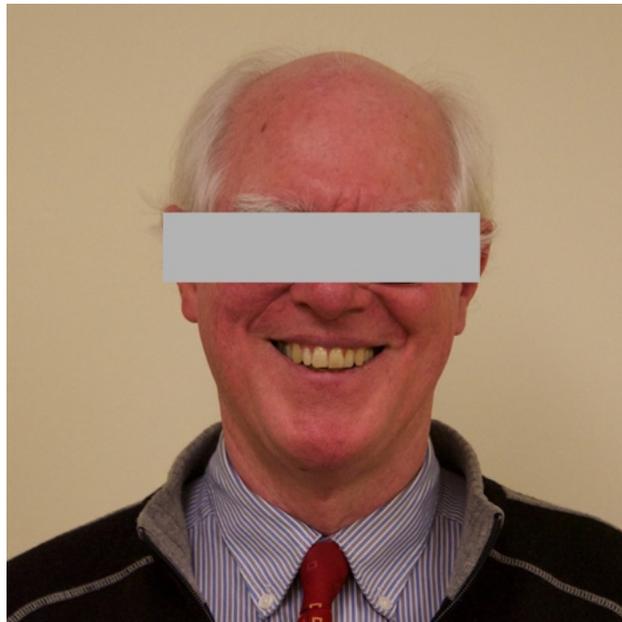


# Lab 1: Face Recognition and Signal Detection Theory: Are Eyes Important?

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## Overview of the Experiment

Recognition of human faces is a remarkably good. Even after 50 years have passed, people are able to choose which of two photographs is a high school classmate with an accuracy of almost 90 percent correct (H. P. Bahrick, Bahrick, & Wittlinger, 1975). The eyes and surrounding areas of the face are found to be very important for successful face recognition (Bruce & Young, 2012; Vinette, Gosselin, & Schyns, 2004). In this lab you will test the hypothesis that obscuring the eyes makes it more difficult to later recognize a face. Additionally, during lecture we have introduced two main theories that describe how observers detect stimuli: The High Threshold Model (HTM) and Signal Detection Theory (SDT). In this lab you will test the hypothesis that the SDT model makes better predictions of face recognition performance than does the HTM.

As before the experiment will be run under computer control using PsychoPy (J. W. Peirce, 2007, 2009; 2018). The experiment has 2 phases: (a) the learning phase, followed by (b) the test phase. During the learning phase, you will be shown a series of 64 photographs of faces to remember. Thirty-two of the faces have the eyes covered over and the other 32 are normal faces with the eyes visible. Study each face carefully during the 2 sec exposure time. Your face recognition memory will be tested with another series of 128 faces, half of which you have seen before and half of which you have not previously seen. All the test faces will be in full view (i.e., the eyes will not be covered). Your task is to decide on each trial whether or not the face had been previously seen. You will use a six-point confidence rating scale:

1. Confident it is a new face
2. Think it is a new face
3. Guess it is a new face
4. Guess it is an old face
5. Think it is an old face
6. Confident it is an old face

A six-point rating scale corresponds to having five different decision criteria (i.e., the boundaries between each confidence rating).

From your responses you will calculate five hit rate – false alarm rate (HR, FAR) pairs (one pair for each of these decision criteria) for the two types of faces (with eyes and without eyes. You will then compare how well the faces seen with eyes are remembered compared with faces seen without eyes. The two detection models will also be compared see which model better predicts the observed data.

This experiment differs from the Lab 0 Oblique Effect experiment in that the stimuli are external image files that PsychoPy imports and displays. You are provided a PsychoPy script that has been “broken” by removing some of the experiment components. After you “fix” the PsychoPy script, you will carry out a face recognition experiment. You will then use the software RScorePlus (Harvey, 2017) to fit HTM and SDT models, which we will then compare to determine which model best predicts the observed data.

