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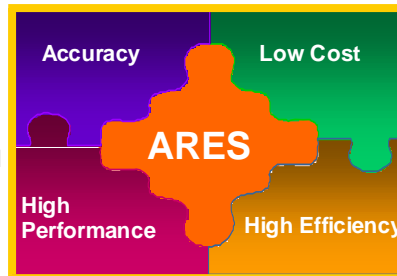
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ARES Receives Frost & Sullivan Best Product of the Year Award

Recognizing Advanced Brain Monitoring, Inc.'s innovation in launching a broad line of emerging products and technologies, Frost & Sullivan named the Apnea Risk Evaluation System (ARES™) the 2006 Product Innovation Award for the European sleep diagnostics and associated data management systems market.

The Frost & Sullivan Award for Product Innovation is presented each year to the company that has demonstrated excellence in new products and technologies within their industry. To choose a recipient of this Award, the Frost & Sullivan analyst team tracked all new product launches, R&D spending, products in development, and new product features and modifications. This was accomplished through interviews with the market participants and extensive secondary research and technology analysis. All new

product launches and new products in development in each company were compared and evaluated based on degree of innovation and customer satisfaction. Companies were then



ranked by number of new product launches and new products in development. The recipient of the Frost & Sullivan Award for Product Innovation is based on excellence in introducing significant new products, the competitive advantage of the new product, the product innovation in terms of unique or revolutionary technology, the product acceptance in the mar-

ketplace, new product value-added services provided to customers, and/or number of competitors with similar product(s).

"The laboratory-level accuracy, portability, ease of applicability and affordability make it one of the best choices for the large number of undiagnosed patients unknowingly suffering from serious sleep disorders which impacts overall individual performance," says Frost & Sullivan's analyst Jessy Varghese.

While mentioning that the European sleep diagnostic market is fragmented with great potential for an explosive growth, Frost & Sullivan identified the ARES laboratory-level accuracy, portability, ease of applicability and affordability as one of the best choices for dealing with the large numbers of undiagnosed patients unknowingly suffering from serious sleep disorders.

ABM Confirms Prevalence of Undiagnosed OSA in Commercial Drivers and Legal Implications for Ignoring a National Safety Concern

In a study published in the April issue of Sleep Diagnosis and Therapy, the Apnea Risk Evaluation System (ARES™) confirmed previous reports on the prevalence of undiagnosed OSA in pre-hires and managers of a U.S.-based trucking company. Results replicated the Stanford University Sleep Disorders Center estimated prevalence of important undiagnosed sleep disordered breathing at 50% in commercial drivers. "The prevalence in this population is two- to three-times

greater than the estimates of undiagnosed OSA in the general male population," stated Dr. Philip Westbrook, Chief Medical Officer of Advanced Brain Monitoring.

The report includes validation of a fast, easy to administer, inexpensive screening questionnaire and computer-based analysis which identifies Obstructive Sleep Apnea (OSA) risk (those who should undergo a sleep study) and OSA severity (the likelihood of having mild, moderate or severe OSA). In an

analysis of 608 cases, the screener sensitivity (correctly identifying those with more than five abnormal breathing events per hour) was 0.96 and the specificity (correctly identifying those with no significant sleep disordered breathing) was 0.79. The prediction of OSA severity is especially useful to clinicians who need to identify those in most urgent need of care when screening community populations such as truck drivers and patients undergoing general anesthesia. "Based on the accu-

(Continued on pg. 2)

ABM Confirms Prevalence of Undiagnosed OSA (Continued from pg. 1)

“Several recent events have increased the potential legal exposure for transportation companies who choose to do nothing about OSA.”

**Don Carper
Professor
Emeritus
CSU—
Sacramento**

racy of the OSA risk and OSA severity predictions, the ARES Screener is an optimal solution for hospitals intending to meet the JCAHO National Patient Safety Goal to reduce the risk of perioperative complications for patients with OSA,” stated Dr. Westbrook.

