DEFENSE SCIENCES OFFICE (DSO)

DARPA

NARRATIVE NETWORKS (N2)

THE NEUROBIOLOGY OF NARRATIVES

Lt Col William Casebeer, Ph.D.
Program Manager

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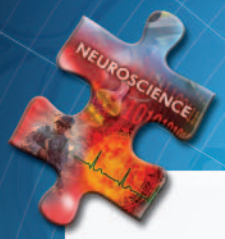

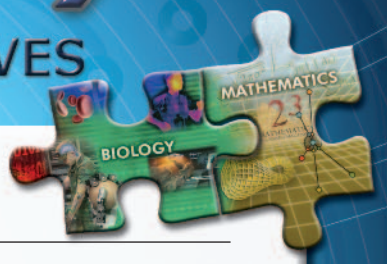

AGENDA

APRIL 25, 2011

1300–1400 Registration / Snacks and Beverages
Presidio Ballroom

1400–1500 Introduction and Welcome
Lt Col William Casebeer
Program Manager, DARPA/DSO

SESSION I: THE NARRATIVE STIMULUS

1500–1600 Dr. Timothy Tangherlini
University of California Los Angeles

Dr. Jordan Grafman
Kessler Foundation Research Center

1600–1615 Break

SESSION II: NARRATIVES AND NEUROCHEMISTRY

1615–1650 Dr. Paul Zak
Claremont Graduate University

SESSION III: NARRATIVES, LEARNING AND MEMORY

1650–1750 Dr. Ken Kishida
Virginia Tech Carilion Research Institute

Mr. Alexander Huth
University of California Berkeley

1750–1915 Dinner
Embarcadero Ballroom

SESSION IV: NARRATIVES AND MORAL NEUROBIOLOGY

1915–2015 Dr. David Eagelman
Baylor College of Medicine

Dr. Patricia Churchland
University of California San Diego

2015 Adjourn

APRIL 26, 2011

0800–0900 Breakfast
Presidio Ballroom

SESSION V: NARRATIVES AND EMOTIONS

0900–1030 Dr. Scott Makeig
University of California San Diego

Dr. Greg Berns
Emory University

Dr. Jon Morris
University of Florida

1030–1045 Break

SESSION VI: NARRATIVES AND SOCIAL COGNITION

1045–1215 Dr. Greg Stephens
Princeton University

Dr. Risto Miikkulainen
The University of Texas at Austin

Dr. Emile Bruneau
Massachusetts Institute of Technology

1215–1330 Checkout/Lunch
PM Deck

1330–1500 5 Minute Research Presentations

1500–1600 Discussion Q/A

1600–1800 Poster Session / Reception
Embarcadero Ballroom

1800 Adjourn

Plenary Speaker Biographies

Plenary Speaker Biographies:
Narrative Networks (N2): The Neurobiology of Narratives

Lt Col William Casebeer
Program Manager, DARPA/DSO

LtCol Casebeer joined DARPA in August 2010. An intelligence analyst, he holds a bachelor of science in political science from the U.S. Air Force Academy, a master of arts in national security studies from the Naval Postgraduate School, a master of arts in philosophy from the University of Arizona and a joint Ph.D. in cognitive science and philosophy from the University of California at San Diego.

Formerly an associate professor of philosophy at the Air Force Academy, LtCol Casebeer was a fellow at the Carr Center for Human Rights Policy at Harvard's Kennedy School of Government from 2005 to2006. He was a term member of the Council on Foreign Relations and is an experienced Middle East analyst with multiple deployments. His research interests include the intersections of cognitive science and national security policy, neuroethics, terrorism, philosophy of mind and military ethics.

He is author *of Natural Ethical Facts: Evolution, Connectionism, and Moral Cognition* (MIT Press), co-author of *Warlords Rising: Confronting Violent Non-State Actors* (Lexington Books), and has published on topics from the morality of torture interrogation to the rhetoric of evil in international relations in venues such as *Nature Reviews Neuroscience*, Biology and Philosophy, and *International Studies*.

Before joining DARPA, LtCol Casebeer was Deputy Head of the Joint Warfare Analysis Center's Technology Advancement Department. His most recent intelligence assignment was Chief of Eurasian Analysis at NATO Military Headquarters in Belgium.

Session I: The Narrative Stimulus

Dr. Timothy Tangherlini
University of California Los Angeles

Dr. Timothy Tangherlini is a folklorist at UCLA. His research focuses on storytelling and its use as part of individual's political behavior. Current work focuses on using computational methods for story discovery and classification in large poorly labeled corpora. He is the author of numerous articles on storytelling, as wells as two books: Interpreting Legend (1994) and Talking Trauma: Storytelling among paramedics (1998)

Dr. Jordan Grafman
Kessler Foundation Research Center

Dr. Grafman received his B.A. degree from Sonoma State University in California and his Ph.D. from the University of Wisconsin-Madison in 1981. Immediately following his graduation, Dr. Grafman entered the US Air Force and became the Neuropsychology Chief on the Vietnam Head Injury Study, a multidisciplinary study conducted at Walter Reed Army Medical Center in Washington, D.C. In 1986, he joined the NINDS as a Senior Staff Fellow in the Clinical Neuropsychology Section. In 1989, Dr. Grafman became Chief of the Cognitive Neuroscience Section in the NINDS. In January of 2011 Dr. Grafman joined the Kessler Foundation Research Center as the Director of the Traumatic Brain Injury

Research Laboratory. He is an elected fellow of the American Psychological Association and has received the Defense Meritorious Service Award, the National Institutes of Health Award of Merit, and most recently the NIH Director's Award for his work on Traumatic Brain Injury. Dr. Grafman's Laboratory is attempting to identify the nature of representational knowledge stored in the human prefrontal cortex including social and executive functions, the types of cognitive neuroplasticity that occur during learning and recovery from brain damage, the relationship between genetic predisposition and outcomes after traumatic brain injury.

