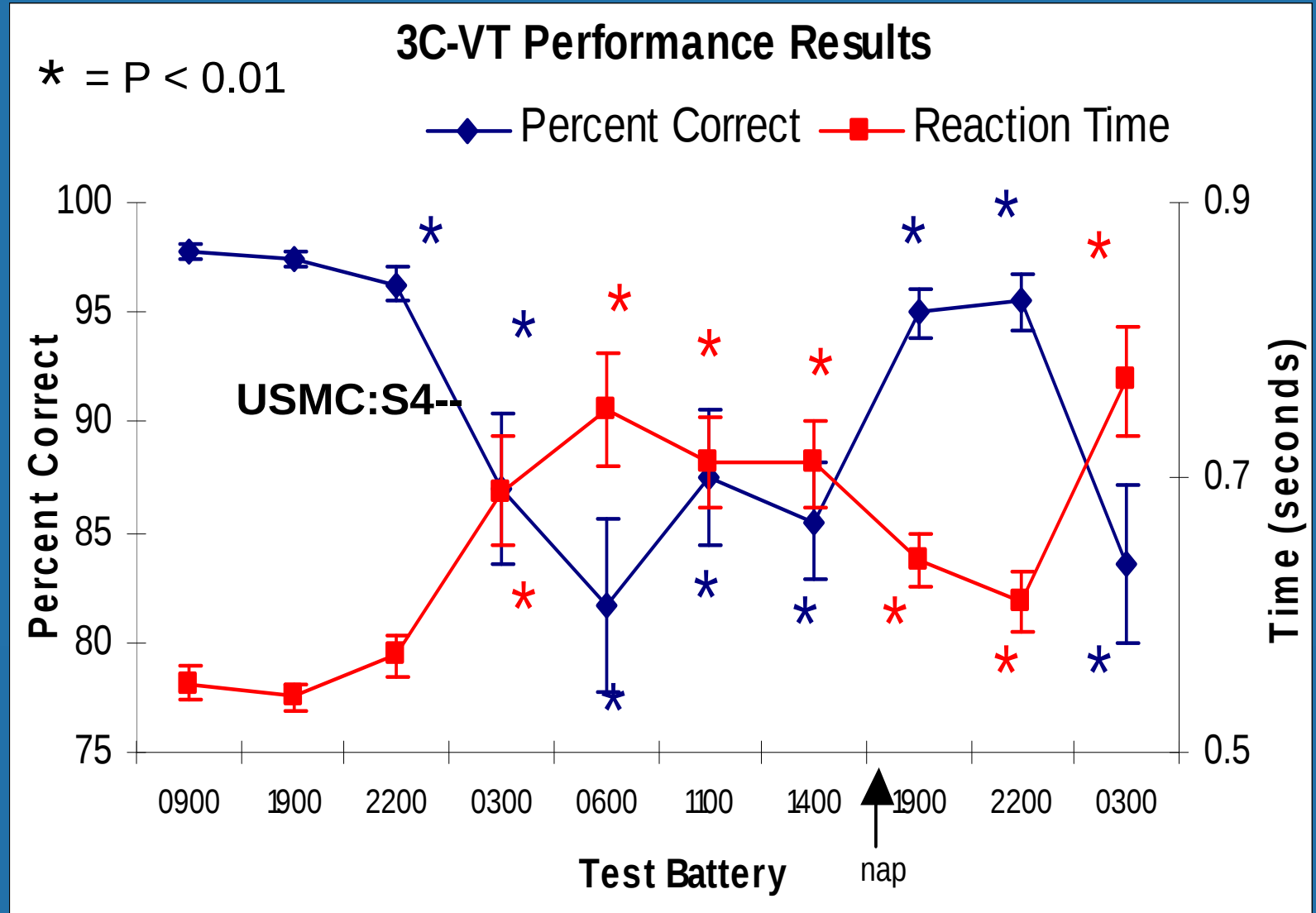


# Addressing the Baseline Problem

- Scheduling morning sessions for baselines is impossible with USMC at 29 Palms
- Approvals from command were obtained just prior to start of Mojave Viper
- A fully-rested, stress-free baseline may be impossible to obtain from active marines
- Potential solutions
  - Compare to ABM healthy database (n=200) fully-rested & sleep-deprived
  - Acquire data from fully-rested marines when they first arrive at Camp Pendleton



# Results: 3C-VT Accuracy & Reaction Time





## Conclusions

- Mobile wireless EEG/HR/HRV acquisition technologies provide valid objective measures of fatigue in an operation environment
- Data obtained without interfering in ongoing operations
- EEG/HR/HRV assessed during the 3C-VT quantitatively showed fatigue to be a serious problem in Marines before deployment
- Data indicate that Marines do not self-report fatigue, increasing the need for objective measurements of fatigue



## Relevance of Study Results

Fatigue in USMC convoy operations is a serious problem

Estimated 35-50% of US casualties in Iraq occur during convoy attack

Results suggest feasibility of objective fatigue assessment in operational settings

Coupled with appropriate interventions fatigue monitoring could improve safety and save lives



Advanced Brain Monitoring, Inc.

Q & A