By the end of this lab you will be able to:

- Add and edit properties of PsychoPy components (text, image, loop).
- Evaluate model goodness-of-fit using Chi-square and Akaike Information Criterion (AIC) statistics to test which model, the High Threshold Model or Signal Detection Theory, best predicts your observed data;
- Use Signal Detection Theory sensitivity measure,  $d_a$  to test whether seeing the eyes enhance your ability to later recognize faces;
- Compute and evaluate effect sizes using bootstrap analysis;

# The Face Recognition Experiment

## Testing the “Eyes Hypothesis”

To test whether seeing eyes during learning a face enhanced later recognition, we need some way to numerically represent recognition performance. Detection models provide a way of numerically representing the sensory process and the decision process. The High Threshold Model (HTM) represents sensitivity by  $p$ , the probability that a stimulus exceeds the “threshold.” The Signal detection model (SDT) represents sensitivity as the separation between the means,  $d'$  or  $d_a$  of the probability distributions that represent the various stimulus conditions of an experiment. In the lab, we will calculate the sensitivity,  $p$  under the high threshold model (Equation 1 in the Detection Theory Handout) and sensitivity under the generalized signal detection model ( $d_a$ ) (Equation 9b in the Detection Theory).

## Sensitivity Description Formulae

Model	Sensitivity	Equation
High Threshold	$p = \frac{HR - FAR}{1 - FAR}$	Equation 1
Signal Detection	$d_a = \sqrt{\frac{2}{1+b_1^2}} (z(HR) - b_1 z(FAR))$	Equation 9b

where  $b_1$  is the slope of the straight line that best fits the z-score hit rate and the z-score false alarm rate.

The term sensitivity in perception research refers to the ability of an observer to make correct judgments and avoid incorrect judgments (Macmillan & Creelman, 2005, McNicol (1972)). In this experiment, both  $p$  and  $d_a$  measure a subject’s ability to discriminate (e.g., “tell the difference”) between new and old faces during the test phase. A higher  $p$  or  $d_a$  indicates a greater sensitivity; a lower  $p$  or  $d_a$  indicates a lower sensitivity. We’ll compare these measures from the two learning conditions: (a) faces with eyes visible during learning (eyes), and (b) faces with eyes obscured during learning (noEyes).

## Testing the “Model Hypothesis”

We will also examine which model (HTM or SDT) provides a better fit to the face recognition data. One widely-used measure is the Akaike Information Criterion (AIC) (Leeuw, 1992, Akaike (1974), Akaike (1973)). Since the parameters of each model were computed using a maximum-likelihood regression, the appropriate test is to calculate how well each model predicts the six response frequencies under the three stimulus conditions (new faces (s0), old faces without eyes (s1) and old faces with eyes (s2)).

## Lab Instructions

### Download *Lab 1 Tools* from the course website

1. In a web browser, navigate to the course webpage and double click on Lab 1 Tools. The folder will download to your computer;
2. The file is a zip archive and should automatically be unzipped;
3. Move the Lab\_1\_Tools folder from the Downloads folder into a Lab\_1 folder (where you keep all the files for this lab) on the Desktop. Keep all your working files and folders in the Lab\_1 folder on the Desktop, that way you won’t overlook a crucial file when you logout!