Session II: Narratives and Neurochemistry

Dr. Paul Zak

Claremont Graduate University

Paul J. Zak is a scientist, prolific author, entrepreneur, and public speaker. He is the founding Director of the Center for Neuroeconomics Studies and Professor of Economics, Psychology and Management at Claremont Graduate University. Dr. Zak also serves as Professor of Neurology at Loma Linda University Medical Center. He has degrees in mathematics and economics from San Diego State University, a Ph.D. in economics from University of Pennsylvania, and post-doctoral training in neuroimaging from Harvard. He is credited with the first published use of the term "neuroeconomics" and has been a vanguard in this new discipline. He organized and administers the first doctoral program in neuroeconomics. Dr. Zak's lab discovered in 2004 that the brain chemcial oxytocin allows us to determine who to trust. His current research has shown that oxytocin is responsible for virtuous behaviors, working as the brain's "moral molecule." This knowledge is being used to understand the basis for civilization and modern economies, improve negotiations, and treat patients with neurologic and psychiatric disorders. His book *The Moral Molecule: Vampire Economics and the New Science of Good and Evil* will be published in 2012. See also http://en.wikipedia.org/wiki/Paul_J._Zak

Session III: Narratives, Learning and Memory

Dr. Ken Kishida

Virginia Tech Carilion Research Institute

Ken Kishida received a Ph.D. from the Baylor College of Medicine; Houston, TX 2006, currently a Postdoc working with Read Montague in the newly formed Human Neuroimaging Lab and Computational Psychiatry Unit at Virginia Tech. As a postdoctoral associate Ken gained extensive experience at all levels of investigation using functional magnetic resonance imaging (fMRI). Ken is currently working on the development of a novel fMRI paradigm, which has the ability to monitor continuously changing subjective assessments of pain and preference. This paradigm will allow for the measurement of neural responses related to the effect simple narrative manipulations have on changing the subjective experience of susceptible individuals. Ken is currently investigating how the “placebo narrative” (a.k.a. the placebo effect) can provide insight into the mechanisms of suggestibility.

Dr. Alexander Huth

University of California Berkeley

Mr. Alexander Huth completed an Undergraduate and Master's Degree in Computation and Neural Systems at Caltech, where he worked with Drs. Christof Koch and Antonio Rangel. As an undergraduate research fellow in Dr. Koch's group, Alex gained expertise in functional magnetic resonance imaging (fMRI) while examining cross-modal plasticity in the visual cortex of blind and formerly blind subjects. Later as a Master's student in the neuroeconomics-focused Behavior and Social Neuroscience program at Caltech, Alex studied rapid value-based decision making with Drs. Rangel and Koch. He's now pursuing his Ph.D. with Dr. Jack Gallant at UC Berkeley studying the brain's representation of natural visual scenes using fMRI and developing advanced fMRI techniques. Alex's current work is focused on applying linguistically derived models to the problem of how the brain represents the description, or semantic content, of a visual scene.

Session IV: Narratives and Moral Neurobiology

Dr. David Eagleman

Baylor College of Medicine

David Eagleman, Ph.D, is a neuroscientist with joint appointments in the Department of Neuroscience and Psychiatry at Baylor College of Medicine in Houston, Texas. He directs the Laboratory for Perception and Action and is the founder and director of Baylor College of Medicine's Initiative on Neuroscience and Law. His areas of research include time perception, vision, synesthesia, and the intersection of neuroscience with the legal system. He is the author of several neuroscience books, including Wednesday is Indigo Blue: Discovering the Brain of Synesthesia (MIT Press, 2009), and Incognito: The Secret Lives of the Brains (Pantheon, 2011) and Livewired: The Dynamically Reorganizing Brain (Oxford University Press, 2012). Dr. Eagleman writes about neuroscience in the New York Times, Wired, Discover, Slate, and New Scientist.

Dr. Patricia Churchland

University of California San Diego

Patricia Smith Churchland is a Professor emerita of Philosophy at the University of California, San Diego, and an adjunct Professor at the Salk Institute. Her research focuses on the interface between neuroscience and philosophy. She explores the impact of scientific developments on our understanding of consciousness, the self, free will, ethics, and religion. She is author of the groundbreaking book, *Neurophilosophy* (MIT Press 1986), co-author with T. J. Sejnowski of *The Computational Brain* (MIT 1992), co-author with Paul Churchland of On The Contrary (MIT 1998). *Brain-Wise* was published by MIT Press in 2002. Her current work focuses on morality and the social brain, and will appear in *Braintrust: What Neuroscience tells us about Morality*, published in March 2011 by Princeton University Press. She has been president of the American Philosophical Association and the Society for Philosophy and Psychology, and won a MacArthur Prize in 1991 and the Rossi Prize in 2008. She was chair of the Philosophy Department from 2000-2007. An extended interview can be found on The Science Network www.tsn.org and on Philosophy Bites http://www.philosophybites.libsyn.com

Session V: Narratives and Emotions

Dr. Scott Makeig

University of California San Diego

Scott Makeig completed an honors bachelor of arts degree entitled 'Self in Experience,' at the University of California Berkeley (UCB) in 1972 and a Ph.D., 'Music Psychobiology,' from the University of California San Diego (UCSD) in 1985. After spending a year in Ahmednagar, India as an American India Foundation research fellow, he became a Psychobiologist at UCSD and then a Research Psychologist at the Naval Health Research Center, San Diego. In 1999, he moved to the Salk Institute, La Jolla, as a Senior Staff Scientist and moved to UCSD as Research Scientist in 2002 to develop the Swartz Center for Computational Neuroscience which he now directs. In 2010 he was named Chief Scientist of the ARL Collaborative Technology Alliance on Cognition and Neuroergonomics and Professor of Neurosciences at UCSD. He and colleagues have pioneered the introduction and use of time/frequency analysis and independent component analysis (ICA) to EEG and other electrophysiological recording. His laboratory studies human brain dynamics via high-density and portable EEG and multimodality recording, including simultaneous recording of high-density portable EEG, body motion capture, eye gaze tracking and scene recording, etc., a modality he calls Mobile Brain/Body Imaging (MoBI). He and his colleagues develop and distribute the widely used and NIH-supported EEGLAB signal processing environment for Matlab, and are now developing the HeadIT resource for human electrophysiological data and tools.

