Lee Baugh, Ph.D.
Director – Center for Brain and Behavior Research (CBBRe)
Director - Human Functional Imaging Core
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UNIVERSITY OF SOUTH DAKOTA

http://www.usd.edu/cbbre

Where is CBBRe Located?

University of South Dakota

≈10,000 students (graduate & undergraduate)

Liberal Arts campus in the SD University system

Includes the Medical School, College of Arts & Sciences, School of Education, College of Fine Arts, Business School and Law School

Located in Vermillion, SD (pop 10,800)

1 hr south of Sioux Falls, SD (pop 187,200) and 30 mins north of Sioux City, IA (pop 82,700)

What is CBBRe?

- **C**enter for **B**rain and **B**ehavior **Re**search
- NIH Center of Biomedical Research Excellence (COBRE) Grant
  - Funded the Neuroscience Group (Basic Biomedical Sciences & Biology Dept.) from 2000 through 2011
  - Expansion to include many other departments across campus in August 2013
  - CBBRe formally designated center status by the University of South Dakota in January 2014.

What is CBBRe?

- **Mission**

*CBBRe will build and support a **nationally recognized research and training center** in South Dakota to advance the understanding of brain structure, function and health. Specifically, the Center will promote **innovative basic to translational research** that addresses problems in **neurology, neuropsychology and psychiatry** and provide **outstanding training of research students and fellows**, feeding the pipeline of creative independent scientists in the fields of neuroscience and behavioral science within the **northern plains states and nationally.***

What is CBBRe?

Membership

Department/Division	College/School	Faculty Count	Graduate Student/Post Doc
Addiction Studies	Health Sciences	1	0
Basic Biomedical Sciences	Medicine	19	35
Beacom School of Business	Arts & Sciences	2	0
Biology	Arts & Sciences	4	9
Biomedical Engineering	Arts & Sciences	1	1
Communication Sciences and Disorders	Arts & Sciences	4	0
Computer Sciences	Arts & Sciences	1	0
Counseling and Psychology in Education	Education	7	6
Kinesiology and Sports Management	Arts & Sciences	3	0
Neurosciences/Neurology	Medicine	1	0
Occupational Therapy	Health Sciences	2	0
Pediatric Neurosurgery	Medicine	1	0
Pediatrics	Medicine	11	1
Pediatrics, Population Health	Medicine	1	2
Physical Therapy	Health Sciences	3	2
Physician Assistant	Health Sciences	1	0
Psychiatry	Medicine	2	4
Psychiatry /Avera Institute for Human Genetics	Medicine	2	0
Psychology	Arts & Sciences	8	20
Public Health	Sanford Research	1	0
Sanford Research	Sanford Research	2	3
Sports Science and Orthopedic Research	Medicine	1	0
Grand Total		78	103

CBBRe: Participating Institutions

- Division of Basic Biomedical Sciences
- Department of Biology
- Department of Chemistry
- Division of Counseling & Psychology in Education
- Department of Psychology (Clinical Psychology & Human Factors PhD)
- Department of Communication Sciences & Disorders
- Beacom School of Business
- Department of Kinesiology
- Sanford Research*
- Avera Institute for Human Genetics*

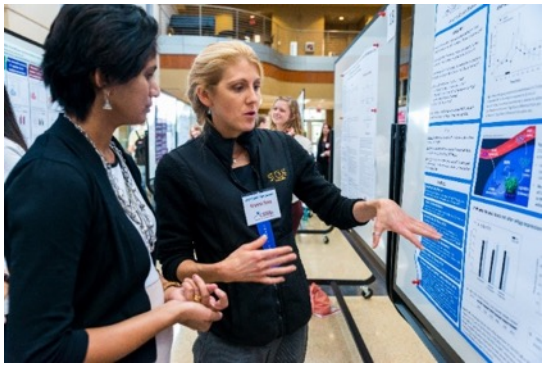
* In Sioux Falls, SD

Working Goals

- Increase the profile of neuroscience and behavioral science research and training within the region.
- Increase number of federally-supported training grants in neurosciences and behavioral sciences.
- Integrate and enhance the training experience in neuroscience and behavioral science at USD.
- Increase number core faculty in the CBBRe.
- Increase number of quality research grant applications to external agencies.