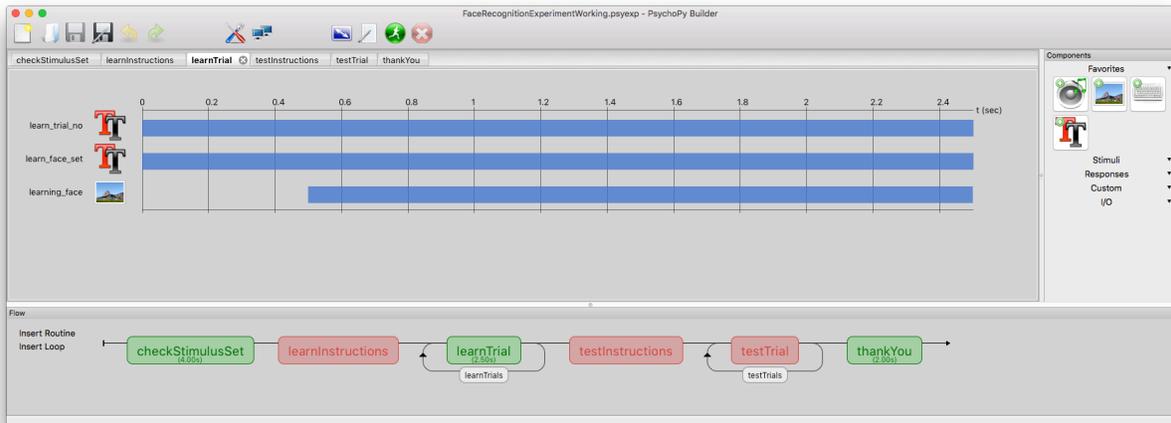


Figure 1: Flow panel for the 'fixed' FaceRecognitionExperiment.psyexp PsychoPy experiment

## Start the PsychoPy2 application, and open the Face-Eyes experiment:

From the File menu, Open Lab\_1\_Tools > Face-Eyes exp > FaceRecognitionExperiment.psyexp This PsychoPy script has been “broken” by removing a few components, and you will need to make a few minor additions before taking this experiment. To fix the experiment, you will add

- a text component for instructions
- an image component for picture display
- a loop to run more than one test trial

First, take a look at the Flow panel at the bottom of the Builder view. The Flow panel is shown in the lower part of Figure 1.

This experiment has 5 Routines (shown as red or green rounded boxes), and should have 2 Loops (shown as black arrows looped around the `learnTrial` routine and `testTrial` routine). You'll note that your Flow view does not match that shown in Figure 1; the `FaceRecognitionExperiment.psyexp` is missing the `learnTrials` loop, which you will add. You will also have to add the other missing components inside routines.

**When adding components, be certain that you have selected the correct routine!!!!**



Figure 2: The Text component is the one with the red and black Ts, encircled with a red ellipse in the figure. Click on this icon to add a text component to a routine.

## Fix the PsychoPy Script

### Add Instructions to `learnInstructions` Routine

- In the Builder view, select the `learnInstructions` routine.
- Add a `Text` component to the `learnInstructions` routine by clicking on the Text icon with the red and black Ts in the *Components* panel (right hand side) of the PsychoPy window. See Figure 2.
- Edit the settings for the new text component. All the correct settings are shown in Figure 3. Be absolutely certain that your Text Properties window looks exactly the same as in Figure 3.
- Type the following instructions into the large field labeled `Text`:

"You will be shown 64 faces for 2 sec each. Try to remember each face. You will be asked to recognize them later. Press space key to continue."

### Add Image Component to the `learnTrial` Routine

- Add an Image component to the `learnTrials` routine. Select the `learnTrial` routine (it is green). Click the add Image icon in the Components panel. It's the icon with a picture; see Figure 2.
- Edit the settings for the new Image component.
- Rename the new Image component to `learning_face`.
- All the correct settings are shown in Figures 4 and 5.
- In the Image field, note the dollar sign before Stimulus. The dollar sign tells PsychoPy to find the actual name of the picture file from a column in the Excel conditions file labeled "Stimulus".
- There are two tabs for the Image component: Basic and Advanced. Verify that the settings agree in both Basic (Figure 4) and Advanced (Figure 5) tabs.