Dr. Gregory Berns

Emory University

Gregory Berns, M.D., Ph.D. is the Distinguished Professor of Neuroeconomics at Emory University, where he directs the Center for Neuropolicy. He is a Professor in the Economics Department. He is a founding member of the Society for Neuroeconomics. He is the author of ***Satisfaction: The Science of Finding True Fulfillment*** (Henry Holt & Co., 2005) and ***Iconoclast: What Neuroscience Reveals About How To Think Differently*** (Harvard Business School Press, 2008). He graduated cum laude in physics from Princeton University, received a Ph.D. in biomedical engineering from the University of California, Davis and an M.D. from the University of California, San Diego. He subsequently completed a psychiatry residency at Western Psychiatric Institute and Clinic in Pittsburgh, PA.

Dr. Berns specializes in the use of brain imaging technologies to understand human motivation and decision-making. His interest is in neuroeconomics and neuropolitics. Current projects include the biology of decision making and how peer pressure affects the brain. He also uses neuroimaging to understand moral decision making. He has received numerous grants from the National Institutes of Health, National Science Foundation, and the Department of Defense and has published over 40 peer-reviewed original research articles, in such journals as *Science*, *Nature*, and *Neuron*. Dr. Berns' research is frequently the subject of popular media coverage including articles in the *New York Times, Wall Street Journal, Money, Oprah, Forbes, The Financial Times, The New Scientist, Wired, Washington Post, Chicago Tribune, International Herald Tribune,* and *Los Angeles Times*. He speaks frequently on *CNN* and *NPR*, and has been profiled on ABC's *Primetime*.

Dr. Jon Morris
University of Florida

Dr. Morris is the developer of the AdSAM® measure of emotional response and a professor at the University of Florida. He along with Cathy Gwynn and others developed and refined AdSAM's unique, reliable, and valid emotional response model. Dr. Morris is involved in all projects either directly or indirectly. In addition, he conducts academic research that focuses on emotional response and is designed to improve the understanding, usefulness, and applicability of the AdSAM model.

He earned his Ph.D. from the University of Florida. His research has appeared in: The Journal of Advertising Research, The Journal of Advertising, The Journal of Targeting, Measurement, and Analysis for Marketing, Advances in Consumer Research, and The Journal of Current Issues and Research in Advertising. He has also written chapters in: Handbook of Advertising, Edited by Tim Ambler and Gerard Tellis, (Thousand Oaks, CA: Sage) In Fit for the Global Future. Esomar, Lisbon, Portugal. The Electronic Election. Lea: Martis Graphics.

Conference papers have also appeared in the Proceedings of the American Academy of Advertising, and The Association for Consumer Research. Currently he is a professor at the University of Florida. His previous experience focused on the marketing and advertising industry. He worked for several agencies, including Nicholson-Morris, Doyle Dane Bernbach (Now DDB Needham) and Dancer Fitzgerald Sample (Now Saatchi and Saatchi).

Session VI: Narratives and Social Cognition

Dr. Greg Stephens
Princeton University

Dr. Greg Stephens received his Ph.D in Theoretical Physics under the direction of Bei-Lok Hu from the University of Maryland with a dissertation on Topological Defect Formation in Non-Equilibrium Phase Transitions. Following his Ph.D, Dr. Stephens moved to Los Alamos National Laboratory where he first worked with Wojciech Zurek in T-division and then with Gar Kenyon in P-division after switching fields to Computational Neuroscience. Dr. Stephens is currently a Swartz fellow working with Bill Bialek at Princeton University.

Dr. Risto Miikkulainen
The University of Texas at Austin

Risto Miikkulainen is a Professor of Computer Sciences at the University of Texas at Austin. He received an M.S. in Engineering from the Helsinki University of Technology, Finland, in 1986, and a Ph.D. in Computer Science from UCLA in 1990. His current research includes models of natural language processing, self-organization of the visual cortex, and evolving neural networks with genetic algorithms; he is an author of over 250 articles in these research areas. He is currently on the Board of Governors of the Neural Network Society, and an action editor of IEEE Transactions on Autonomous Mental Development, IEEE Transactions on Computational Intelligence and AI in Games, the Machine Learning Journal, Journal of Cognitive Systems Research, and Neural Networks.

Dr. Emile Bruneau

Massachusetts Institute of Technology

Emile Bruneau received his bachelor's degree from Stanford, and his PhD from the University of Michigan in Neuroscience. Punctuating his academic work, Dr. Bruneau enjoyed a brief career teaching, both in high school, and at an alternative elementary school which focused on providing children with practical conflict resolution tools. Dr. Bruneau has also lived overseas in a number of conflict regions: South Africa immediately after the fall of Apartheid, Sri Lanka, The Palestinian West Bank, and Ireland, where he worked with a conflict resolution program serving Catholic and Protestant children.

Dr. Bruneau is now a postdoctoral fellow in the lab of Rebecca Saxe at MIT. His work focuses on developing tools, such as implicit assessment methods and functional magnetic resonance imaging (fMRI), and using them to evaluate changes in inter-group bias following positive inter-group interventions.

5 Minute Research Update
Speaker Biographies

5 Minute - Research Presentations
Speaker Biographies:
Narrative Networks (N2): The Neurobiology of Narratives

Robert J. Bobrow - BBN Technologies

Education:

Ph.D. program (Mathematics) Massachusetts Institute of Technology, 1965-1970

B.S. (Mathematics) Massachusetts Institute of Technology, 1965.

Robert "Rusty" Bobrow is a Lead Scientist at Raytheon BBN Technologies with several decades of experience in AI, knowledge representation, perceptual approaches to information visualization, and natural language processing. He has a strong interest in applying these tools to real-world problems. He is the principal investigator of a new computational cognitive neuroscience effort that is funding multiple MIT (primarily CSAIL) faculty, research scientists, post-docs and graduate students (including Profs. Patrick Winston, Tomaso Poggio, Earl Miller, Antonio Torralba and Joshua Tenenbaum, as well as Dr. Boris Katz). He is currently supporting NGA's Innovision Geospatial Analytics Branch, under contract as an IRAD SME. Current activities there include support of research in geospatial activity representation and neuroscience approaches to computer vision

He developed a new approach to information visualization based on human motion perception, and oversaw the team that transitioned technology from basic research to deployment at US Government agencies within a five year period, and holds multiple patents on this technology. He has been leading efforts to apply this technology to support the integration of semantic web technologies and bio/pharma research. He has led the development of natural language tools for extracting semantic representations from Notices to Airmen, as well as reasoning systems to allow these NOTAMS to constrain flight planning systems and provide input to various mapping systems. This work went from basic reasearch for AFRL to a deployed system over the course of four years.