CBBRe: Activities

- Pilot awards for faculty- and student-led research projects.
- Support for student travel to meetings and training opportunities.
- Student mentoring/support
  - Active graduate & undergraduate student organizations
  - Opportunities for peer mentoring
- Annual symposium that includes:
  - Talks from 4 distinguished external speakers (and opportunities for students to meet with these speakers)
  - Talks from both CBBRe faculty and students (at least 2 student talks every year).
  - Student/Faculty/Staff Poster session.



What are CBBRe's Research Strengths

- ***Stress:*** Neural and behavioral processes underlying stress, mood and emotion, and related psychiatric disorders, particularly addiction/substance dependence and affective disorders.

- ***Development:*** Neural, cognitive and behavioral development and related developmental disorders, particularly behavioral/cognitive disorders, learning disabilities, and communication disorders.

- ***Plasticity***: Neural and behavioral processes underlying learning, memory and motor function, and related neurological disorders, particularly stroke, traumatic brain injury, Parkinson's disease, Huntington's disease, and Alzheimer's disease.

CBBRe: Some of our current projects

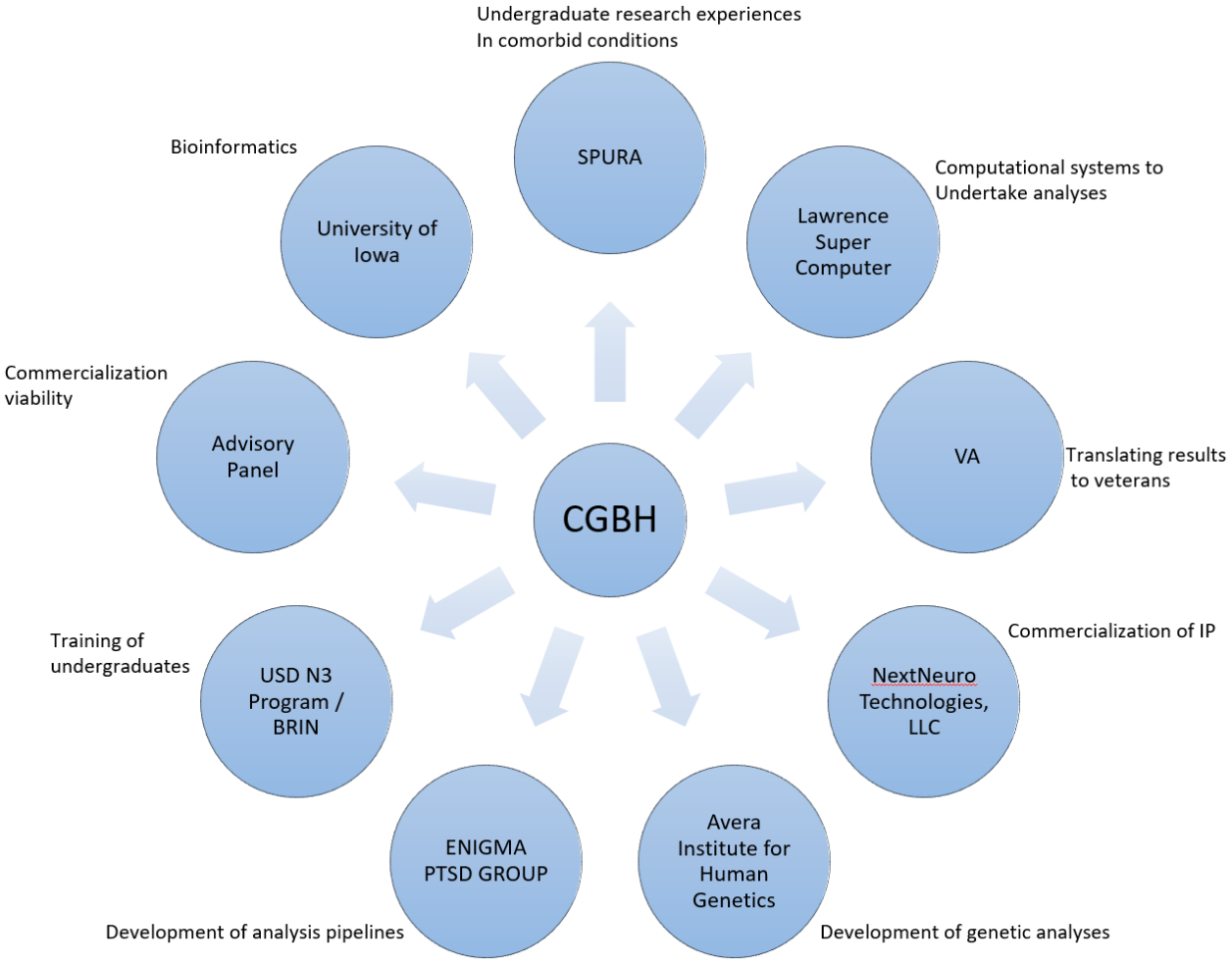
- Neuroplasticity and neurochemistry underlying nociception
- Identifying molecular targets for the treatment of Huntington's disease
- Using stem cell based therapies to treat neurological disorders
- Understanding molecular processes underlying neurodevelopmental disorders and brain cancer
- Neural and behavioral recovery following stroke or brain injury in human and non-human primates and rodent models
- Neural and behavioral correlates of tool use in humans
- Educational and clinical aspects of addiction counseling with native and non-native populations
- Central auditory processing disorders in humans
- Transcranial Magnetic Stimulation (TMS) and Transcranial Electrical Stimulation (TES) as treatments for Parkinson's Disease
- Neural and behavioral factors underlying PTSD and alcohol use disorder in both animal models and at-risk clinical populations