The clinical study was combined with commentary pertaining to the legal implications for truck drivers, employers and physicians who are involved in the transportation industry. “Several recent events have increased the potential legal exposure for transportation companies who choose to do nothing about OSA,” stated Don Carper, professor emeritus at the College of Business Administration California State University, Sacramento and one of the authors. “First, the prevalence of undiagnosed OSA in commercial drivers is exceptionally high, much higher than the general population. Second a recent major initiative by Trucking Industry leader, Schneider International, has demonstrated the cost of diagnosis and treatment of OSA can be rapidly recouped by savings in annual health care expenditures alone. Finally and most importantly, treating drivers will significantly reduce the number of avoidable accidents with lost

lives and serious injury. Schneider International’s initiative reported a 73% reduction in preventable accidents in diagnosed and treated drivers. Preventing any accident will save anguish and money; the Federal Motor Carrier Safety Administration in



1999 found the average legal cost of one large truck crash involving a fatality was \$3.54 million.”

Expanding the perspective on the legal implications of OSA, the commentary discusses the legal issues for drivers and physicians as well as employers. A number of cases whereby a driver faces imprisonment or is in prison as a result of OSA are referenced. “One of the most common symptoms of OSA is drowsiness,” stated Dr. Westbrook, “and most drivers are unaware that they could face prison sentences if they continue to drive when fatigued and then

have an accident causing loss of life.” The paper also points to the need for additional scrutiny by occupational medicine physicians who perform Department of Transportation (DOT) mandated fitness-for-duty physicals. Some drivers fear that a diagnosis of OSA might limit employment options and many are concerned this fear can lead to less than candid responses to the usual diagnostic questions. The study found that responses to questions similar to those mandated by the DOT physical (i.e., do you snore or do you wake up choking) were unusually normal for the pre-hires as compared to the managers. “Unlike some of the other questionnaire-based screening tools available, we have incorporated multiple analyses techniques in order to reduce the likelihood of a false-negative result if the driver provides a misleading response,” stated Dan Levendowski, the lead investigator in the clinical study. “Once driver’s realize that misleading responses places them in legal jeopardy this problem may disappear. Until that time, systematic use of the ARES and treatment of drivers for OSA is one way transportation companies and DOT physicians can reduce their legal exposure.”

ARES Selected for Hispanic Community Health Study

Advanced Brain Monitoring, Inc. and the Apnea Risk Evaluation System (ARES™) was selected by the National Heart, Lung and Blood Institute and six other components of the National Institute of Health (NIH) to acquire sleep study data for the largest long-term study of health and disease in the Hispanic/Latino populations. “The Hispanic population is the largest minority population in the United States and is expected to triple in growth by 2050,” said NIH Director Elias A. Zerhouni, M.D. As many as 16,000 participants of Hispanic/Latino origin will be studied as part of the 6 ½ year epidemiological study designed to identify the prevalence

and risk factors for a wide variety of diseases, disorders and conditions, one of which will be obstructive sleep apnea. The ARES was proposed for use in this study by Dr. Susan Redline, the principal investigator at Case Western Reserve University who will oversee the analysis of all of the sleep study data

“With the enrollment expected to exceed the NIH Health Heart Sleep Study by over 50%, the study is unprecedented in its size and scope,” said Dr. Redline. The sleep studies are expected to begin in the fall of 2007 and will be conducted over a three year period.



ABM Study Finds Treatment of OSA by Mandibular Advancement Device Highly Efficacious

In a study published in the June edition of *Sleep and Breathing*, 96% of patients treated with a Tap II Mandibular Advancement Device (MAD) had a post-treatment apnea-hypopnea index less than 10 and/or at least a 50% reduction in sleep disordered breathing. Pre- and post-treatment sleep studies were conducted in the patient's home with the ARES. Significant reductions in snoring, depression, daytime sleepiness, and hypoxemia and improvements in quality of life were reported. This multi-site research study was conducted with funding provided by the National Institute of Dental and Craniofacial Research Health as part of a Phase I Small Business Innovative Research grant.