Previously, Mr. Bobrow was the technical director of the BBN component of the Logistics Anchor Desk project of the Joint Logistics ACTD. This project involves the operation of a distributed, collaborative decision support system pulling data from a wide variety of legacy military database systems deployed on more than thirty Sun workstations deployed from Bosnia-Herzegovinia through various major military command centers in Europe and throughout the Continental United States. Mr. Bobrow is leading the development of the next generation of LogAD which will be a web-based system capable of operating on networks of PCs and Sun workstations.

Kendall Haven
Master Storyteller/Author/Story Consultant

The only West Point graduate to turn professional storyteller, Haven holds a Doctorate in Oceanography and, during his 25+ years as a touring master storyteller, has performed for 5 million in 44 states. Haven has published five audio tapes and 28 books including six award-winning books on the structure and application of story. His research is the first in the nation to combine the findings from sixteen fields of neural-, biological-, and informational-science with years of practical testing with live audiences to establish both the practical and theoretical basis for the narrative elements that define effective story architecture. Haven now consults with government agencies, corporations, educational institutions, and nonprofit organizations on the development, crafting, and telling of their stories.

Prof. Deborah Jenson
Duke University

Deborah Jenson is Professor of French and co-director of the Franklin Humanities Institute "Haiti" Humanities Laboratory at Duke University. Her work includes the books *Trauma and Its Representations: The Social Life of Mimesis in Post-Revolutionary France* and *Beyond the Slave Narrative: Politics, Sex, and Manuscripts in the Haitian Revolution*. She has engaged with the problem of narrative from many disciplinary angles and has a forthcoming article with neuropsychiatrist Marco Iacoboni (UCLA). She will be teaching a course on the work of Gustave Flaubert in neuroscientific perspective in the fall ("Flaubert's Brain"), and will be co-leading a working group co-sponsored by the Franklin Humanities Institute and the Center for Cognitive Neuroscience at Duke in the fall, "Neurohumanities," with co-leaders Michael Platt and Richard Mooney. Jenson is also leading an inter-disciplinary research team project on trauma and PTSD in cross-cultural perspective, and has a co-edited volume on the globalization of psychoanalysis, *Unconscious Dominions*, coming out in the fall with Duke University Press.

Dr. Chris Poulin
Dartmouth College

Chris Poulin is currently Co-Director of the Dartmouth College Metalearning Working Group at Dartmouth Thayer School of Engineering. Dartmouth Metalearning researches optimal decision making given disparate 'multi-modal' data types. Poulin is also Principal Partner in Patterns and Predictions (Predictive Analytics). In this role, Poulin was co-author of the P&P software tool, a Bayesian classification and decision engine used in universities worldwide, and by industrial clients. Further, Poulin is co-inventor of Centiment, a semantic analysis based event prediction system being deployed for the DARPA Healing Heroes program. Other research affiliations include University of Massachusetts in the area of high performance computing (HPC). He was previously VP of Advanced Technology (R&D) for a commercial search entity, (Viziant) a provider of Search/KM for the US Military. Prior to this, Poulin held senior IT positions, including dot com/networking projects with Nortel Networks. Finally, he is a patent holding inventor in Federated Web, Information Retrieval, and Predictive Analytics related systems.

The Dartmouth Metalearning Working Group: Metalearning is the formal study of best practices in machine learning and data mining. Specifically, it enables the selection of optimal learning algorithms that best fit the search space of any given problem. In the case of our proposed group, we seek to build operational prototypes that utilize a metalearning protocol of an asymptotically optimal ensemble of algorithms and a novel algorithm to enable a consistent analysis and decision capability. We envision a new level of automation in classification tasks that guarantees a consistent quality of service based on an understanding of optimal classifier topology. The applications are many, including the ability to consistently analyze sparse data sets, as well as scalably make sense of tremendous volumes of data, such as those generated by search, biotech, and most relevantly, defense intelligence.

Mrs. Schmer-Galunder
Smart Information Flow Technology

Mrs. Schmer-Galunder started working at Smart Information Flow Technology in the spring of 2009. She has a bachelor's degree in Psychology/Neuroscience and a master's degree in Cultural Anthropology from Lund University, Sweden. Prior to working for SIFT, she was employed as research scientist at the Social, Cognitive and Affective Neuroscience Lab of Dr. Ed Smith, Dr. Tor Wager and Dr. Kevin Ochsner at Columbia University, where she worked on several projects investigating the interaction between the neural basis of emotion perception and bodily expressions. Her work has involved the psychology of emotional behavior and brain activity (measured with functional magnetic resonance imaging) and its relation to peripheral physiology, including measures of autonomic and endocrine activity, in particular under perceived psychosocial stress. She worked on the development of novel experimental paradigms that integrate methodologies and knowledge from cognitive neuroscience and behavioral endocrinology in order to study complex cognitive, emotional and somatic neurocircuitry. Mrs. Schmer-Galunder worked on research of stress resilience to post traumatic stress disorde(PTSD) among 9-11 terror attack survivors, a study investigating why psychological and neural mechanisms render some individuals resilient in the face of trauma. Other projects involved the influence of social context information on emotional processing and the influence of placebo effects on cognition. In 2006, she worked at the Davachi Memory Lab at New York University on the experimental development with the goal to understand the role of the hippocampus in transitive inference judgments for social dominance relations.

During her time at the Lunds University, she gained experience working with Latent Semantic Analysis (LSA) and has authored two papers and presented posters on the use of LSA as a subjective and automatic measure of gender valence in huge media text corpora. She has contributed to developing a new software using LSA for the generation of semantic spaces, featuring an integrated set of tools for studying, crating, collecting and visualizing semantic spaces.

