Summer 2021 Laboratory Research Activities

Dr. Elena Z. Biffi (NECO)
Cerebral Small Vessel Disease (CSVD) is a common progressive neurovascular disease of aging, affecting small caliber arteries of the central nervous system. Currently, our ability to reliably diagnose CSVD is very limited. Recent technological advancements in the field of Optical Coherence Tomography (OCT) can allow for rapid, non-invasive, user-friendly imaging of neurons and blood vessels in the retina. Retinal neurons and small vessels closely resemble their cerebral counterparts in structure and function, and, therefore, retinal imaging can potentially revolutionize clinical approaches to CSVD. Our central hypothesis is that non-invasive imaging of retinal neurons and small vessels with OCT and electroretinography (ERG) can effectively diagnose cerebral small vessel disease. Study participants will undergo MRI, OCT and ERG testing at Massachusetts General Hospital. From these scans we will extract information on established neuroimaging markers of CSVD. As part of this project, NECO T35 students will have an opportunity to study associations between retinal imaging measurements and long-term risk of CSVD-related stroke, cognitive and functional decline. Ideal candidates should have experience with OCT and/or ERG image acquisition and interpretation. Proficiency with Microsoft Office Suite (Excel, etc.) is required.

Dr. Alex Bowers (Schepens Eye Research Institute, Boston)
My lab is part of the Mobility Enhancement and Vision Rehabilitation Center at Schepens Eye Research Institute, of Massachusetts Eye and Ear in downtown Boston. Our research focuses on understanding more about how normal aging and vision impairment affect activities of daily living (especially walking and driving) as well as evaluating the benefits of optical devices, new training techniques and advanced driver assistance systems for people with vision impairment. Many of our studies involve the use of a high-fidelity driving simulator. Depending on the COVID situation, possibilities for summer projects in 2021 include studies evaluating the potential of tactile and/or auditory cues to assist driving of people with vision impairment (e.g., cues to provide warning of potential hazards or cues to remind the driver to scan) or a survey to quantify the use of advanced driver assistance systems by drivers with vision impairment. Students will be involved in all aspects of the research process including data collection, data analysis and presentation of results.

Dr. Gang Luo (Schepens Eye Research Institute, Boston)
Dr. Gang Luo’s lab at Schepens Eye Research Institute, Harvard Medical School, invites T35 students to participate in a validation study of a novel refraction error measurement kit. Made up only of vision charts and a tape measure, the low cost kit is designed to address the issue of lack of vision care in rural areas by enabling lay persons to measure refraction error. The evaluation study will be conducted in Boston. Working with Dr. Luo’s lab as well as with Dr. Richard Jamara from NECO, the student will be in charge of measuring the refraction error in a small group of subjects using the kit. To reduce the risk of exposure to COVID-19, the subjects may include the student’s peers, friends, family members, etc.

Dr. Sangeetha Metlapally (NECO)
Current research studies in the laboratory are broadly centered on understanding the influence of optical aberrations on binocular vision and accommodation, and future directions will be based on outcomes from these studies. Our recent focus has been on understanding the relative effects of abnormally increased ‘high-order aberrations’ (HOAs) and ‘aniseikonia’ (differences in perceived retinal image sizes between two eyes) on the worsening of binocular three-dimensional depth perception. Such effects are relevant in patients with keratoconus (or
any ectatic corneal condition), or those with a history of refractive surgery, as they experience increased magnitudes of HOAs, and mismatched optics between the two eyes. Our studies merge basic and clinical research, both in binocular vision and advanced optics to study these effects. Tools used in the research include, but are not limited to, optical wavefront analyses, psychophysics, data analyses with Matlab/SPSS and computational modeling. Note that previous experience with these tools is not required. The research will inform clinical management strategies or lead to strategies that alleviate visual discomfort and improve binocular visual quality in patients with these conditions.

Dr. Thanasis Panorgias (NECO)
Eye-tracked multi-focal ERGs in a low vision population
The fixation stability of patients without foveal vision is compromised. Therefore, standard multi-focal ERG testing on those patients lacks both spatial specificity and resolution. In this project we aim to combine eye-tracking technology with an ERG system, to improve the diagnostic value of the multi-focal ERG technique on this clinical population.

Dr. Eli Peli (Schepens Eye Research Institute, Boston)
In my lab we have numerous projects covering various aspects of low vision and binocular vision. Projects include:
- Novel prism treatment for tunnel vision, including use of virtual reality for performance evaluation
- Headlight glare impact on driving with cataract and following cataract surgery, including use of a driving simulator
- Confocal imaging for retinal prostheses, including training of blind people in use of a vision substitution device
- Hemianopia and strabismus; evaluation of the possible benefit of eye deviation for field expansion
- Stereo virtual reality displays and motion sickness
- Augmented reality system for tripping obstacle detection and avoidance for partial sight

Dr. Nicole Ross (NECO)
Students will participate in the Community Access through Remote Eyesight (CARE) Study, a randomized clinical trial evaluating the efficacy of a novel mobile technology, Aira, to improve quality of life in older adults with low vision by expanding community access and providing assistance with activities of daily living. Aira provides real-time remote personal assistance through a sighted Aira agent providing direct feedback to assist with visual tasks. Our objectives are to evaluate Aira in a wide range of visual disability. Outcome measures will include assessment of changes post-intervention for: visual ability, health state (including depression), self-efficacy, loneliness, life space, distances travelled from the home and types of services obtained. We will elucidate factors related to improvements in patient outcomes in order to develop a profile of patients who are most likely to benefit from this technology.

Dr. Christopher Taylor (NECO)
My lab studies how differences in the ocular biometry of the eye affect behavior. We measure the ocular biometry of the eye together with visual psychophysical performance. This project aims to extend the finding that reading text of different colors (e.g., black/white text versus black/white background) changes the choroid and myopes’ visual performance. This project aims to determine if motion discrimination changes with ocular biometry and if exposure motion stimuli can alter the choroid.

Dr. Fuensanta Vera-Diaz (NECO)
T35 students this summer can work on the following projects in my laboratory:
(1) Effect of retinal image quality on accommodation and 3D vision in children and adults
(2) Effect of atropine eye drops on scleral stiffness, accommodation and optical aberrations.