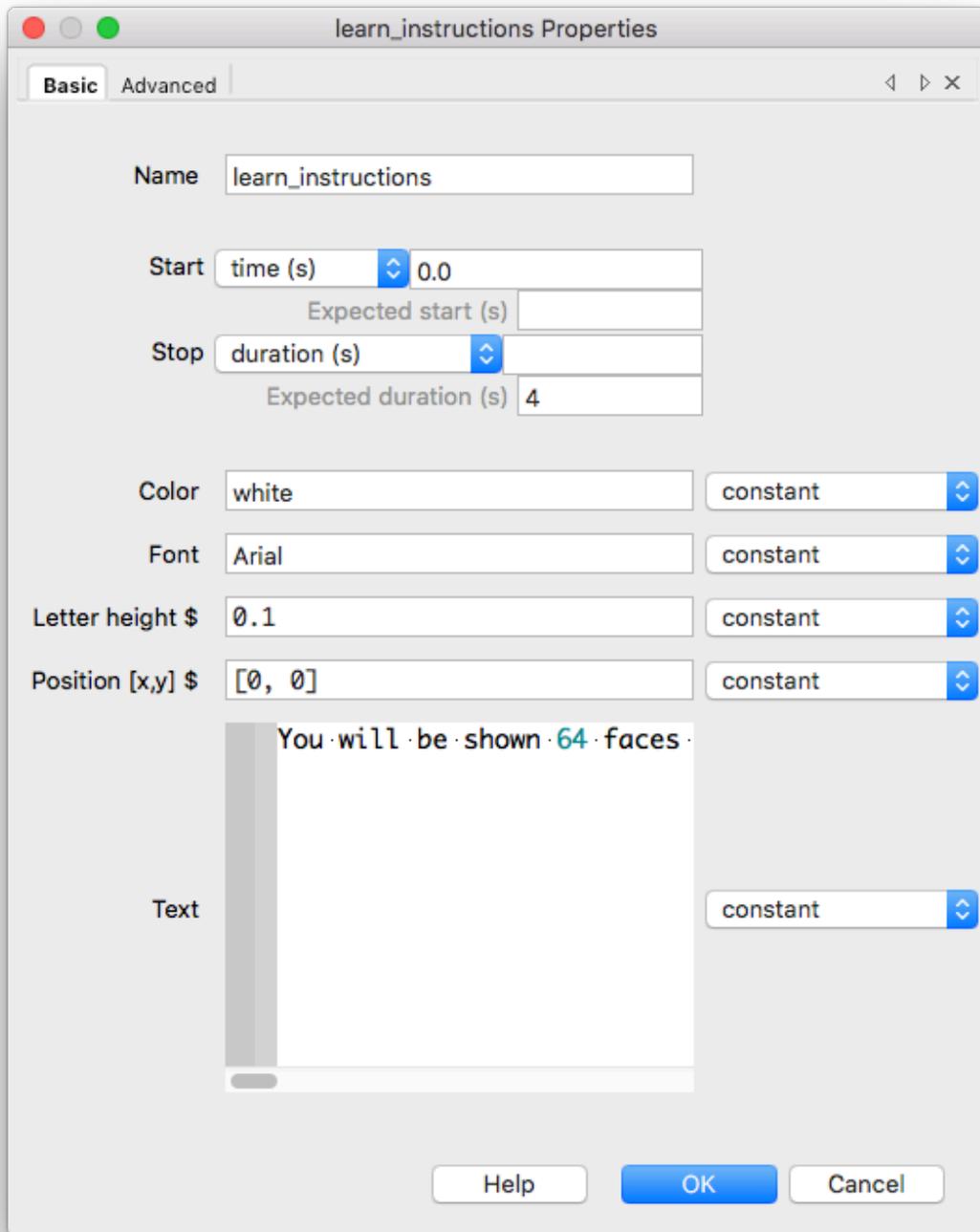


Figure 3: The properties for the Text component 'learn instructions'.