Dr. Avgusta Y. Shestyuk
Helen Wills Neuroscience Institute
University of California, Berkeley

Research Experience

Neural circuits of emotion-related processing
In collaboration with researchers from the Helen Wills Neuroscience Institute (UC Berkeley), University of California San Francisco School of Medicine, Johns Hopkins School of Medicine, and Stanford University School of Medicine, I collect and analyze electrocorticogram (ECoG) data during processing of emotional verbal and visual information in patients with implanted subdural electrodes for pre-operative epilepsy monitoring. The goal of this project is to determine temporal dynamics and spatial specificity of neural engagement during processing of emotion-laden information in both visual and auditory modalities with specific emphasis on language processes.

Role of the orbitofrontal cortex in social stress appraisal and physiological reactivity
In collaboration with researchers from the Helen Wills Neuroscience Institute (UC Berkeley), Department of Psychiatry at UC San Francisco, and the Mind, Brain, Body, & Health MacArthur Network, I have conducted a series of experiments aimed to elucidate the specific roles of the orbitofrontal (OFC) and medial frontal (mPFC) cortices in subjective appraisal of psychosocial stress and in subsequent activation of peripheral physiological systems implicated in stress reactivity (e.g., the autonomic nervous system

[ANS] and the hypothalamic-pituitary-adrenal axis [HPA]). The brain-periphery interaction during appraisal and response to psychosocial stress has been investigated in healthy individuals, using the fMRI brain imaging technique, and in individuals with organic brain damage to the OFC/mPFC using a number of behavioral manipulations.

Role of automatic and controlled processes during encoding of emotional information in normal cognition and mood disorders

In collaboration with researchers of the Psychophysiology and Psychopathology Laboratory at Harvard University, I have conducted the following series of studies examining cognitive and neurophysiological mechanisms of emotional processing in normal cognition and in major depressive disorder (MDD). Specifically, I have utilized event-related brain potential (ERP), electrocardiogram (ECG), and skin conductance measures to investigate contributions of both automatic and sustained controlled processes during encoding of emotional information to the etiology and maintenance of emotional memory biases in control participants and individuals with current or past MDD.

Dr. Colin P. Williams
NASA Jet Propulsion Laboratory, California Institute of Technology

Dr. Colin P. Williams is a Senior Research Scientist (SRS), and Program Manager for Advanced Computing Paradigms at the NASA Jet Propulsion Laboratory, California Institute of Technology. He holds a Ph.D. in artificial intelligence from the University of Edinburgh, a M.Sc. and D.I.C. in atmospheric physics and dynamics from Imperial College, University of London, and a B.Sc. in mathematical physics from the University of Nottingham. He was formerly a research assistant in quantum cosmology to Prof. Stephen W. Hawking, at the University of Cambridge, a research scientist at Xerox PARC, and acting Associate Professor of Computer Science at Stanford University. Colin's research interests have spanned many areas connecting physics with computer science. In his thesis work Colin developed an artificial intelligence system for reasoning about the physical world via qualitative and quantitative differential equations. He then became interested in the links between statistical physics and computer science, invented the theory of computational phase transitions, and applied it understanding the deep structure of NP-Complete problems. Later, Colin became interested in the connections between quantum physics and computer science. He wrote the first book on quantum computing (the second edition of which was published in January 2011) and followed it up with two others, launched the Quantum Computing Group at JPL, and quickly broadened its scope to include research on quantum communications, quantum sensors, and quantum metrology. Lately, as Program Manager for Advanced Computing Paradigms, Colin has expanded his interests to include cognitive computing, neuromorphic computing, spintronics, virtual environments, computational nanomaterial design, computational cameras, and intelligent energy applications. Colin is also a Laboratory Senior Research Scientist ("SRS") – a designation established at JPL in 1977 to provide special recognition, benefits, responsibilities and privileges for outstanding individual researchers in science and technology.

Dr. Bradley Voytek
University of California, Berkeley

I received PhD in neuroscience from the University of California, Berkeley and did my undergraduate work at the University of Southern California. I will be doing my postdoctoral research at the University of California, San Francisco researching neuroplasticity, attention, and working memory. With my wife I created brainSCANr.com, which is a data mining website built to infer relationships between brain structure, function, and disease based upon the scientific literature. I'm very interested in how the metaphors used in neuroscientific research affect the actual research performed.

Dr. Jason Sherwin
Columbia University

Jason Sherwin joined the Department of Biomedical Engineering at Columbia University in Fall 2010 for a research faculty position as Post---Doctoral Research Scientist. He works with Prof. Paul Sajda in the Laboratory for Intelligent Imaging and Neural Computing (LIINC).Currently, with Prof. Sajda, Sherwin spearheads two projects at LIINC, One involving the use of hierarchical Bayesian models for EEG decoding and another studying the cognition of musical expectation violation. Before joining LIINC, Sherwin graduated in May 2010 with his Ph.D. from the Department of Aerospace Engineering at the Georgia Institute of Technology. Prof. Dimitri Mavris, Boeing Professor of Advanced Aerospace Systems Analysis, was his advisor and mentor since 2005 at the Aerospace Systems Design Laboratory. Sherwin has a Bachelor of Arts in Physics from The University Of Chicago (2005) and a Masters of Science in Aerospace Engineering from Georgia Institute of Technology (2006).

Poster Abstracts

DEFENSE SCIENCES OFFICE (DSO)

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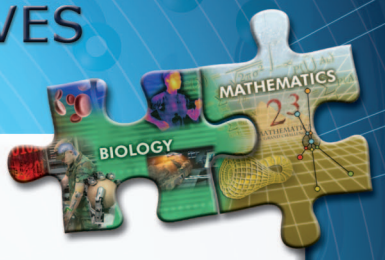
NARRATIVE NETWORKS (N2)

THE NEUROBIOLOGY OF NARRATIVES



POSTER SESSIONS

KENNETH T. KISHIDA, STEPHEN LA CONTE, ELLEN LUMPKIN, AND P. READ MONTAGUE

Virginia Tech Carilion Research Institute Roanoke, VA

Department of Physics, Virginia Tech, Blacksburg, VA

Poster Title: The Placebo Effect, Hot Sauce, and the "Suggestibility Phenotype"