Mission of the CGBH

- Significantly improve the mental and physical health of those exposed to traumatic events
  - Place South Dakota at the forefront in personalized treatment of trauma-related illness
    - Reduce the health, financial, and personal burden of PTSD and associated disorders
  - Identification of risk factors in the development of PTSD
  - Enhance personalized treatment to improve behavioral, pharmaceutical, and community interventions

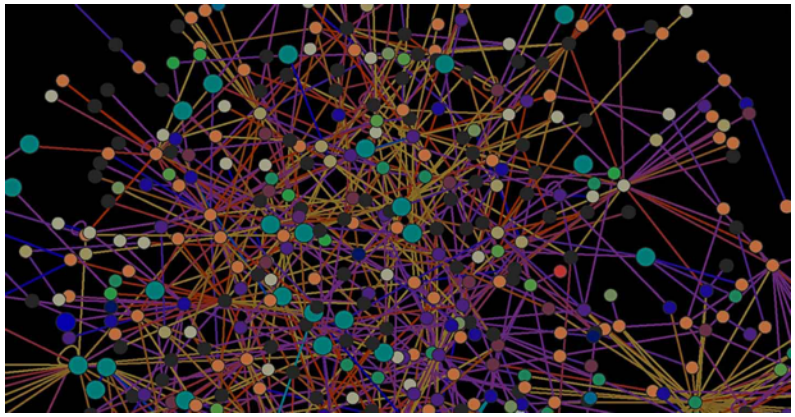
Mission of the CGBH

- Single lab not capable of performing research at this scale
  - 14 PhDs
  - 7 Research Staff (to date)
  - 8 PhD students (to date)
  - 1 MD student
  - Numerous undergraduates



Putting it all together

- Not including GWAS data we end up with hundreds of thousands of data points
  - Each participant is over 100GB of data
  - Making sense of the data requires specialized pipelines
    - Data collection
    - Data storage
    - Data analysis
    - Cross participant comparisons
- Bioinformatics expertise and world-class network of collaborations