This study was designed to demonstrate two models of collaboration between a dental sleep medicine specialist and a sleep medicine physician in the monitoring of a patient treated with a

MAD. The results suggest that the ARES can be used to improve the quality and consistency of post-treatment patient care.

"One of the interesting aspects of our study is that over 80% of the participants had failed CPAP therapy," stated Dr. Philip Westbrook, Chief Medical Officer of Advanced Brain Monitoring. "Recent studies suggest that as few as 25% of patients who are provided a CPAP remain using it after five years. Many clinicians believe that MAD therapy is only effective for patients with mild to moderate OSA. However, 30% of the study participants had severe sleep disordered breathing and received efficacious treatment with MAD therapy. Our findings suggest this treatment option should be made more widely available, especially for patients who fail CPAP therapy."

The study included the development of an algorithm that utilized pre-treatment sleep study

data and patient information to predict which patients would have a successful outcome with MAD therapy. "The combination of OSA severity coupled with neck circumference and body mass index provided a much more accurate predictor of who was going to have a successful outcome," stated Daniel Leventowski, the lead investigator. "These variables make sense: the upper airway tends to be narrower in patients with more fatty tissue around the neck, and the additional mass combines with gravity to contribute to greater collapsibility when sleeping supine. The goal of this effort is to provide the guidance needed to recommend an oral appliance as an initial treatment option for more severe patients. Alternatively, substantial differences between the predicted and actual post-treatment AHI could help dentists determine when a patient has not been fully titrated."

See ARES at...

American Dental Sleep Society
Minneapolis, MN
June 8-10
Booth 18

Associated Professional Sleep Societies
Minneapolis, MN
June 11-14
Booth 1102

American Society of Bariatric Surgery
San Diego, CA
June 13-15
Booth 111

American Academy of Otolaryngology
Washington, DC
September 16-19

American Society of Anesthesiology
San Francisco, CA
October 13-17

American College of Chest Physicians
Chicago, IL
October 22-25

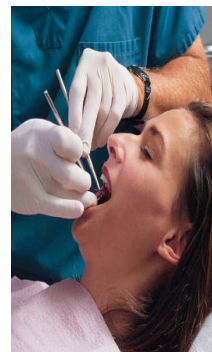
NIH Funded Phase II Study of the Efficacy of Mandibular Advancement device (MAD) Therapy for OSA Awarded

In March 2007, the National Institute of Dental and Craniofacial Research Health awarded ABM a two-year \$880,000 grant to continue its investigation of the treatment efficacy of mandibular advancement device (MAD) therapy for the treatment of OSA. Phase II will include 100 patients who undergo multiple ARES sleep studies to assess changes in nocturnal breathing as a result of the therapy. "There are very few studies which assess whether the improvement in sleep disordered breathing resulting from MAD therapy are permanent or how often the MAD may need to be routinely adjusted to remain effective," stated Todd Morgan, DMD, a co-investigator from Scripps Memorial Hospital, Encinitas. "One of our goals in the study is to develop a titration protocol which will allow novice dentists to achieve a successful MAD for their patients." The study will also assess differences in the benefit of treatment using TAP vs. Herbst appliances.

Patients enrolled in the study will also undergo multiple daytime studies with Advanced Brain Moni-

toring's Alertness and Memory Profiler (AMP). "It is presumed that because MAD therapy does not eliminate sleep disordered breathing as thoroughly as CPAP, that it is not as efficacious," stated Dr. Westbrook. "This is the first large study to objectively assess changes in alertness and memory as a result of MAD therapy. We intend to determine if these changes are similar to those which occur in patients treated with continuous positive airway pressure (CPAP) therapy."

While Phase I included mostly patients who failed CPAP therapy, Phase II will include a number of patients previously undiagnosed with OSA and identified prior to surgery. Recent estimates state 20% of patients undergoing general anesthesia and over 19 million American's are suffering from undiagnosed OSA. Given that as few as 25% of patients who are provided a CPAP machine for OSA treatment still use the device after five years, the study is designed to assess whether MADs provide a viable treatment alternative.