E-mail: read@vt.edu

MARK FINLAYSON AND DR. PATRICK WINSTON

Computer Science and Artificial Intelligence Laboratory

Massachusetts Institute of Technology

Poster Title: Learning and Using Plot Patterns

E-mail: markaf@mit.edu

ELIZABETH WHITAKER

Georgia Tech Research Institute

Poster Title: Brain-based Cognitive Architecture for Training through Stories

Email: betty.whitaker@gtri.gatech.edu

JONATHAN TOURYAN, LAURIE GIBSON, JAMES HORNE, PAUL WEBER

Science Applications International Corporation

Poster Title: Measuring the familiarity of faces with event-related potentials

E-mail: Jonathan.O.Touryan@saic.com

RON STEVENS

UCLA IMMEX

Poster Title: Team Neurodynamics

E-mail: immex_ron@hotmail.com

MICHAEL WEISEND

The Mind Research Network

Poster Title: Transcranial Direct Current Stimulation (TDCS)

E-mail: mweisend@mrn.org

DEBORAH JENSON

Duke University

Poster Title: PTSD Questionnaires and Trauma Narratives in Post-Earthquake Haiti

deborah.jenson@duke.edu

LEARNING AND USING PLOT PATTERNS

Mark A. Finlayson and Patrick H. Winston
Computer Science and Artificial Intelligence Laboratory
Massachusetts Institute of Technology
Cambridge, MA, 02139, USA
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We describe a proof-of-concept pipeline that combines three systems in development at MIT. We have demonstrated the ability of the pipeline system to learn plot patterns from sets of example narratives, and then identify those plot patterns in developing stories. Such a capability points the way to a number of interesting technological capabilities, for example, an early warning system that detects developing problems and prompts intervention, or a military information analyst's workbench that would retrieve relevant precedents for a situation under consideration, potentially stopping serious blunders. It is also a model that speaks to human's cognitive abilities in story understanding and retrieval.

The first system in the proof-of-concept pipeline is the Story Workbench annotation tool, which allows us to deeply analyze the semantics of free text. The tool allows semi-automatic annotation, meaning that the tool itself does a great deal of automatic processing of text using the latest NLP technologies, but allows a human to veto, correct, or augment the information provided automatically. This tool allows a nearly three-fold increase in annotation speed over other computerized annotation tools, while simultaneously reducing costs four-fold by allowing the use of non-linguistically trained layperson annotators.

The semantic analysis of the Story Workbench is fed into the Genesis Story Understanding system, which augments the explicit information in the surface text of the story with commonsense semantic inferences. The result is an *elaboration graph* that ties together the events in the story in preparation for higher-level discovery of plot patterns or further processing by the Analogical Story Merging Algorithm

The Analogical Story Merging algorithm, which is a modified form of Bayesian Model Merging, takes advantage of semantic constraints to find plot patterns. These plot patterns are then fed back into the plot pattern library that the Genesis system uses for story understanding at the level of concepts such as *revenge* and *sell out.*

Dr. Kenneth T. Kishida and Dr. P Read Montague

Virginia Tech Carilion Research Institute

Title: The placebo effect as an approach to study the impact of narratives on human behavior

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Abstract:

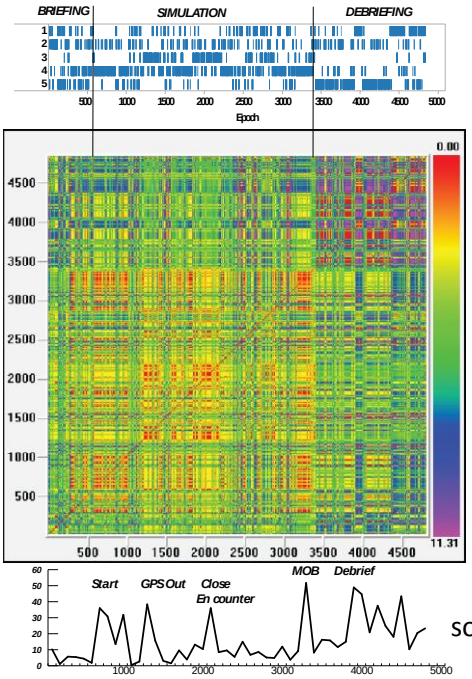
Title: The placebo effect as an approach to study the impact of narratives on human behavior

Abstract:

There is a large volume of literature on the powerful impact of the placebo effect in a vast array of domains ranging from how beliefs and expectations impact the physiological effects of drugs (Mayberg et al., 2002; Geers et al., 2005; Benedetti et al., 2006), to physical symptom relief following sham arthroscopic knee surgery (Moseley et al., 2002). In each of these scenarios the role of the simple placebo-narrative is established, though the neurobiological effects of the placebo effect inducing narrative are largely unexplored. Consequently, the opportunity is presented in which onecould develop a procedure that provides an unbiased way to detect individuals for whom such narrative effects are large. Our approach will use real-time functional magnetic resonance imaging (real-time fMRI) based upon modern machine-learning techniques to characterize the sensitivity of individuals to the placebo-narrative during a continuous subjective assessment task for pain and preference.

Ron Stevens, Ph.D, IMMEX/UCLA, Chris Berka, MS. Advanced Brain Monitoring

Team Neurodynamics



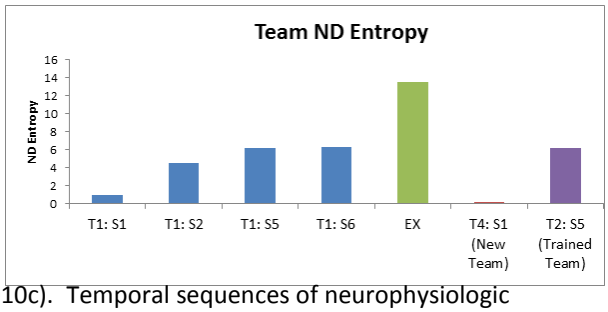
Our goal for modeling the neurodynamics of teams is to be able to rapidly determine the functional status of a team in order to assess the quality of a teams' performance / decisions, and to adaptively rearrange the team or task components to better optimize the team.

Neurophysiologic synchronies (NS) are low level data streams derived from EEG-based measures of Engagement and Workload from team members following normalization and pattern classification by self-organizing artificial neural networks. The temporal expression of these patterns can be mapped onto team events and related to the frequency of conversation among team members. They can be collected and analyzed in near real time and in realistic training settings. like submarine piloting and navigation, high school team problem solving, or anti-submarine warfare tactical training.