BIG Collaboration as a Necessity

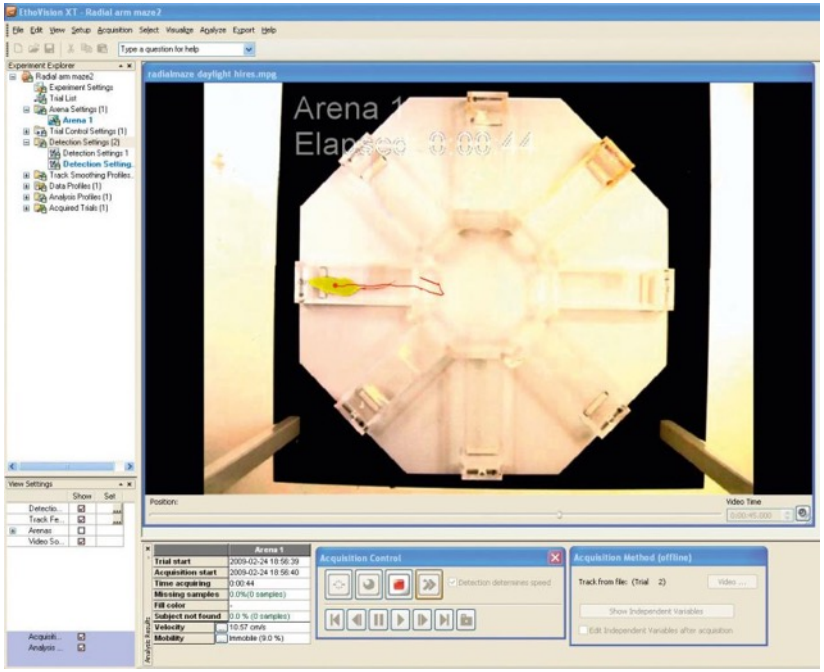
- Although 450 participants seem like a lot…
  - **E**nhancing **N**euro**I**maging **G**enetics through **M**eta-**A**nalysis (ENIGMA)
    - Specific working groups on PTSD and related disorders, such as major depressive disorder (MDD) and traumatic brain injury
  - World's largest brain-mapping project
  - 900 Researchers across 39 Countries

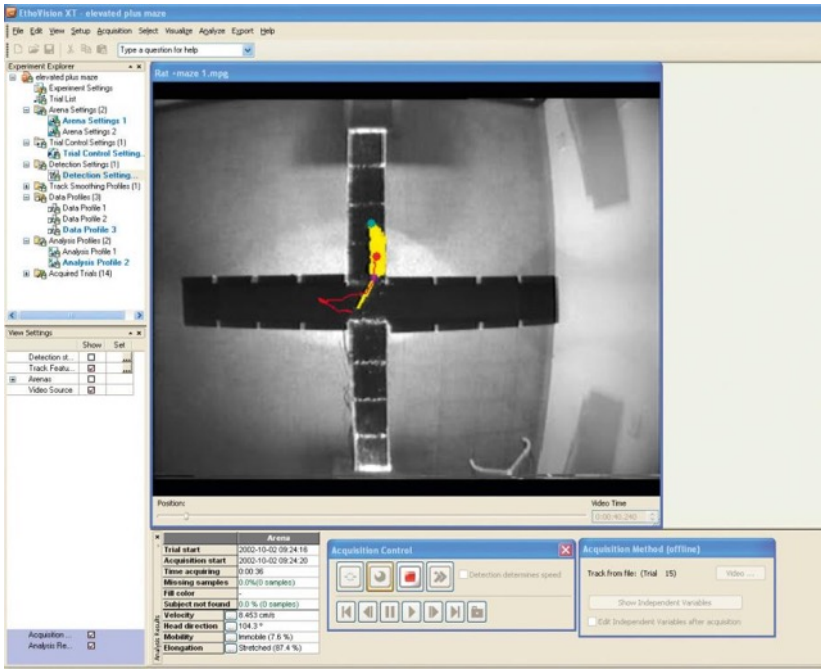
CGBH Summary

- Although still in the early days, the Center for Genetics and Behavioral Health is beginning to create the foundational knowledge required to advance PTSD identification and treatment
- We are living in an exciting time!
  - Novel tools and techniques are allowing us to explore the link between brain and behavior in ways previously unattainable
  - Large scale multi-site collaborations are allowing for concerted efforts to tackle complicated psychiatric conditions that a single group alone would likely be incapable of
    - Much of the results presented are the result of much effort from multiple labs and multiple investigators
- Already, pooled data from across sites is revealing relationships between psychiatric conditions and brain function that were unknown
  - Accelerated “brain aging”
  - Changes to white matter pathways
  - Cortical volume abnormalities
  - Changes in covariance networks
  - Changes in cortical thickness and surface area

What Resources Are Available?