The ARES is the only device on the market which meets all of the criteria considered necessary or desirable as determined by a published survey of 75 members of the American Academy of Sleep Medicine.

Journal of Clinical Sleep Medicine. (2007). Vol. 2(3), p. 318-320.

ARES Meets All Recommended Criteria in a Survey of Sleep Experts

The results of a survey published in the Journal of Clinical Sleep Medicine provided a level of consensus among sleep experts with respect to portable (Level III) sleep studies. Authored by Dr. Philip Westbrook, Chief Medical Officer of Advanced Brain Monitoring, the survey polled 75 members of the American Academy of Sleep Medicine in an effort to provide guidance to other stakeholders including other insurers device manufacturers and patients as to what features are important when comparing portable systems.

Seventy-five percent of those who responded had 16 or more years in the practice of Sleep Medicine and 23% had 11 to 15 years in the practice. Each was asked to rate the importance of 20 separate parameters for limited channel devices for the diagnosis of OSA. Each signal or scoring parameter could be rated on a scale of 1 to 5,

with 1 being "necessary," 3 being "desirable," and 5 being "unimportant." They were also asked to rate 11 parameters for assessing the quality validation studies in the same manner.

The ARES is the only device on the market which meets all of the criteria considered necessary or desirable. The features which differentiated the ARES from its primary competitors were: its ability to allow automated scoring or to fully manually editing of the recording; inclusion of airflow by nasal pressure, and providing a full disclosure recording with the detection of periods with poor signal quality. As for the clinical validation criteria, the ARES is the only monitor which has conducted a multi-site study of at least 100 patients with 20% healthy controls and resulted in a failure rate of less than 10%.

ARES Independent Validation Study at NYU Completed

An independent validation study of the ARES conducted by Dr. David Rapoport and colleagues at the New York University School of Medicine Sleep Disorders Center was recently completed. The study included 88 comparisons of ARES self-

applied within the home and 92 simultaneously acquired comparisons of ARES to PSG. In the manuscript recently submitted for publication, the investigators concluded that the sensitivity and specificity obtained in the group supports the utility

of an ambulatory limited monitoring approach not only for diagnosing sleep disordered breathing (case finding) but also to rule out sleep disordered breathing (screening) in suitably selected groups.



NIH Awards the ARES a \$428,000 Phase III SBIR Grant

With funding from the National Heart Lung and Blood Institute, the next generation Apnea Risk Evaluation System (ARES™) Unicorder is ready for product launch. The new Unicorder is 33% thinner than the previous model and includes voice instructions to the patient when problems are recognized during sleep. However, the product improvement that most influenced the funding decision was a proposal to add the capability to acquire the signals needed to stage sleep.

"We have developed technology to acquire and stage sleep using two dry electrodes on the forehead without compromising the ease of use that makes the ARES such an attractive product," stated Dan Levendowski, President of ABM. "The addition of electroencephalography, electrooculography, and electromyography will enable the ARES to be used for unattended polysomnographic studies that include sleep (EEG) staging. Voice message alerts for users when problems are encountered further improves ARES' industry-best successful study rate. ARES is the only sleep study device on the market which monitors signal qual-

ity and provides feedback, while allowing the clinician to conduct a post-study review of the signals."

The grant award includes funding for a large validation study to assess the accuracy of the auto-staging algorithms conducted by New York University School of Medicine Sleep Disorders Center under the supervision of David Rapoport, M.D. "I believe in the near future in-home sleep studies will become an accepted, reimbursable alternative to laboratory polysomnography, especially if controls are built in to ensure that they are part of a full diagnostic and treatment algorithm that includes an experienced sleep professional," stated Dr. Rapoport. "The improvements that have been made to the ARES Unicorder should add to the momentum for this paradigm shift."

An application for the ARES Unicorder with EEG has been submitted to the Food and Drug Administration and pre-market clearance is expected prior to the Associated Professional Sleep Societies annual meeting in June 2007.

