Sustaining and Enhancing High OpTempo Performance of Soldiers

Rebecca Steinberg, Logan Trujillo, Ed Coyle, Brad Love, and David Schnyer
The University of Texas at Austin

David Eagleman
Baylor College of Medicine

Michael Matthews and Kimberly DeFiori
United States Military Academy

Kelvin Oie, Laurel Allender, and Rene de Pontbriand
U.S. Army Research Laboratory

Paul Funk Jr.
U.S. Army First Cavalry Division

Steve Kornguth
The University of Texas at Austin

ABSTRACT:

Rapid comprehension of data for appropriate decision making is needed as Army platforms shift to agile, lightly armored vehicles that are vulnerable. The transformation of the US Army into a highly networked force has increased the need for vast amounts of data in a format readily comprehended, and an assessment of the degree of comprehension by the Soldier. In high operations tempo (optempo) conditions on the modern battlefield, constant attention to the emergence of a potential threat, recognition of the threat, and appropriate response to the threat are necessary. Additionally, it is increasingly necessary to differentiate a threat from neutral or friendly forces. At present, insufficient research has been done to improve display of data and comprehension, particularly while under high optempo. The Center for Strategic and Innovative Technologies and Institute for Advanced Technology of The University of Texas at Austin (UT-A), in collaboration with the U.S. Army Research Laboratory, United States Military Academy (USMA) at West Point, Baylor College of Medicine and the First Cavalry Division of the U.S. Army have established a multi-institutional and multi-dimensional study to provide real-time assessment of fitness for duty. The assessment is based on physiological measures of Soldiers and commanders, technologies for enhancing Soldier comprehension of data sets, improved leadership training based on physiological outcomes, and analyses of brain areas directly involved in decision making. Volunteer participants from West Point-USMA, UT-A ROTC, and UT-A athletes are subjected to 36 hours of sleeplessness. Participants were tested for physical performance including multiple physiological measures, and were tested for cognitive and decision making abilities both during and apart from functional MRI sessions. The test battery schedule on day 1 is matched as closely as possible to that of day 2 to match circadian cycles and facilitate direct comparison of performance between the awake and the sleepy/fatigued state. To improve performance, a novel computer tank simulator was designed to match information display to situation and personal preference.

Although the participants experienced 36 hours of sleeplessness, the MRI portion of the experiment was completed at 30 hours of sleeplessness. Preliminary results suggest that physiological measures of physical strength and endurance do not decline after 30 hours of sleeplessness. During the cognitive battery and MRI session, participants were tested on two tasks

while undergoing fMRI and additionally, high-resolution structural MRI scans (T1 and Diffusion Tensor images) were acquired. The two tasks included the virtual reality patrol (VRpat) and a multidimensional decision making task with novel stimuli (Demon), Behavioral effects of fatigue were evident in both the VRpat and Demon tasks. During the VRpat, participants were delayed in their detection of events in their environment by over 2 seconds as determined after participants were awake for 30 hours. On the Demon task, participants showed decline in all decision making except the simple detection control task but the effects of fatigue were disproportionally evident in the complex decision making that required integrating separate unidimensional decisions. The slowdown in event detection on the VRpat task had a corresponding effect in brain function. When comparing the brain activity associated with detection of a threat event to that of just driving in the environment, a robust network of frontal, temporal and parietal regions were active. This neural network has previously been associated with vigilance and attention. On day 2 there was a striking difference in the level of engagement of the anterior cingulate cortex, a region associated with task vigilance and anomalous event detection, while reliable changes were not evident in other portions of this network. The brain analysis is anticipated to lead to the development of techniques to monitor and enhance cognitive awareness for extended periods of time during high optempo events.