



*Monk by the Sea, Caspar David Friedrich (1809)*

## Vision & Art (Neur320)

### It matters where you look! An investigation of eye movements.

Background Reading: Vision and Art: the biology of seeing (by M.S. Livingstone) Chapter 5

Your visual acuity is not homogenous across the visual field—your fovea (the region of your retina corresponding to the center of gaze) has much higher acuity. To convince yourself of this, try reading this text with your peripheral vision. Because your visual field is not seen with uniform acuity, you must move your eyes to bring objects into your fovea. This process is effortless and can be unconscious. What kind of objects do you direct your gaze towards and how do artists take advantage of this when they compose a painting? In this lab we will investigate your eye movements using an infrared eye tracker and custom software generously provided by ISCAN (<http://www.iscaninc.com/>). This device works by shining an infrared (IR) beam onto your eye while you look at an image with your head still (you will place your head on a chin rest, braced against a forehead bar). A camera is trained on your eye and detects the reflection of the IR beam from your cornea. The camera also detects the reflectance “hole” of the pupil. As you move your eye, the corneal reflection and the pupil make corresponding movements. Please consult the ISCAN Operating Instructions guide attached at the end of the lab.

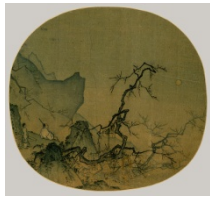
The lab will consist of two parts. In part I you will measure and analyze your eye movements while you look at two sets of digital images: the first set involves a reproduction of a painting (*Monk by the Sea*, above) and a digitally manipulated version of this painting. The second set will be a painting from the Chinese Southern Song period. In part II you will measure and analyze your eye movements during two tasks: first while you track an object moving across a computer monitor, and second during a voluntary eye movement. You will use MATLAB to analyze your data and plot figures for your lab report. The images you need to complete the lab are included in a PowerPoint presentation that has been loaded onto the lab computers. At the end of the lab is a list of issues I expect you to address in your lab report.

## Part 1: Measuring where you look

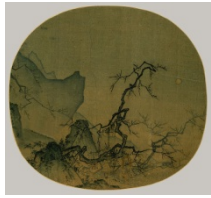
In the PowerPoint presentation loaded onto the lab computer are four digitally manipulated paintings, including *Monk by the Sea*. The other three are paintings from the Chinese Southern Song period. Once you complete your data collection and begin analysis we can discuss the idea behind doing this experiment in more detail.

The images:

1



2



3



4



1 – moon1.tif (original)

2 - moon2.tif (edited)

3 – sea3.tif (original)

4 - sea4.tif (edited)

They will be presented in the following order: 2, 4, 1, 3

The MATLAB files you will be using for Analysis are in the folder on the lab computer that has been assigned to you.

To run the experiment, for each subject:

1. Open ISCAN and get setup (follow Operating Instructions...this can be found in your folder)
2. Launch power point and load Eye\_Experiment.ppt from the stimulus computer desktop
3. Explain to the subject that a series of images will appear on the screen for 30 seconds each and they are to visually investigate it freely.
4. Record separate 30 second runs for each image. (following operating guide)
5. Save the files as 'subjectID\_expt1'. Use an appropriate subjectID. (see Operating Instructions for details on saving as the proper file type, you want a .tda file in ASCII)

To plot data output on the images:

1. Transfer the .tda file to a flash drive and load it onto your computer, put the file in the folder that contains the AnalyzeEyes.m scripts
2. Open MatLab and set you current directory to your folder.
3. Run analyzeEyes.m and follow the command line instructions. The program will ask you to input your data, your image, etc.

4. You can analyze the data by quadrant, or by user defined regions. Use the save workspace option to save the processed data for further custom analyses.

## Part II: Saccadic Eye Movements and Smooth Pursuit

What is the difference between smooth pursuit, visual fixation, and saccades?

In this part, you will be presented with a point of fixation and asked to make a saccade from left to right as a point appears on the right hand side of the monitor. Next, you will be presented with a point of fixation that after a moment begins to move from left to right along the same horizontal axis. You will track the movement of this point with your gaze. You will plot the results in MatLab following the guidelines outlined below.

What do you expect the results of these tasks to look like? That is, how will the results from the two tasks compare?

