

## WFC Update

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### The Efficacy of Modafinil as a Fatigue Countermeasure Over Several Days of Reduced Sleep

- A recent study conducted by AFRL/HEPF aimed to further warfighter alertness and vigilance for full-spectrum global operations. AFSOC directed & USSOCOM funded, the research lab together with Survival, Escape, Resistance, and Evasion (SERE) instructors from Fairchild Air Force Base, Washington partnered in performing the Sustained Activity Escape and Evasion Field Study. The objective of this study was to evaluate the effectiveness of Modafinil for maintaining alertness and performance during a 4-day period of reduced sleep in a field environment. Enhanced alertness during field-based operations may improve the safety, survival, and efficiency of military personnel. Results will aid in developing the operational guidelines for the Special Forces community and provide support for the inclusion of Modafinil in aircrew survival kits. This study was important in several ways for determining the usefulness of Modafinil. First it applied Modafinil to a field environment with a requirement for moderate physical activity. Second, those who participated in the study simulated some of the potential users, and were able to offer a great deal of relevant experience to address the research question. Participant acceptance of Modafinil was very high and they unanimously agreed that Modafinil was useful for field operations. Finally, results of the study can be applied to other long duration missions. Warfighters will benefit from the use of Modafinil in terms of increased survivability, increased mission success rate, and increased performance in escape and evasion environments.

### In the News

#### Sports Illustrated interview

Dr. J. Caldwell was interviewed by George Dohmann, a staff writer for Sports Illustrated (SI) Magazine, about the Air Force's research using Modafinil and other fatigue countermeasure techniques. Sports Illustrated was seeking background for a story to appear in an upcoming issue concerning potential use of pharmacological aids to improve athletic performance. POC: Dr. J. Caldwell/  
HEPF/DSN 240-3251

- J. Whitmore,  
Technical Report in Review

### Cognitive Performance Following Sudden Awakening While Under the Influence of Zolpidem and Melatonin

During sustained operations, USAF aircrews may be allowed to use approved pharmaceutical aids to promote sleep during regulated 12-hour pre-mission crew rest periods. This procedure is promulgated on the basis that the crewmembers have the opportunity for 8 hours of uninterrupted sleep without risk of being suddenly awakened and required to immediately perform complex tasks. The hypnotic Zolpidem and the hormone melatonin were evaluated for their effects on cognitive performance in a sudden-awakening paradigm. Adhering to a repeated measures experimental design and double-blind procedures, 8 male and 5 female volunteers randomly received single oral doses of 5 or 10 mg melatonin, 10 or 20 mg Zolpidem, or placebo immediately before retiring at 1300 for a 2-hour nap. Performance testing and subjective evaluations occurred prior to dosing (1100-1300) and following awakening (1500-0700). Repeated measures ANOVA identified significant and consistent decrements in cognitive performance upon awakening while under the influence of Zolpidem, the impact

being greater and longer lasting for the 20 mg than the 10 mg dose. Three of the participants, on being awakened under the 20 mg Zolpidem condition, were too nauseated to perform for 2-4 hours. Systematic decrements in grammatical reasoning, memory, mathematical processing, and reaction time were prevalent 8 hours after awakening for 20 mg Zolpidem and 4 hours for 10 mg Zolpidem. For Zolpidem postural sway was increased immediately and at or for up to 2 hours following awakening; grip strength was reduced at two hours after awakening but not immediately upon awakening. Performance decrements related to melatonin were relatively infrequent and temporally unsystematic. Enhanced performance did not occur at any time for Zolpidem or melatonin. Personnel sleeping with the aid of Zolpidem, when awakened with significant blood levels of the drug, are not able to perform well and may require assistance in situations where their safety, or the safety of others, is at risk.

-- W. Storm,  
Technical Report in Review

## **Fatigue on Team Performance**

The C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance) Team Communication and Performance Under Sustained Operations research study is one of the first investigations of the effects of fatigue on team performance. It implemented a networked system simulating the decisions made on an Air Warning and Control System (AWACS), utilizing three human roles and one synthetic agent. Subjects trained for 1 week on the system to approach asymptote on their performance prior to the start of the study. The study began at 1830 on a Friday evening after a full day of training. Subjects engaged in C4ISR tasks in simulated wartime scenarios until 1030 the next morning. We used embedded individual and team measures to assess fatigue and mission effectiveness.

The C4ISR simulation system records team and individual process and outcome measures, such as hostile targets destroyed and friendly assets lost. In addition, all voice communication among team members was digitally recorded and then coded for analysis. Preliminary results show changes in communications over time. For example, initial comparisons between 1830 (at the beginning of the study) and 0430 the next day (near the end of the study) show that subjects engaged in less communication about strategy and shared less information about assets under fatigued conditions. Data analysis from the first 10 teams will be ongoing for the next few months, followed by Phase II of this study involving an additional 20 teams.