New ARES Publications

- Ayappa, I., D. Rapoport, P. Westbrook, et al. Validation of a Self-Applied Unattended Monitor for Sleep Disordered Breathing (SDB). *Sleep*, 2006. 29(Abstract Supplement 29): p. A343.
- Carper, D., D. Levendowski. Assessment of Obstructive Sleep Apnea Risk and Severity in Truck Drivers: Commentary on the Legal Implications for Ignoring a National Safety Concern. *Sleep Diagnosis and Therapy*, 2007. 2(2), 27-30.
- Levendowski, D., T. Morgan, J. Patrickus, et al. In-Home Evaluation of Efficacy and Titration of a Mandibular Advancement Device for Obstructive Sleep Apnea. *Sleep and Breathing*, In press.
- Levendowski, D., R. Olmstead, D. Popovic, et al. Assessment of Obstructive Sleep Apnea Risk and Severity in Truck Drivers: Validation of the Screening Questionnaire. *Sleep Diagnosis and Therapy*, 2007. 2(2), 20-30.
- Levendowski, D., N. Zack, S. Rao, et al. Is One Night of Laboratory Polysomnography Sufficient to Assess Treatment Outcomes. *Sleep*, 2007.
- Sasse, S., P. Westbrook, D. Levendowski, et al. Timing of Changes in Oxyhemoglobin Saturation Resulting from Breath Holding. *Sleep Medicine*, 2006. 7 (Suppl. 2): p. S46.
- Westbrook, P. Letter to the Editor: Survey Regarding Limited Diagnostic Systems for Sleep Apnea. *Journal of Clinical Sleep Medicine*, 2007. 3(3), 318-320.
- Westbrook, P., M. Dickel, D. Nicholson, et al. Comparison of Two Limited-Channel Systems for the Diagnosis of Sleep Apnea/Hypopnea in the Home. *Sleep Diagnosis and Therapy*, 2007. 2(1), 33-37.
- Westbrook, P., D. Levendowski, D. Henninger, et al. Predicting Effective Continuous Positive Airway Pressure (CPAP) based on Laboratory Titration and Auto-titrating CPAP. *Sleep Medicine*, 2006. 7 (Suppl. 2): p. S84.
- Westbrook, P., D. Levendowski, T. Morgan, et al. Predicting Treatment Outcomes for Oral Appliance Therapy for Sleep Apnea using Pre-treatment In-home Sleep Studies. *Sleep Medicine*, 2006. 7 (Suppl. 2): p. S96.