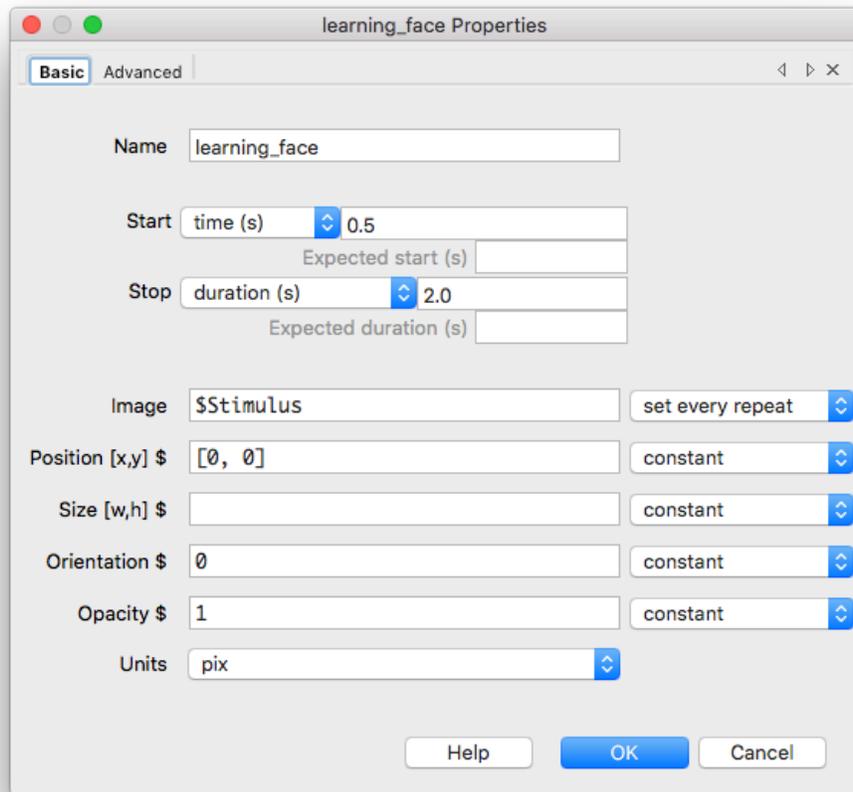


Figure 4: The properties for learning face (Basic tab).

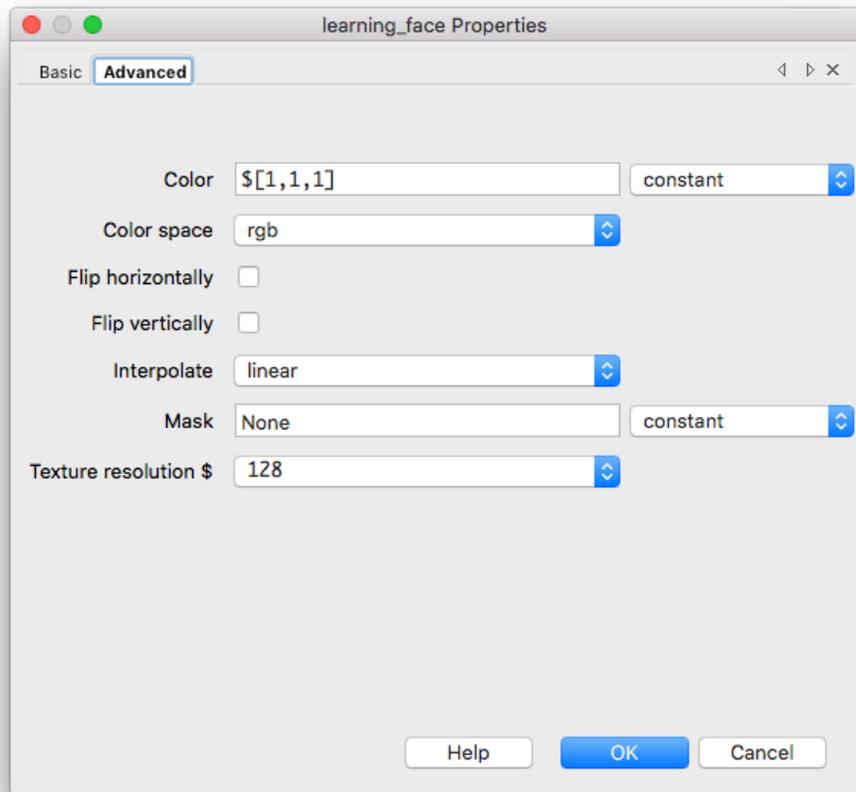


Figure 5: The properties for learning face (Advanced tab).