Analyzing the data:

Just as you did in part one, save the file and transfer it to your computer using the flash drive. This time open the file in notepad, copy the data and paste it into an excel spreadsheet. Now, this time you will write the script to plot this data...

*To write a new script, you will need to create a new M file. File → new M file*

*First, you want to enter your data and assign it to a set of vectors. We will be plotting horizontal position vs. time for both the voluntary and smooth pursuit saccades, so these are the variables you need to create:*

`H_v = [paste horizontal position data here from run 1];`

`H_s = [paste horizontal position data from run 2];`

*Now, we need to create time vectors. The first column in your excel spreadsheet is sample#. Each sample is recorded every 16 ms. We will use this information to generate our time vector:*

`S_v = [paste raw sample # data here for run 1, the voluntary saccade];`

`S_v = S_v - min(S_v);` *(this line corrects for the fact that the sample # doesn't go back to zero after the first run...it redefines the previously defined variable)*

`S_s = [paste raw sample # data here for run 2, the smooth pursuit];`

`S_s = S_s - min(S_s);`

*Now we just multiply the adjusted sample vectors by 16 to get a vector of time in ms.*

`t_v = S_v * 16;`

```
t_s = S_s * 16 ;
```

Now that you have defined your vectors, it's time to plot the results. Let's start with one plot, then add another:

```
plot(t_v, H_v)
```

Save and run your script. If you were successful, you should see a plot. But, right now only you know what it means. Let's add some labels to our axes:

```
xlabel('time [ms]')
```

```
ylabel('horizontal position')
```

```
title('Voluntary Saccade')
```

Let's add the line for smooth pursuit now. In order to plot a second line on top of your first plot, you need to tell MatLab to **hold on** to the old graph. This is done by adding the line 'hold on' before plotting the next graph. You will also want to make the second plot a different color. This is done by adding a third command in the plot command, here we will make it red ('r'):

```
Hold on
```

```
Plot(t_s, H_s, 'r')
```

```
xlabel('time [ms]')
```

```
ylabel('horizontal position')
```

```
title('Smooth Pursuit')
```

Save and run your script. At this point, your script should look something like this (note that anything that follows the percent sign is not part of the code, these are comments, and are very helpful. Get in the habit of commenting your code). Obviously your code will have data:

```
%Saccadic Eye movements
```

```
%created by Rosa Lafer-Sousa on Feb. 20 2009
```

```
H_v = [insert data here]; %horizontal position for run 1: Voluntary saccade
```

```
H_s = [insert data here]; %horizontal position for run2: Smooth pursuit
```

```
S_v = [insert data here]; %sample# vector for run1
```

```
S_v = S_v - min(S_v); %adjusted to start at zero
```

```
S_s = [insert data here]; %sample# vector for run2
```

```
S_s = S_s - min(S_s); %adjusted
```

```
t_v = S_v * 16; %time vector for run 1
```

```
t_s = S_s * 16 ; %time vector for run2
```

```
plot(t_v, H_v)
```

```
xlabel('time [ms]')
ylabel('horizontal position')
title('Voluntary Saccade')
hold on

Plot(t_s, H_s, 'r')
xlabel('time [ms]')
ylabel('horizontal position')
title('Smooth Pursuit')
```

*Congratulations! You have just completed your first MatLab script.*

**Your Lab report:**

Your lab report should follow the same format as a standard scientific paper: abstract, introductions, methods/results, discussion, references. Combine your results from the two parts in one lab report. Your lab report is due two weeks from the day you complete the lab (please upload it to the course conference). In your lab report be sure to describe the different types of eye movements and which ones you observed. When considering the results from Part I, discuss the differences (if any) of the pattern of eye movements you observe when viewing the original versus the digitally manipulated images. Are there striking differences? How can you account for the differences in time you spend gazing at the different regions of the painting and the digitally manipulated version of the painting? How are the digital manipulations of the *Monk by the Sea* and the other painting you examined similar? Were the eye movement differences between the original and manipulated image the same for the two paintings? Do you think eye movements will be different between people of different cultures? Explain your reasoning. Finally, what predictions do you have about the impact eye movements will have on an artist engaged in making a painting? In addressing this last question you may find it useful to use a specific example (say drawing a still life).