Facilities – Animal Behavior Core





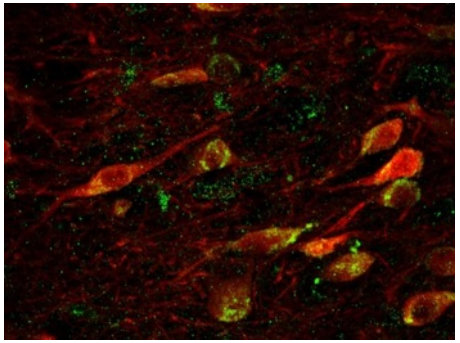
Apparatus including radial arm maze, elevated-plus maze, Morris water maze, open field arenas, rotorod, pain assessment apparatus.

Ethovision XT and Observer XT behavioral testing software from Noldus

Other Core Facilities

Cell/Tissue Imaging Core

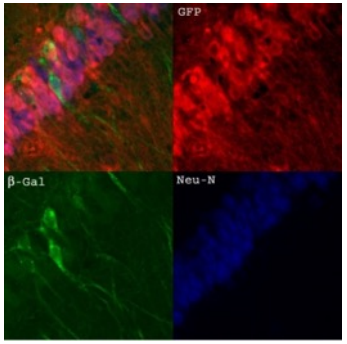
- Includes Confocal Microscope & Laser Dissection Microscope



Genomics Core

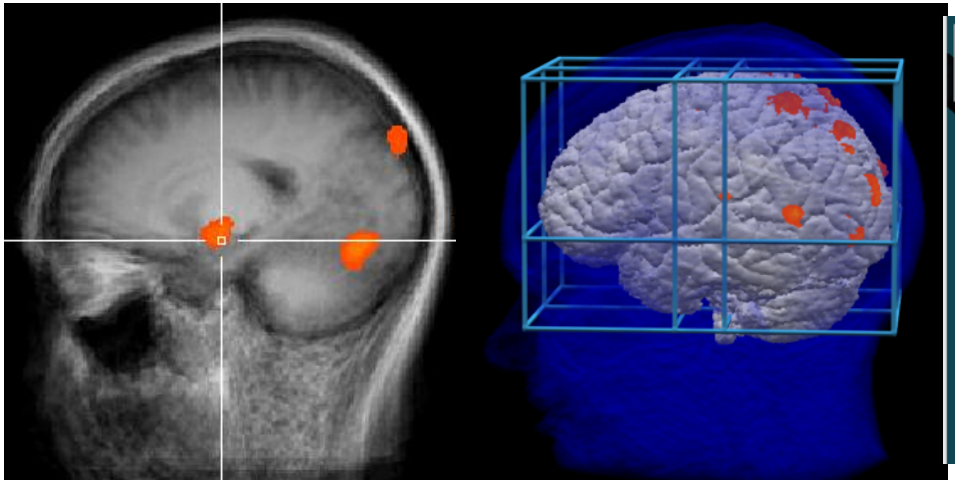
Proteomics Core

Physiology Core

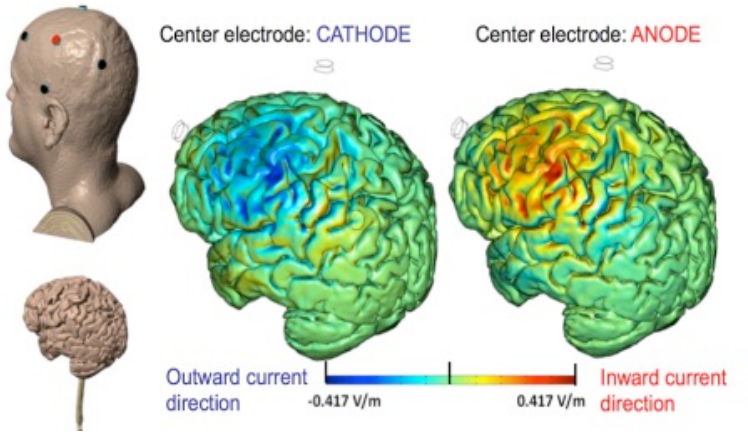


Facilities – Human Functional Imaging Core

- 3 Tesla fMRI facility
  - Avera Sacred Heart Hospital
  - Strctural, fMRI, DTI
- All major neuroimaging software support (BrainVoyager, SPM, FSL, FreeSurfer)
- Member of the ENIGMA consortium