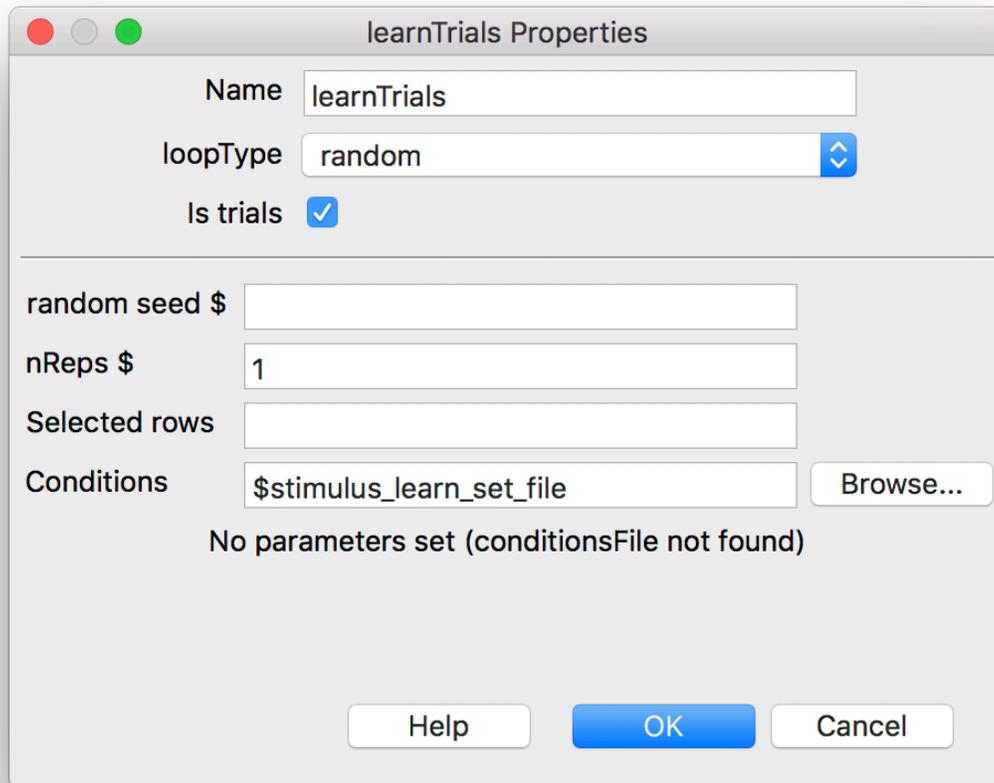


Figure 6: The properties for learnTrials loop.

## Add a Loop Around the learnTrial Routine

- In the Flow panel, click Insert Loop (down on the left side)
- You'll see a black dot on the experiment Flow. Move the mouse so that the dot is to the left of the `learnTrial` Routine, click to set one end of the loop at that location.
- Move the mouse so that the other end of the loop (indicated by the black dot) is immediately to the right of the `learnTrial` Routine (see Figure 1 for the correct placement of the learnTrials loop).
- Loops have properties as well. The correct properties are shown in Figure 6.
- To set the condition field type the text below exactly as it appears into the field:

`'$stimulus_learn_set_file'`

- Confirm that your settings look exactly like Figure 6. **Save your changes.**

## Run the Experiment

Click the Run button. In the dialog box that appears (see Figure 7) you will see four items.

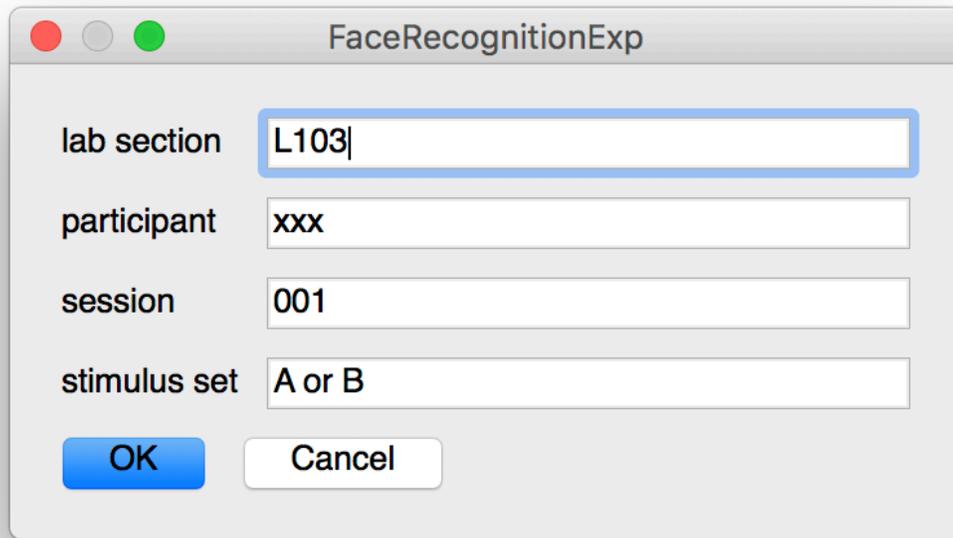


Figure 7: Experiment Dialog screen.