New EEG Publications

- Berka, C., D. Levendowski, G. Davis, et al., Nicotine Administration and Withdrawal Effects on EEG metrics of Attention, Memory and Workload: Implications for Cognitive Resource Allocation. *Augmented Cognition: Past, Present and Future*. D. Schmorrow, K. Stanney, and L. Reeves, Editors. 2006, Strategic Analysis, Inc.: Arlington, VA. p. 174-183.
- Berka, C., D. Levendowski, G. Davis, et al. Objective Measures of Situational Awareness using Neurophysiology. *Augmented Cognition: Past, Present and Future*. D. Schmorrow, K. Stanney, and L. Reeves, Editors. 2006, Strategic Analysis, Inc.: Arlington, VA. p. 145-154
- Berka, C., D. Levendowski, M. Lumicao, et al. EEG Correlates of Task Engagement and Mental Workload in Vigilance, Learning and Memory Tasks- in press. *Aviation Space and Environmental Medicine*, 2007. 78(5, Section II, Supplement).
- Berka, C., G. Davis, R. Johnson, et al. Psychophysiological Profiles of Sleep Deprivation and Stress during Marine Corps Training. To be presented at APSS, June 2007. Minneapolis, MN.
- Braich, K., C. Berka, P. Westbrook, et al., Evaluation of Subjective Measures of Sleepiness in Obstructive Sleep Apnea Patients Pre- and Post-Treatment with CPAP and Comparison to Healthy Controls. *Sleep*, 2006. 29: p. A195-196.
- Cowell, A., K. Hale, C. Berka, et al. Construction and Validation of a Neurophysio-Technological Framework for Imagery Analysis. To be presented at the 12th International Conference of Human-Computer Interaction, October 2007. Beijing, P.R. China.
- Kahol, K., J. French, S. Panchanathan, et al. Evaluating the Role of Visio-Haptic Feedback in Multimodal Interfaces through EEG Analysis. *Augmented Cognition: Past, Present and Future*. D. Schmorrow, K. Stanney, and L. Reeves, Editors. 2006, Strategic Analysis, Inc.: Arlington, VA. p. 289-296.
- Poythress, M., C. Russell, S. Siegel, et al., Correlation between Expected Workload and EEG Indices of Cognitive Workload and Task Engagement. *Augmented Cognition: Past, Present and Future*. D. Schmorrow, K. Stanney, and L. Reeves, Editors. 2006, Strategic Analysis, Inc.: Arlington, VA. p. 32-44.
- Stevens, R., T. Galloway, and C. Berka. EEG-Related Changes in Cognitive Workload, Engagement and Distraction as Students Acquire Problem Solving Skills. To be presented at the User Modeling Conference. 2007. Athens, Greece.
- Stevens, R., T. Galloway, and C. Berka. Exploring Neural Trajectories of Scientific Problem Solving Skill Acquisition. To be presented at the 12th International Conference on Human-Computer Interaction, October 2007. Beijing, P.R. China.
- Stevens, R., T. Galloway, and C. Berka. Integrating Innovative Neuro-Educational Technologies (I-Net) into K-12 Science Classrooms. To be presented at the 12th International Conference on Human-Computer Interaction, October 2007.

Construction and Validation of a Neurophysio-Technological Framework for Imagery Analysis in the Intelligence Community

“Images of interest may be identified using neural signatures, thus eliminating the need for behavioral responses and improving the speed of image throughput.”

This July, ABM has the opportunity to present our developing research in imagery analysis at the HCI International Conference in Beijing. In collaboration with Design Interactive and Pacific Northwest National Laboratory, ABM is developing a tool to support the intelligence community's (ICs) central mission to help the nation avoid strategic surprise, providing Intelligence Analysts (IAs) with tools that can help them focus analytic attention on the most critical information found within massive data. IAs are bombarded with enormous volumes of imagery, which they must visually filter to identify relevant areas of interest (Aoi). Interpretation of such data is subject to error due to (1) large data volumes, creating the need for faster and more effective processing, and (2) misinterpretation, creating the need for enhanced analyst/system effectiveness.

The system under development, Revolutionary Advanced Processing Image Detection (RAPID), is designed to significantly enhance both image throughput and analysis accuracy by incorporating neurophysiology measurement techniques into a closed-loop system that tracks the imagery analysis process. When complete, the system will identify images of interest as well as specific Aoi within each image.

A future goal of the project will be to determine whether mitigating biases will enhance imagery processing.

The method of detection is twofold: innovative electroencephalographic (EEG) and eye tracking technologies. This allows



the system to detect and flag Aoi, potentially without an analyst's conscious intervention or motor responses, while detecting and mitigating problems with tacit knowledge, such as anchoring bias to reduce the possibility of human error.

The first component, EEG/ERP, offers excellent temporal resolution and tracking of neural activity representing the flow of information from sensory processing and analysis to initiation of a response. Thus, images that contain Aoi may be identified using neural signatures, thus eliminating the need for behavioral responses and improving the speed of image throughput. Past research also indicates the feasibility of using EEG/ERP to differ-

entiate between correct responses (i.e. hits and correct rejections), and highly biased responses (e.g. false alarms and misses) thus supporting the potential for using neurotechnology for enhancing decision accuracy.

As for the second component, eye tracking technology has been used to assess system usability (e.g. user perception and interpretation difficulty) by utilizing metrics such as overall number of fixations and gaze duration mean on each Aoi. Behavioral differences between novices and experts have been measured by eye tracking search patterns, percentage of time looking at Aoi, and fixations. Eye tracking has also delivered promising results as a measure of cognitive load, attention level, and task difficulty.