Facilities – Human Functional Imaging Core



- Single pulse, paired-pulse, and repetitive transcranial magnetic stimulation
- High-definition transcranial direct current stimulation
- Multiple EEG systems
  - 128-Channel active electrode system
  - 64-Channel TMS/tDCS compatible system
  - 32-Channel portable/wireless system
- Current studies at this facility include
  - Motor control in healthy individuals
  - TES as a treatment for Mental Fatigue
  - Recovery of motor function in stroke patients
  - Potential interaction between brain injury and PTSD
  - Neurostimulation as a treatment for PD

Overview

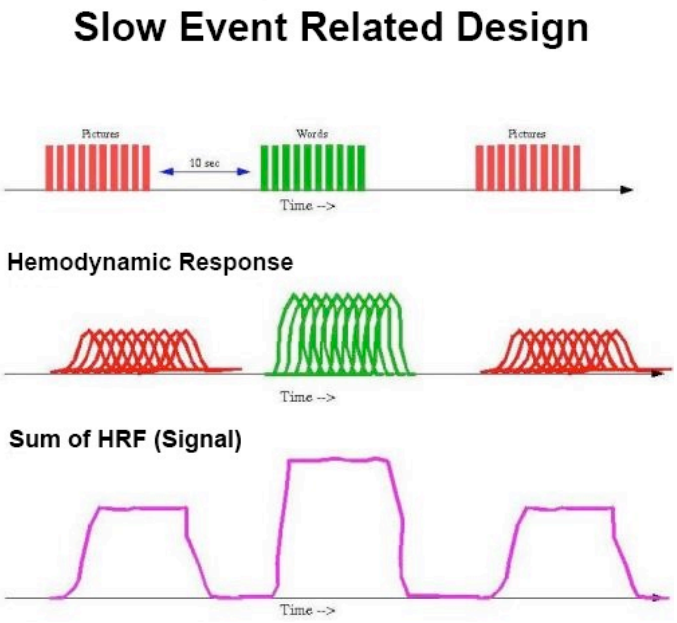
- The core's mission is to foster an environment that will aid and enhance the excellence of research using human neuroimaging techniques by providing a well-equipped physical facility and appropriate support services for interested investigators across campus, the community, the state, and beyond.

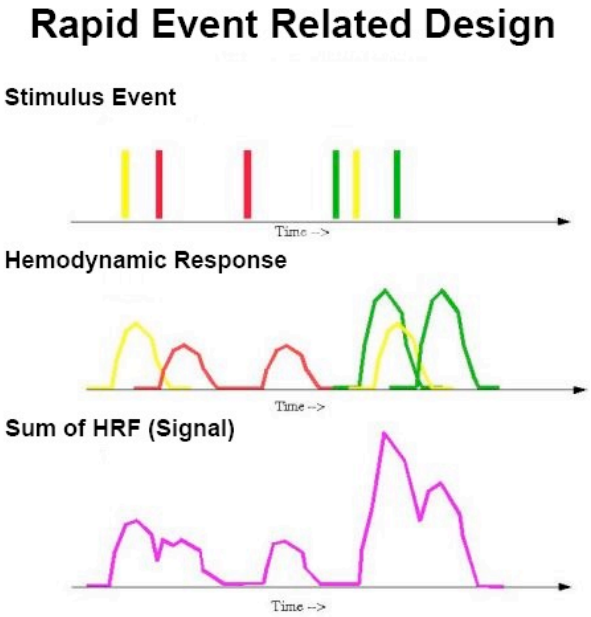
Safety Training

- Working in a high-tesla environment
- Identifying and handling unexpected findings
- Noise mitigation
- Participant identity protection
- Data security
- TMS Training
- EEG Training

Experimental Design

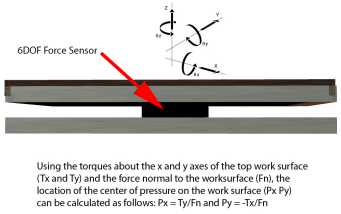
Depending on which regions of interest (ROIs) one's hypotheses pertain to, a different scanning sequence may be optimal.





Equipment

- 3-Tesla wide-bore
  - All common fMRI and DTI sequences
- Range of equipment to conduct experiments
  - Visual presentation
  - Auditory presentation
  - Button boxes
  - Trackball
  - Force/Torque sensors
- Custom fabrication
  - We run custom software and hardware
  - If we don't have it, we can likely build it!