- lab section: it should be L103 for Tuesday and L104 for Thursday. Edit if necessary.
- participant: replace the xxx with your own initials.
- session: Don't change it
- stimulus set: Type A or B depending on your birthday
  - If your birthday is on an odd numbered day, enter A.
  - If your birthday is on an even numbered day, enter B.

Click OK when you are ready to start the experiment. The experiment will take about 20 to 30 minutes.

Your data will be automatically saved in the data folder in a text file whose name starts with your initials with the date and time added to it. The file extension is csv (comma-separated values). After the experiment has finished you can double-click on the file to open it in Excel to examine it. There should be 193 rows in the csv data file. Do not modify this data file. It represents a lot of judgments and work on your part.

To help you keep track of your data, PsychoPy names outputted .csv files with participant initials, followed by a timestamp: For example, below is the filename for subject smp, who took this experiment January 15, 2016 at 12:50 PM.

*smp\_2016\_Jan\_15\_1250.csv*

If your csv data file looks complete, upload it to the Canvas Assignment dropbox *Lab 1 csv data file*. You may now quite PsychoPy.

## Individual Data Analysis

Now that you have uploaded your own csv data file to Canvas it is time to take a look at the file. Download the **Lab 1 Report Template** folder from the course website and put it into your Lab 1 folder on your desktop. This template is very similar to the one you used for Lab 0. Place a copy of your csv data file (the one you uploaded to Canvas) into the Report Template `additional_files` folder

The raw data from this experiment are the number of times (the frequencies) that you used each of the rating categories under the three stimulus conditions (new faces, old faces without eyes, and old faces with eyes). Your data analysis begins with a series of transformations of the raw data through the following sequence (exactly like you did in Part 2 of Homework 2:

1. response scale frequencies;
2. response scale probabilities;
3. cumulative probabilities (hit rates and false alarm rates);
4. z-score transformation of the cumulative probabilities.

These transformations will be carried out by a special signal detection computer program, `RscorePlus` (Harvey, 2017), but you first have to compute the frequencies of each rating scale number that you used. We have an R script for that located in the `additional_files` folder of the Report Template: it is called `lab1_ProcessRawData.Rmd`.

To tabulate the number of times you responded 1, 2, 3, 4, 5, or 6 to the three different signal conditions (`s0` = new faces; `s1` = old faces seen without eyes; `s2` = old faces seen with eyes, open the R markdown file `lab1.1ProcessRawData.Rmd`. Read the text carefully, change the name of the input file to match your data file name (the csv file you uploaded to Canvas) and execute the code. The script will produce an output file with your initials and a `.txt` extension in the additional files folder. It will also open the `RscorePlus` application on the Mac (Harvey, 2017). The window should look like Figure 8. Click on the blue ‘Open Data File’ button and locate the `*.txt` file produced by the raw data script. Then select the Gaussian Model and click on the ‘Fit Model to Data’ button. Now select the High Theshold Model button and click on the ‘Fit Model to Data’ button a second time. `RscorePlus` will create four new files in the Additional Files folder for each of the two models. The names of these files will need to be inserted on lines 30-33 in the `my_lab_1.5a_Individual_Results.Rmd` file of your lab report.

Now you can select the `Run All` command from the `Run` tab of the edit pane; it is at the top on the right side. If all goes well R Studio will execute the R code in each of the code chunks in sequence and any output produced by the code will appear below the chunk. Scroll down the the file until you find graphs. We will walk you through this process and explain what it all means.