The vision is that RAPID's neurophysiological technology would one day provide IAs with the ability to rapidly assess massive image data that would otherwise not be viewed due to sheer volume, while ultimately resolving issues of misinterpretation and bias. The RAPID architecture is expected to lead to significant increases in the amount of imagery reviewed and categorized, as identification and localization of Aoi within images may occur without an analyst's conscious intervention or motor responses.



EEG Team Explores Link Between Depression and Sleep Apnea

Advanced Brain Monitoring is studying a large group of patients with Obstructive Sleep Apnea (OSA) to characterize the effects of OSA on alertness, memory, mood and performance and the impact of various therapies on these factors. We are beginning to identify key questions that need to be explored, including the relationship between depression and OSA. These two disorders often occur together, but we don't know why. Previous research has examined this relationship, but a number of

questions remain. Does OSA cause depression? Is there a moderating factor in this relationship such as an individual's weight? Do individuals with OSA and depression differ from individuals with either condition alone? This last question is particularly interesting for us because we hope that our Alertness and Memory Profiling system with EEG can provide more accurate diagnosis and help to evaluate effects of treatment.

To begin to address these questions, we are

(Continued on pg. 7)

EEG Team Explores Link Between Depression and Sleep Apnea (Continued from pg. 6)

planning future investigations of the relationship in previous research. A review of prevalence rates reveals that the occurrence of depressive symptoms among individuals with OSA is between depression and OSA by measuring the occurrence of OSA in a depressed sample, an area that has not received much emphasis between 17% and 58%. Even the lowest estimate is still higher than the range of 6 - 9% found in a sample of the general population. While many researchers have investigated the occurrence of depression among individuals with OSA, investigations to determine the prevalence rates of OSA among a depressed sample are rare. These rates may be as high as 17.6%, which is again considerably higher than the rates found in the general population.

In a presentation at the 2006 APSS conference we reported significant impairments in alertness and memory in patients with OSA when compared to a healthy control group. We also found that OSA patients reported higher levels of depression reported than controls. Four cognitive factors were identified that characterized the OSA-related deficits: sustained attention, processing speed, verbal memory, and visuospatial memory. After three months of successful treatment of OSA with CPAP, improvements were observed in sustained attention and processing speed but not in verbal memory.

We were surprised to find that a sub-group of OSA patients who were receiving treatment with antidepressant medication did not show the same degree of verbal memory impairment prior

to treatment with CPAP and were more likely to show memory improvement after CPAP therapy than non-medicated OSA patients. This led us to wonder why this had occurred. A number of studies have shown that OSA may have long lasting effects on cognitive abilities due to cell death occurring in the brain as a result of insufficient oxygen levels. It is likely that the cell death involves an area known as the hippocampus. The hippocampus is a region of the brain that is known to be critically important in memory. It is also one of the few locations in the brain where neurogenesis (generation of new cells) occurs in humans. In rats, antidepressants have been shown to aid or stimulate neurogenesis in the hippocampus. If antidepressants stimulate neurogenesis in humans in the hippocampus, this may explain why individuals taking antidepressants may be protected against memory deficits associated with OSA.

The finding that antidepressants aid in recovery of cognitive deficits associated with OSA is preliminary, but it provides an interesting framework for future research. For example, depression leads to neural and cognitive deficits and may be involved with the cognitive deficits associated with OSA. It is not known if the antidepressant finding applies to everyone with OSA or just those with combined OSA and depression. Future studies will help us to address these and other questions that could lead to more accurate diagnoses and better treatment outcomes.