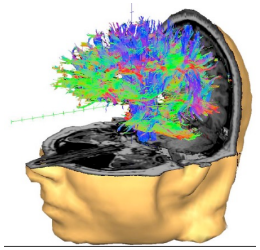


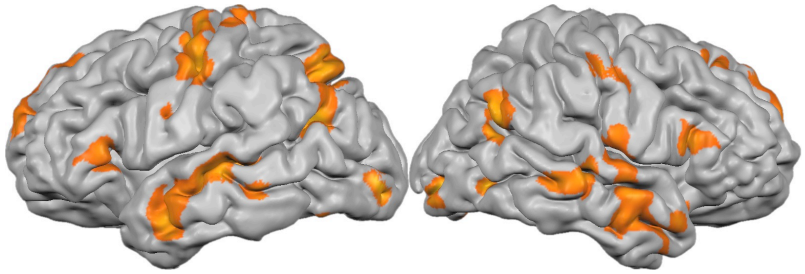
Equipment

- MagStim Transcranial Magnetic Stimulation
  - Standard RAPID^2
  - BISTIM^2
    - Paired Pulse
  - Brainsight

Data Analysis

- Full range of data analysis support
  - We can provide the tools
    - Remote access to 16 Core Server
      - NVIDIA CUDA Processing
    - Range of Analysis Packages
      - AFNI
      - SPM
      - BrainVoyager
      - FSL
    - Sample data sets
  - We can train you or your staff/students in their appropriate use
  - We can analyze your data





CBBRe: Student Training

- Students enroll in the graduate programs in the individual departments.
  - Have a concentration in Neuroscience or Behavioral Science.
  - Also an option for an MD/PhD in Basic Biomedical Sciences.
- Psychology, Counseling & Psychology in Education, and Communication Sciences & Disorders programs offer opportunities for a program that combines clinical training with research experience.
- Recently-funded NSF graduate training program.
- Also have a NIDA-funded summer undergraduate research program (opportunity for graduate students to engage in mentorship).

Graduate Student Training Program: USD-N3

USD Neuroscience Nanotechnology Networks

USD Neuroscience, Nanotechnology & Networks (USD-N3) program

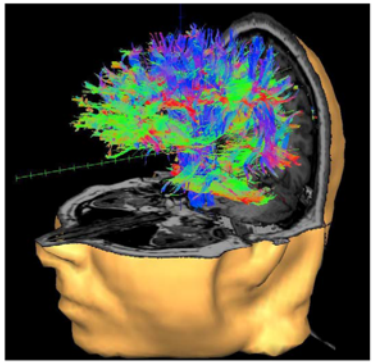
Funded by the National Science Foundation Research Traineeship (NRT) program.

Combines interdisciplinary research training & professional skills needed to prepare for a more diverse range of STEM careers.

Part of the professional training includes opportunities to take grad-level classes in the Business School, School of Law, School of Education and Department of Communication Studies.

CBBRe: Student Training

INTERESTED IN LEARNING ABOUT RESEARCH IN ADDICTION & MENTAL HEALTH?



SUMMER PROGRAM FOR UNDERGRADUATE RESEARCH IN ADDICTION **(SPURA)**

USD undergraduate students will work with a faculty mentor for 10 weeks over the summer of 2021 on a dedicated research project in the area of addiction or mental health, and will present their work at the poster session held at the end of the summer program

Applications are Due February 15th 2021

CBBRe
Center for Brain and Behavior Research

Sponsored by a National Institute on Drug Abuse (NIDA) grant R25-DA033674, and the USD Center for Brain and Behavior Research (CBBRe)

SPURA SUMMER 2021

Laboratory or Clinical-Based Research Experiences

Program Includes Social, Scientific Events and Professional Development

SPURA Provides $4000 Summer Stipend, $800 Housing Allowance, and $1000 for Research Supplies/Travel

FOR MORE DETAILS:

http://www.usd.edu/cbbre/spura

or email Drs. Brian Burrell (bburrell@usd.edu) or Lisa McFadden (Lisa.McFadden@usd.edu)

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CBBRe: Student Training

- Graduate Research Training Initiative for Student Enhancement (G-RISE)
  - Funded by NIH's modified T32 program
  - Produce a diverse pool of highly qualified, biomedical scientists that are prepared for a variety of career paths in the public and private sector
  - Similar to N3 program in terms of offering students experiences geared towards a wide-range of careers

