The Brain and the Body: Multimodal Psychophysiological Imaging to Understand Cognition

PROJECT DESCRIPTION: Understanding an individual's cognitive state is of critical importance to the Air Force to effectively train, plan missions, and design relevant interventions if performance goes awry. To characterize an individual's state, a combination of neural (e.g., EEG), peripheral (e.g., EKG, eye tracking, pupillometry), and behavioral (e.g., task performance) data are combined. These rich multimodal data – capturing the interaction of the brain and the body – are modeled alongside task performance to understand which signals provide the most value, in which settings, and derive actionable insights using sophisticated analytical and machine learning techniques.

LEARNING OBJECTIVES: With access to data from cognitive neuroscience laboratory settings as well as in-flight physiological recordings, there will be opportunities for students to develop their statistical skills and coding abilities (experience with MATLAB, R, or Python is required), data visualization, multi-sensor data fusion, algorithm development, and expand their conceptual and theoretical knowledge of physiologically measured cognitive states. Students will gain experience in critical thinking, public speaking, and collaborating with multidisciplinary teams.

ACADEMIC LEVEL: Doctoral; Masters

DISCIPLINE NEEDED: Cognitive Neuroscience, Biomedical Engineering, Data Science

RESEARCH LOCATION: Wright-Patterson Air Force Base, Dayton, Ohio

RESEARCH MENTOR: Grace Clements, PhD
Cognitive Neuroscience, University of Illinois Urbana-Champaign, 2022

Grace Clements, Ph.D., is a research psychologist at the Air Force Research Laboratory. After completing her undergraduate degree in Psychology and Neuroscience at Miami University, Grace pursued a Ph.D. in Cognitive Neuroscience at the University of Illinois Urbana-Champaign, where she specialized in advanced imaging methods (EEG, MRI, fNIRS). Her research focuses on how brainwave activity changes with attention, how "background noise" in the brain is a signal that varies across the lifespan, and how the brain's white matter health relates to age, fitness, and the brain's vascular health. In 2024, Grace joined the 711th Human Performance Wing at AFRL, where she designs studies and tests products with human neuroscience and psychophysiological methods and advanced statistics to understand human cognitive and functional state to protect Airmen and Guardians.

Photo Courtesy of Air Force Research Laboratory