If all the code is working you are ready to produce a beautifully formatted pdf document. Just click the `Knit` tab at the top left of the edit pane. R Studio will produce a polished, formatted pdf file that contains your text and the output of the R code in the chunks. Next week we will work on analyses of the group data in order to produce a complete lab report.

## Complete Lab Report

Next week you will produce a complete lab report once we have assembled the group data from the class, as we did for Lab 0. This report will include the title page, short abstract, introduction, methods, results, discussion and reference sections that make up a standard American Psychological Association (APA) journal article. Check out the *Sample APA Manuscript (Guide)* that is posted on the course website:

[http://psych.colorado.edu/~lharvey/P4165/P4165\\_2018\\_3\\_Fall/Main\\_Page\\_2018\\_Fall\\_PSYC4165.html](http://psych.colorado.edu/~lharvey/P4165/P4165_2018_3_Fall/Main_Page_2018_Fall_PSYC4165.html)

You will use the APA journal article format for all lab reports during the semester. Next week we will provide you with the results of every person in the class and guide you through an analysis of these group data for inclusion in the final lab report.

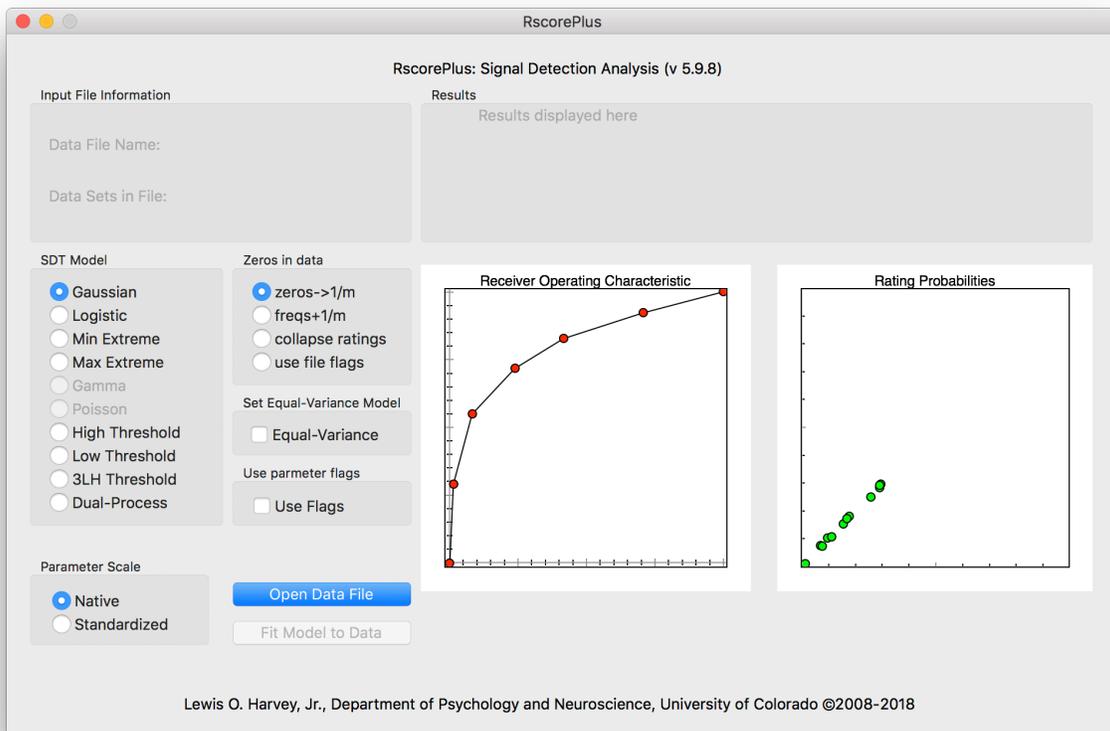


Figure 8: The main window of the RscorePlus application. Click on the blue 'Open Data File' button and locate the \*.txt file produced by the raw data script. Then select the Gaussian Model and click on the 'Fit Model to Data' button. Now select the High Theshold Model button and click on the 'Fit Model to Data' button a second time

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