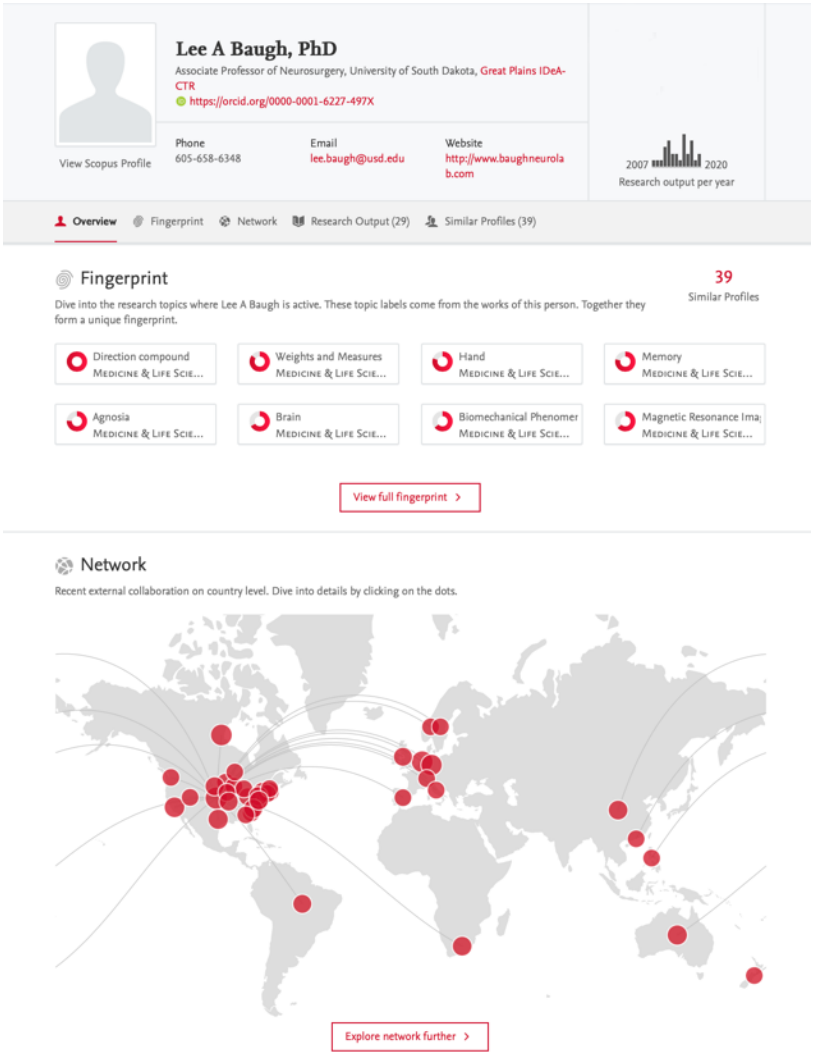
CBBRe: Student Training

USD CBBRe students have

- Successfully competed for NIH pre-doctoral fellowships (NRSA).
- Gone on to post-doctoral positions at Carnegie-Mellon, Harvard, Stanford, UC-San Diego, University of Alabama-Birmingham, and Mt. Sinai School of Medicine.
- Succeeded in “alternative” career pathways, e.g. biotechnology, patent law, and even the electronic gaming industry.

How Might We Collaborate?

- Many of us are listed in the Research Nebraska Directory



How Might We Collaborate?

- Contact CBBRe
  - If you have…
    - A research idea and think that we can help
    - A project that would benefit from another recruitment site
    - Multi-institution grant ideas
    - Common research interests
    - A student looking to stay in the region but wants to be a little adventurous
  - If you want…
    - Looking for consultation / advice
    - Access to expertise or equipment
  - Just to chat ☺

More Information

CBBRe:

Website/email: www.usd.edu/cbbre, CBBRe@usd.edu

Lee Baugh

Website / email: www.baughneurolab.com, lee.baugh@usd.edu

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Supported by the USD Sanford School of Medicine, School of Education, College of Arts & Sciences, the National Institute on Drug Abuse (*R25-DA033674*), the Nation Science Foundation (*DGE-1633213*), and the South Dakota Governor's Office for Economic Development (*GOED*).

Thanks, Great Plains Idea - CTR