PROJECT SUMMARY

In natural vision, we move our eyes around quickly to look at objects of interest in the world. We do this because we get much better information from our central vision about object identity than we do from our peripheral vision. Where we point our eyes, or fixate, will depend strongly on what we are trying to accomplish. For example, when you are searching for your keys you might look in your bag, on the kitchen counter or maybe in the grocery bags. You would be unlikely, however, to look in the refrigerator. We may also make several saccadic eye movements to an object when we are trying to identify it. For example, when recognizing a face, we tend to look at the eyes and mouth.

The goal of this proposal is to gain a better understanding of the information processing and decision strategies that underlie eye movement planning in both the normal and diseased state. In patients with age-related macular degeneration (AMD), central areas of the retina are damaged, creating a large blind spot that forces them to rely solely on residual vision in the periphery. Rehabilitation outcomes for these patients can be successful, but are often inconsistent. Some individuals scan more or less “efficiently” than others.

Objectives. We use an information-theoretic model to motivate fundamental experimental questions about the eye movement planning system in humans. The answers to these questions are used to refine the model and enhance our understanding of the system in general. We then apply the model framework to investigate differences in eye movement behavior between AMD patients and normally-sighted individuals.

Methods. Eye movements will be measured using a carefully designed shape learning task in which the prior knowledge, task and visual information are well-controlled. We will conduct psychophysical experiments to determine how normally-sighted observers encode the visual information as a function of space and time when planning their movements. The residual visual profile of AMD observers will be measured directly using a scanning-laser ophthalmoscope (SLO). The results from psychophysics and SLO mapping will be used to refine an information-theoretic model of the normal and diseased state. The model will then be used to analyze the behavior observed in the eye movement task. What information-gathering strategies are observers using to plan eye movements? How efficient is their strategy? Are AMD observers using different, less efficient strategies, even when the residual vision is taken into account? What is the predicted benefit of training observers to 1) use a new “pseudo-fovea” for eccentric fixation or 2) follow an optimal or normal movement strategy?

Intellectual Merit. The interplay of model development and experimental investigation will significantly increase our knowledge of how humans use prior knowledge, task demands and new visual information to plan eye movements. The results will have broad relevance to neural decision making in general.

Broader Impacts. The application of the model to a clinical population will bring much-needed objective measures to understanding the extent of impairment in individuals with AMD. With this understanding comes great potential for improving rehabilitation training strategies that will improve the quality of life for these patients and their families.