Adaptive Brain and Behavior Across the Lifespan

Background: Our aim is to understand adaptation and improve human lives in various contexts. Inequalities and environments in which people live affect their health and behavior — and their success of remaining healthy for a lifetime. Virginia Tech has embraced the idea of understanding how the brain is linked to human experiences, constraints, and behavioral choices that not only affect neural well-being, but overall health. The effort is aided by new, sophisticated technologies (e.g., ones that map the brain in real time or allow clearer diagnosis of disease). Individuals must continue to function in the world in terms of addictions or life consequences from poor decision-making, developmental disabilities such as cerebral palsy, brain cancer, and other health challenges. Pursuit of innovative science to cure diseases is an important thrust of this Destination Area, in concert with evidence-based treatments and interdisciplinary training of individuals who work with people who are affected for the long-term by diseases and atypical disorders and conditions. Virginia Tech is mobilizing all emerging tools to improve people's lives.

Today, neuroscientists understand our brain in action, at the level of molecules, cells, circuits, systems, and behavior — but more remains to be understood. Likewise, brain diseases and traumatic brain injuries, which can result from diverse causes that range from drug addiction to physical impact, have been difficult for society to grasp. Our current knowledge and research in both the human and animal domain will provide substantial opportunities for "brain exploration" with an intention to solve human health issues and address societal issues and behaviors across the lifespan. A vital humanities and social science approach connected to neuroscience and medical approaches promises to move solutions to brain and behavior problems forward. We will also focus on social aspects of human development as people live longer, through the creation and application of new technologies.

Current Virginia Tech Differentiators:

- Neuroimaging/functional brain imaging of multiple interacting individuals
- Biomarkers of disabilities and atypical behaviors
- Schools of Neuroscience and Biomedical Engineering, which stretch across the colleges
- Research in veterinary medicine that translates to human systems
- Health across the lifespan, from the laboratory to communities
- Cellular/molecular biology research
- Cross-cutting expertise in environmental science and engineering
- Implementation science, policy, and community members self-advocacy

Experience and Assets: Notable pockets of disciplinary and interdisciplinary expertise will work to advance human health across the lifespan. The work is catalyzed, in part, by the Virginia Tech Carilion School of Medicine and Research Institute, the Biocomplexity Institute, the Fralin Life Science Institute, the Center for Gerontology, the School of Neuroscience, the Laboratory of Neurotoxicity Studies at the Virginia-Maryland College of Veterinary Medicine, the Center for Drug Discovery, and the Center for Autism Research, and collaboration with Wake Forest School of Medicine.

The Department of Human Development in the College of Liberal Arts and Human Sciences runs four centers that provide "living laboratories" for access to populations who develop through time (inclusive

of disabilities) – the Child Development Center for Learning and Research, the Adult Day Services, and two Marriage and Family Therapy Centers. Each of these centers is an avenue to investigate treatments and enable students and researchers understand the expression of disorders as well as typical development and aging. Similarly, the Department of Psychology in the College of Science runs outreach, teaching, and research centers. Students across the university can gain understanding of the unfolding of typical and atypical development and neurodiversity via the diverse disciplinary training associated with this Destination Area.

Computational neuroscientists at the Virginia Tech Carilion Research Institute are working to understand mechanisms in brain tissue, dovetailing with a large-scale research endeavor, the Roanoke Brain Study, which is aimed at understanding the neurobiology of decision-making through the lifespan and its relationship to brain development, function, and disease. Meanwhile, the Addiction Recovery Research Center examines decision-making processes that support dysfunctional behaviors and seeks novel therapeutic means to repair those dysfunctional processes.

Likewise, the Virginia Tech Center for Drug Discovery is an interdisciplinary group committed to grow and advance the stature of the existing drugs. The changing landscape of drug discovery provides opportunities for universities to make significant contributions to human health. Relatedly, Virginia Tech bioengineers work to find solutions to abnormal brain function, and neurological and psychological diseases.

Examples of Targeted Hot Spots:
- Develop and study novel technologies to understand the human brain and treat its disorders; create and support integrated human brain research networks
- Discover dynamic patterns of neural activity that are transformed into cognition, emotion, perception, and action in health and disease
- Neuroethics to solve issues about neural enhancement, data privacy, and appropriate generation and use of brain data in law, education, and business
- Social Neuroscience: Education on the interface of neuroscience, from neuroeconomics to neuroscience in the courtroom
- Personalized portable brain monitoring systems for field deployment
- Development of brain-machine interfaces and smart prosthetics; connect systems, as in neuroscience with engineering
- Device and tissue design/polymer science/drug delivery and drug discovery and therapeutics
- Pursue the human-animal nexus by studying non-human brains and behaviors and developing animal models and taking advantage of the presence of veterinary medical school. Additionally, expertise in sociology, animal science, and entomology will help us pursue relevant intersections, e.g., understanding social insects as a model for neural network dynamics.
- Bridge the fields of basic science, liberal arts, social science, engineering, and medicine through an integrated approach to brain science and the study of behavior.