NS expressions appear to be important constructs for studying team dynamics and cognition as:

- They change rapidly in response to short and long term changes in the task[i];
- They relate to the task and some established aspects of team cognition like speech[ii];
- They can be rapidly reported for use by educators / trainers[iii];
- They can distinguish some aspects of novice / expert performances; and,
- They are sensitive to the effects of training.

This figure shows changes in the entropy of Engagement NS streams as Submarine Piloting and Navigation Junior Officers gain navigation experience.



[i] Stevens, R.H., Galloway, T., Berka, C., & Behneman, A., (2010c). Temporal sequences of neurophysiologic synchronies can identify changes in team cognition. Proceedings: Human Factors and Ergonomics Society 54th Annual Meeting, September 27-October 1, 2010, San Francisco, CA. pages 190-194

[ii] Stevens, R.H., Galloway, T., Berka, C., & Behneman, A. (2010b). A neurophysiologic approach for studying team cognition. Interservice / Industry Training Simulation and Education Conference (I/ITSEC) 2010. Paper No. 10135.

[iii] Stevens, R.H., Galloway, T., Berka, C., & Wang, P. (2011). Developing systems for the rapid modeling of team neurodynamics . HCI Annual Meeting, 2011 Orlando, FLA. Accepted presentation.

Dr. Jonathan Touryan, Laurie Gibson, James Horne, Paul Weber
Science Applications International Corporation

Title: Measuring the familiarity of faces with event-related potentials

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Abstract:

Event-related potentials (ERPs) have been used to study the processes involved in recognition memory, with much of this work focusing on the recognition of faces. In particular, the early familiarity component has been linked to the frontal N400 (negative deflection between 300-500ms), whereas the recollection component has been linked to a later positive deflection over the parietal cortex (500-800ms). In this study, we measured the ERPs elicited by faces with varying degrees of familiarity. Here, subjects viewed a continuous sequence of faces with either low (novel faces), medium (celebrity faces), or high (faces of friends and family) familiarity while performing a separate face-identification task. We found that the level of familiarity was highly correlated with the magnitude of the late parietal component. Additionally, by using a single-trial classification technique, applied to the entire ERP, we were able to distinguish between familiar and unfamiliar faces with a high degree of accuracy. The classification of high versus low familiarly resulted in areas under the curve (AUCs) of up to .99 for some subjects. Interestingly, our classifier model (i.e., a linear discriminant function) was developed using a completely separate object categorization task on a different population of subjects.

Dr. Michael Weisend
The Mind Research Network

Title: Transcranial Direct Current Stimulation (TDCS)

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Abstract:

As part of the DARPA sponsored Accelerated Learning program, The Mind Research Network team has developed transcranial direct current stimulation (TDCS) as a tool for double-blind, neuroimaging guided, non-invasive alteration of brain network activity to enhance task performance in healthy individuals. TDCS is one of several methods (i.e. pharmaceuticals, transcranial magnetic stimulation, deep brain electrodes, etc.) that can be used to exogenously influence brain function. TDCS is delivered through electrodes that are placed on the scalp. A typical stimulation will deliver up to 2 mA of current for up to 30 minutes. Theoretical and empirical evidence suggests that the cortex underlying the anode (+) becomes more excitable during TDCS and for a short period after stimulation (Liebetanz et al., 2002). In contrast, cathodal stimulation (-) reduces the excitability of the cortex (Dieckhofer et al., 2006). These predictable changes in cortical excitability have been used to accelerate the transition from novice to expert performance in two laboratory tasks in two locations. The first task modeled the process of scanning the environment for possible threats using stimuli from the DARWARS environment. The second task is modeled after a target search task that an image analyst might perform in synthetic aperture radar images. In both tasks, the locations for the stimulating electrodes were determined by neuroimaging with magnetoencephalography (MEG) that quantified brain activity while subjects performed the threat and target detection tasks at both novice and expert levels. Activity in the right mesial temporal lobe is low in novice performers and dramatically increased in subjects performing at expert level. Thus, the TDCS anode was located at approximately EEG electrode position F10 to increase the excitability of the right temporal and inferior frontal structures. TDCS at F10 facilitates the transition from novice to expert performance. Interestingly, the F10 position does not facilitate the detection of changes in the image but stimulation at F3 looks promising in preliminary tests. The neuroimaging guided TDCS paradigm, together with electrode development that reduces skin irritation and sensation, makes it possible to non-invasively bias the cortical network to respond with greater plasticity to environmental stimuli and tasks requirements. The use of non-invasive brain stimulation to enhance perception, memory, and cognition, whether in healthy individuals or in patients as a remedy for disorders, is an exciting and rapidly growing area of interest in the neurosciences.

Brain-based Cognitive Architecture for Training

The Georgia Tech Research Institute (GTRI), the applied research arm of Georgia Institute of Technology, in collaboration with two faculty members from the resident instruction side of Georgia Tech, are engaged in an IR&D project to explore new brain-based training architectures. The team consists of Elizabeth Whitaker (GTRI- Artificial Intelligence (AI) and intelligent systems, case-based reasoning), Christopher Hale (GTRI–Cognitive Psychology, task analysis, training), Rudolph Mappus (AI, Machine Learning, Neuropsychology),Ethan Trewhitt (GTRI-Software Engineer), Eric Schumacher (School of Psychology–Neuropsychology) and Mark Riedl (College of Computing–Narrative Generation, training, AI).

The objective of this research is the development of an architecture and approach for conducting training activities based on neuroscientific models of student reasoning, learning, and emotion. We will integrate lessons from brain-based models of human learning and reasoning with more traditional student modeling, teaching and learning theories. We are exploring the integration of case-based reasoning and scenario generation techniques (the use of stories) to drive training content in an agent-based architecture for training and mission rehearsal. This research will support an innovative approach to continuous learning, in pursuit of a system that can A) objectively assess an individual's learning and emotion, and B) act decisively to dynamically adapt training activities to increase training effectiveness.

The automated scenario generation problem is as follows: given a specification of the learning objectives, knowledge about the individual (or small team), and a world model, find a sequence of events that, should they play out in an interactive virtual environment, result in measurable learning gains. Automated scenario generation solves the scenario generation problem by computationally producing a training activity from scratch. Automated scenario adaptation takes an existing training activity and makes changes until it conforms to a new set of specifications and learner attributes.