--- D. Harville  
Technical Report in Review

## **The Efficacy of Modafinil For Sustaining Alertness and Simulator Flight Performance in F-117 Pilots During 37 Hours of Continuous Wakefulness**

The present study determined whether Modafinil (100-mgs after 17, 22, and 27 hours without sleep) attenuated the effects of fatigue on fighter-pilot alertness and performance. A quasi-experimental, single blind, counterbalanced design was used in which five pilots from a previous F-117 fatigue study (in which no fatigue remedy was employed) were retested with Modafinil. Their data were combined with the data from five newly recruited F-117 pilots who were evaluated under Modafinil and then placebo. Modafinil improved vigilance and tracking performance in a divided-attention task, CNS activation, oculomotor performance, and aspects of subjective mood. Flight performance decrements were mitigated on six of eight maneuvers. Benefits were most noticeable after 24 to 32 hours of continuous wakefulness. Although Modafinil did not sustain performance at pre-deprivation levels, its numerous positive effects make it a useful adjunct to the currently approved fatigue countermeasure dextroamphetamine. However, Modafinil should not be considered a replacement for this older compound. A follow-on study is recommended.

-- J. Caldwell  
AFRL-HE-BR-TR-2004-0003

# Consultations

## Fatigue Countermeasure Research Findings

Dr. J. Caldwell presented recent fatigue countermeasure research findings to an audience of Air Force leaders on 9 Feb 04 at Randolph AFB, TX. Discussions centered around the effects of fatigue on piloting performance, escape and evasion alertness enhancement, and the efficacy of Modafinil as a fatigue countermeasure. Dr. Caldwell provided information on potential training interventions to counter fatigue, including AETC participation in the AFRL/HEPF quarterly Military Aviation Fatigue Workshop. Requirements for development of fatigue countermeasure technologies for non-aircrew personnel, such as Security Forces and Maintenance personnel, were discussed. The meeting concluded with positive comments from the group on the importance and relevance of fatigue countermeasure research, as well as a recommendation that Dr. Caldwell be added to the agenda for the next MAJCOM safety conference. POC: Lt J. Smith/HEPF/DSN 240-4777

## Events April/May 2004

### MILITARY AVIATION FATIGUE COUNTERMEASURES COURSE,

**April 21-22, 2004, Brooks City-Base, San Antonio, Texas**

John Caldwell, Ph.D., Lynn Caldwell, Ph.D., James C. Miller, Ph.D., CPE

A 2-day fatigue management course will be conducted at Brooks City-Base in San Antonio, Texas. This course, which will be presented quarterly, will outline the dangers of fatigue in military aviation and related operations, the basic mechanisms underlying fatigue, the most common causes of overly-tired personnel, and the best techniques for optimizing alertness in military environments. Participants will receive instruction on the effective design of crew work/rest schedules and the use of a computerized scheduling tool. A short overview of research topics will be included as well. No prior education in fatigue management, sleep, or circadian rhythms is required. The cost of this course will be \$120.00 to cover the expense of two continental breakfasts and the take-home books containing course-related materials. There is an additional charge for those requesting CME credits. Additional information and advanced course registration (required) is available by email to [wfc@brooks.af.mil](mailto:wfc@brooks.af.mil).

**May 2-6, 2004** - 75th Annual Scientific Meeting of the Aerospace Medical Association in Anchorage. Dr. J. Caldwell, Dr. L Caldwell and Dr. J. Miller will be presenting a portion of their Military Aviation Fatigue Countermeasures Course on Sunday May 2. They will also have various presentations throughout the conference.

## Current Studies

### An Examination of Circasemidian Rhythms in Human Body Temperature, Sleepiness and Response Time: *Principal Investigator – Dr. J. Miller*

The objective is to measure human physiological, subjective and behavioral first-harmonic (12-h) circasemidian rhythms under relatively constant environmental conditions, and to describe them quantitatively with respect to gender and age. This study will help AFRL determine whether we need to take into account circasemidian rhythms in physiology and performance and relevant environmental exposure factors in our efforts to provide operational risk management solutions for fatigued operators.

### Fatigue of Shift Workers and Impact on Operations Errors: *Principal Investigator – Dr. J. Miller*

The purpose of this project is to review the impact of shift worker fatigue on ground mishaps and operations errors. This topic was submitted to the Air Force Inspection Agency (AFIA) as an Eagle Look due to the concern with missile field vehicle mishaps. The AFIA team gathered data and conducted interviews with MAJCOM Safety offices, as well as wing/squadron-level shift

workers from all functional areas. This Eagle Look will not include aircrews or contingency operations.

**Observing cognitive performance during Air Force deployments: *Principal Investigator – J. Whitmore, M.S.***

The objective of this study is to collect real-world cognition and affect data to quantify the impact of AF Ops on cognition and fatigue and for comparison to the FAST model predictions in an attempt to validate certain aspects of the model. Military operations often involve periods where sleep is minimized or disrupted due to OpsTempo or deployment factors (e.g., transmeridian travel). A tool that could effectively predict human performance in such situations would be useful for managing operational risk and maximizing operational efficiency. The FAST model will predict performance to some moderately successful extent. Data from this effort will allow further refinement of FAST.

## Future Studies

- Effects of Simulated Spaceflight on Virus-Specific Immunity
- Fatigue Effects on Team Performance
- Reversal of Sleep Aid Intoxication by Sublingual Administration of the Benzodiazepine Antagonist Flumazenil
- Combined Use of Selected Hypnotic and Alerting Medications to Counteract Aircrew Fatigue Due to Disrupted Sleep During Sustained Operations

For over 30 years the WFC R&D Program has delivered counter fatigue products that enhance warfighter combat effectiveness in global mission extremes demanding night, sustained and 24/7 mental and physiological supremacy. We give American warfighters the “edge” to overcome physiological realities and win.