# NAVSEA 2 –Cognitive testing at HIGH workload levels Improves Performance Discrimination on the Multi-attribute task battery-II

Viola JH, Derrick BJ, Cobb T, Natoli MJ, Schinazi EA, Martina SD, Qin M, Medford M, Scafetta N, Moon RE, Freiberger JJ

Duke Center for Hyperbaric Medicine and Environmental Physiology, Department of Anesthesiology, Duke University Medical Center, Durham, NC 27710, USA

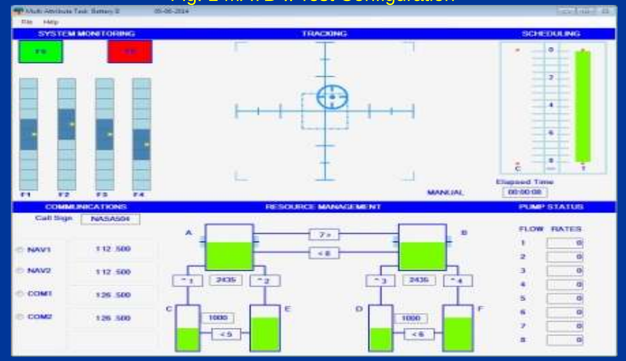
## Introduction:

The Multi-Attribute Task battery II (MATB-II) is a computer-based task battery which was developed to simulate various aspects of flight and is designed to evaluate operator performance and workload. The MATB-II consists of a System monitoring task (SYSMON), a tracking task (TRACK), a communications task (COMM) and a resource management task (RESMAN), each of which has its own "window area" on the monitor (Fig 1). Using NASA's MAT-BII aviation simulation software, the pilot phase of this project showed that TRACKING accuracy at LOW workloads was NOT consistently affected by elevated PCO2 or PN2 (see companion abstract). Because we suspected that this was likely due to performance ceiling effects, we evaluated HIGH versus LOW workload conditions to test if HIGH workloads might counteract the TRACKING task ceiling effect observed. The specific hypotheses, in line with prior research, were that during HIGH workloads, performance would be decreased in all areas compared to the LOW workload scenarios but that practice would mitigate this effect. This study was approved by the Duke IRB and is part of the software and procedure development phase of a larger study into the effects of Hypercapnea on cognitive performance and monitoring.

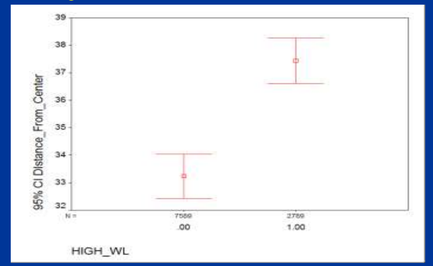
## Materials & Methods:

Ten subjects were studied using a HIGH (n=4) or LOW (n=6) workload MATB-II configuration under surface room-air conditions. The HIGH workload configuration used all MATB-II tasks simultaneously (TRACKING, SYSMON, COMM and RESMON). The LOW workload scenario was limited to TRACKING and SYSMON only. The Tracking task is compensatory in nature to which the subject must respond with a joystick controlled cursor. Second by second, the mean pixel distance from the center is recorded. The System Monitoring task appears in the Left upper corner of the MATB-II main menu and is divided into 2 sub-tasks, warning lights and scales (fig 1). During a run, the light on the left is normally green, indicating an "ON" position. Subjects must detect and respond to the absence of this light by pressing the F5 key to turn it back "ON" (green). The light on the right is normally OFF. When it turns "ON" (red), subject need to turn it "OFF" again by pressing the F6 key. The second task of the SYSMON involves fours scales, each with an indicator light bar graph which moves up and down independently on each scale(2). The graph scales normally fluctuate around the middle of the scale. The subject's task is to detect which light scales shift away from the middle and respond by clicking on the function key (F1-F4)associated with the affected scale whose lights have shifted up or down. In the SYSMON task, MATB-II records subject response or lack thereof, time to reaction as well as correctness of the reaction.

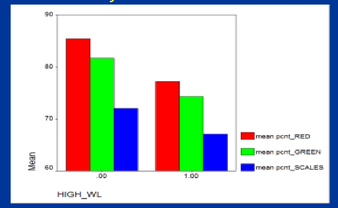
Fig. 1 MATB-II Test Configuration



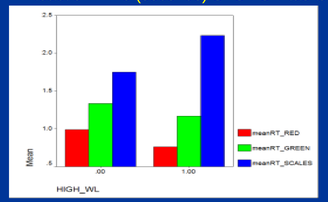

High versus LOW workload TRACKING




% Accuracy of the SYSMON tasks




Reaction Time (seconds) SYSMON tasks




## Results:

1. High versus LOW workload TRACKING was significantly impaired as evidenced by an increase in the second-by-second mean pixel distance from the target from: 33.23 (95%CI 32.5-33.9) to 37.43 (95%CI 36.2-38.6) pixels, as the workload increased from LOW to HIGH. (p<.001 ANOVA).
2. Increasing the numbers of practice sessions significantly and independently improved performance but did not influence the workload effect (p.001 linear regression).
3. Accuracy of the SYSMON tasks was not comparatively different at HIGH versus LOW workloads, however, reaction time was significantly longer (mean RT HIGH=2.12 versus LOW =1.75 ± 0.84sec) during HIGH workload scenarios for more difficult "scale" components of the SYSMON task.

## Conclusions:

Although attention /surveillance tasks are sensitive to LOW workload testing regimens, HIGH workload testing will be required to unmask the narcotic gas impairment threshold for the TRACKING task. These additional tasks will also provide additional memory and problem solving data for analysis under the proposed experimental conditions. Finally, HIGH workload testing may also help identify scenarios where skilled subjects develop strategies to mask overall cognitive impairment by selectively sacrificing one task in order to maintain competence in others. Further pilot testing at HIGH workloads under conditions of elevated PO2, PN2 and PCO2 is planned

Acknowledgements: Funding provided by NAVSEA Deep Submergence Biomedical Contract #N0463A-12-C-0001.

## References:

1. Arnegard, RJ. Operator Strategies under Varying Conditions of Workload. NASA Contractor Report 4385; 1991
2. Fothergill DM, Hedge D, Morrison JB. Effects of CO2 and N2 partial pressures on cognitive and psychomotor performance. Undersea Biomed Res. Jan 1991; 18:1-19
3. Meckler C, Blatteau J-E, Hasbroucq T, Schmid B, Risso J-J, Vidal F (2014): Effects of hyperbaric nitrogen-induced narcosis on response-selection processes, Ergonomics, DOI: 10.1080/00140139.2013.877161

Duke Anesthesiology
Extraordinary Care - Through a Culture of Innovation