What can be learned about the type of decisions being made during a complex scenario using fMRI?

Our research intent is to use fMRI analysis to drive the design of software architectures to support cultural training for military personnel.

- We have chosen as our test scenario a house search being performed in Afghanistan by US Military personnel.
- Soldiers must balance multiple conflicting regulations and guidelines.
- We will have several subjects make similar types of decisions while monitoring their mental processes via fMRI.

Type	Includes	Expected Brain Region(s)
Tactical	Concerns about security, awareness of threats	Medial-temporal lobe (MTL)
Operational	Procedures, rules, general ways of doing things	Pre-frontal cortex (PFC)
Emotional	Empathy, stress, sympathy, interpersonal stress	Amygdala
Cultural	Societal norms and expectations, prohibitions	Basal ganglia (BG) projecting onto PFC

Case Based Reasoning: Using Past Experiences to Reason about New Problems

Case based reasoning provides a means for capturing, knowledge about known entities and situations and adapting it to new unknown entities and situations for reuse in addressing new problems. It can be

applied to capture part of the reasoning process of experts in a particular domain and adapting solutions to new cases. These cases can be presented to students as case-studies or active learning scenarios. Cases or stories in the case library are indexed by a set of predefined features that so that the appropriate case can be retrieved for reasoning or teaching purposes.

Architecture

An advanced architecture is required to make use of these new capabilities and apply them to the delivery of dynamically adaptive training. Figure 1 shows our preliminary thoughts on the brain-based training architecture. We use fMRI to guide the development of the training architecture. Figure 2 shows the brain regions of interest with respect to decision making. Neural signals in prefrontal, parietal and temporal cortices as well as limbic regions (e.g., hippocampus and amygdala) may identify cultural factors related to, e.g., violence. Once discovered, these brain systems may be used as assessment criteria for effective training regimens.

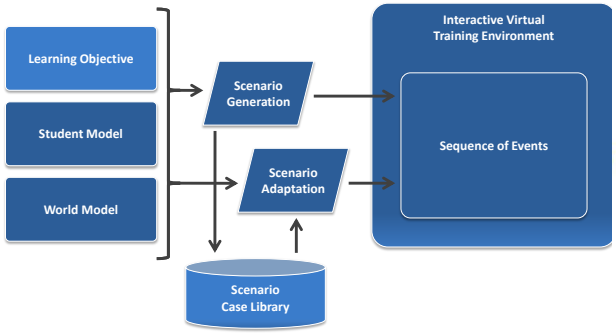

Figure 1. Training scenario generation, adaptation

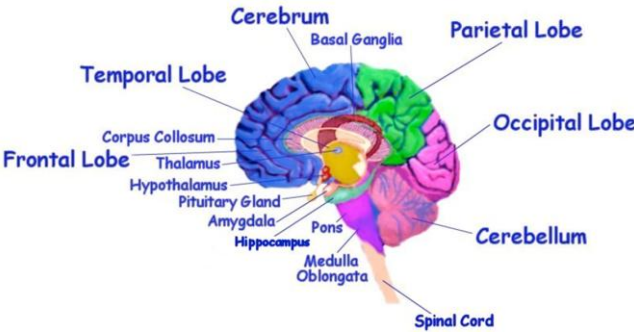

Figure 2. Brain regions

An advanced architecture is required to make use of these new capabilities and apply them to the delivery of dynamically adaptive training. Figure 3 shows our preliminary thoughts on a brain-based training architecture.

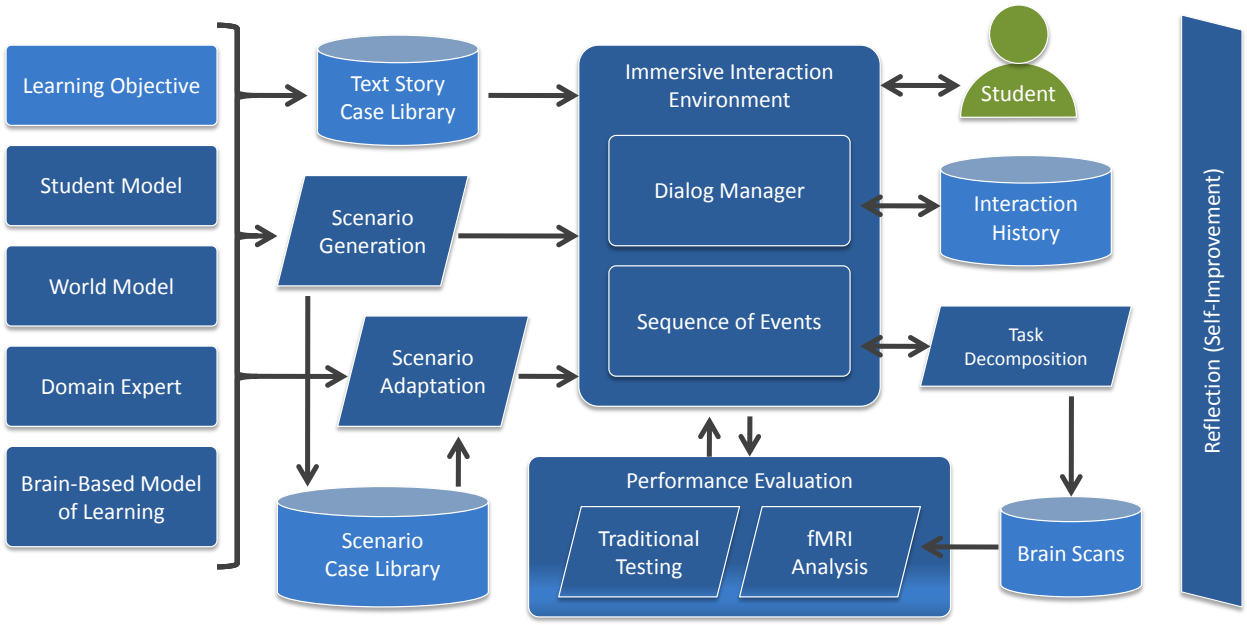

Figure 3. Preliminary architecture

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