## Abstract

This project is an interdisciplinary research effort involving faculty and students from educational technology, special education, UF's Online Learning Institute (OLI), and neuropsychology to translate and integrate relevant neuroscience findings for education and generate conceptual and empirical contributions for the study of dyslexia and design of instructional supports for dyslexic learners. Specifically, this study will determine cognitively optimal multimedia learning formats for dyslexic students based on a comprehensive assessment of multimedia learning conditions using criterion tests of learning, standardized neurocognitive metrics, and electroencephalography (EEG)-based physiological measures of cognitive processing. We will employ an innovative wireless EEG system using validated metrics of cognitive load and engagement to compare the effects of multimedia learning formats on dyslexics' cognitive processing and determine the most appropriate format. The proposed project addresses President Obama's Brain Research through Advancing Innovative Neurotechnologies (BRAIN) initiative and the NSF's recent call for research harnessing the power of emerging neurotechnologies. The goal of the BRAIN initiative is to support research to "better understand how we think, learn, and remember" (White House, 2014, online). BRAIN programs are receiving at least \$110 million in NSF, NIH, and DARPA funding.

The specific aim of the project is to determine the optimal multimedia learning format for dyslexic students based on four multimedia learning conditions. There is a strong research base devoted to how students in general learn under various multimedia conditions (Mayer, 2007). However, research on how dyslexic students learn in such environments is lacking even though 10-20% of the population has dyslexia (Shaywitz, 2008). Our proposed research is timely for several reasons. First, a national movement for schools to recognize dyslexia and prepare teachers to teach such students is making dyslexia more visible to the public (see Congressional Resolution 456). Second, the ability to learn in multimedia environments is more important than ever given the dramatic increases in blended and online learning environments (Allen & Seaman, 2014; Staker & Horn, 2013). The creation of UF Online and the OLI makes our research particularly relevant to our institution as well. Third, our study aligns with President Obama's BRAIN initiative as well as with the principles of Foundational Research (Type #1) discussed in *Common Guidelines for Education Research and Development* published by IES, USDOE, and NSF in April 2013.

The proposed research will likely produce a broad transformative impact on instructional practices in higher as well as K-12 education. This project has implications for teachers, parents, psychologists, offices of disabilities services, educational technologists, learning scientists, and most importantly—students. The project will lead to the development of a protocol allowing the convergence of EEG, neurocognitive, and learning measures to (a) determine if convergence of psychophysiological and behavioral data can allow us to detect patterns of dysfunction, and (b) lead to development of multimedia and online teaching methods to facilitate learning within and across populations with different developmental strengths and weaknesses. The results of this study will be used as preliminary data for an external grant proposal to NSF's EHR Core Research program. The proposal will focus on how dyslexic students learn STEM content in multimedia and other technology-supported environments and will involve collaboration with Dr. Matthew Schneps, director of the Laboratory for Visual Learning at the Harvard-Smithsonian Center for Astrophysics. Dr. Schneps has current NSF funding to study how smartphones and e-readers influence the way dyslexic students learn STEM content.

Additionally, the wireless EEG equipment acquired with ROF funds combined with EEG equipment recently acquired via grants secured by co-PIs Antonenko and Beal will allow us to efficiently carry out the proposed study and enable programs from across UF to enhance their study designs with this novel and powerful methodology for *in-situ* collection and analysis of psychophysiological data in a variety of contexts: multimedia and game-based learning (PI Ritzhaupt), neurocognitive synchronies and team dynamics in STEM problem solving (co-PI Antonenko), development of learning materials for dyslexic students (co-PIs Lombardino and Dawson), development of online learning strategies to support dyslexic students (co-PIs Beal and Dawson), and the study of the visual brain (co-PI Keil). Building our expertise with this innovative neuroscience-based methodology will make our team more competitive for external funding for these projects in the long term.