See EEG Technologies at:

Human-Computer Interaction International Conference
Beijing, China
July 22-27
Visit our session entitled
"Neurotechnology and AugCog Applications: Present and Future"

DARPA Tech
Anaheim, CA
August 7-9th

Human Factors and Ergonomics Society 51st Annual Meeting
Baltimore, MD
October 1-5

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U.S. Marines Use B-Alert EEG to Assess Fatigue and Improve Training with Interactive Neurotechnologies (I-NET)

With funding from DARPA and ONR, Advanced Brain Monitoring EEG Team is working with the USMC at Twentynine Palms training facility to objectively quantify fatigue, sleep debt, and stress and if possible, relating them to decision-making and cognitive skills relevant to operational performance.

The initial study protocols included a combination of physiology (EEG, heart rate variability, actigraphy, hormone sampling), cognitive test performance and self-reported levels of stress, fatigue and mood acquired at four sessions repeated weekly over the 28-day Mohave Viper training program. Phase one involved instructors, initiating the study with a control group who were mildly sleep-deprived but did not face the full rigors of marines in training. The initial group evaluated what worked in the operational environment and shaped the implementation of phase two which

evaluated two battalions of marines. Subjects were required to undergo EEG, HR, self-reported levels of stress, fatigue and mood and cognitive performance testing at four weekly sessions. The study revealed a decrease in vigor on the POMS self-report as well as increasing sleep debt throughout the program, decreasing accuracy on a vigilance test and overall decreases in HR and increases in HRV—all evidence of fatigue significant enough to negatively impact performance.

In addition to providing foundational research for implementing a comprehensive fatigue management program within the U.S. Military, the 29 Palms study demonstrated the versatility and resilience of the B-Alert headset and software. Subjects wore B-Alert systems in tents during the desert warfare training and were exposed to extreme heat.

The wireless B-Alert EEG system is also being employed in an

upcoming study using Interactive Neurotechnologies (I-Net) to increase the efficiency of marksmanship training in the classroom and on the field. I-Net is being developed through ABM's partnership with UCLA CRESST and the Learning Chameleon with DARPA funds under the new Accelerated Learning Program, directed by Dr. Amy Kruse. Marksmanship training is unique in that it is highly specific and incorporates classroom study as well as physical skill and expertise. One objective of this study is to further describe psychophysiological indices associated with levels of skill acquisition and associated efficiency measurements as subjects progress from novice to expert in simple and complex task environments. Another study objective is to determine to what extent interventions triggered by neurophysiologic measures can improve performance when compared to controls with no interventions.



“Dr. Sprang directs a 2-week IMMEX workshop each summer where teachers create additional standards-aligned problem sets to fill gaps in the curriculum and where they receive updates regarding data-driven decision making and IMMEX student models.”

IMMEX™ EEG Project Tested in Orange County School

During the first week in April, a small team from IMMEX™ traveled to Esperanza High School in Orange County to initiate a multi-year project. The project was conducted in the classroom of Marcia Sprang, PHD who is National Board of Professional Teaching Standards Certified, teaches at Esperanza High School, and is the Science Coordinator for La Entrada High School where she oversees the course curricula for all areas of science, including online courses.

Why were we there?

Improved powers of computation, when combined with machine learning tools, provide refined models of student skill acquisition and learning behaviors in science and mathematics. The scope and depth of learning activities probed by these technology-driven tools are becoming increasingly detailed. Although such learner models are capable of identifying student difficulties and needed educational intervention, they still must rely on relatively impoverished input due to the limited range of learner actions that can be detected by a tutoring system.

The EEG project will expand two such learning models using direct estimates of the learners' cognitive effort and attention obtained through real-time EEG measurement of students working in public school classrooms on science and math problem solving.

During our initial study, classroom rotations, student awareness and participation, and professional support from the teachers was excellent. Our hypothesis is that by integrating continuous EEG monitoring of an individual's level of fatigue, attention, task engagement and mental workload on each of these tasks, fine-grained performance models can be developed that will complement and extend current probabilistic and individualized models of learning. Ultimately, this work will birth radical transformations in technology-based learning systems and student development. Our latest collaborative research paper with Project Tomorrow, ABM, and California Science Museum was submitted for a NSF ALT grant titled: Exploring Neural Trajectories of Scientific Problem Solving Skill Acquisition.