

# Lab 5: Cognitive Control I

## Student Worksheet

### Overview

This is the first of a 2-part lab exploring cognitive control. In today's lab you will learn about Stroop Interference and Flanker Interference tasks. Then you will work in groups to design your own interference experiment (each group will complete a homework assignment, working together). In next week's lab, you will finish building your experiment, collect data, analyze the data, and concisely present your results.

### What is Cognitive Control?

We are constantly perceiving and responding to stimuli in the world around us. Much of this happens automatically (from instinct or learning), and some of it unfolds deliberately with focussed attention and effort. An excellent way to explore cognition is by investigating cases where automatic and deliberate processing conflict. What happens when your mind is pulled in two mutually incompatible directions? How is conflict resolved? What is the time course of conflict and resolution? We will be thoroughly considering these questions through experience with tasks, discussion, and designing new experiments.

### Experience Stroop Interference

Perhaps the most extensively examined task in psychology is the Stroop Interference task. Carefully follow these instructions to experience the task and analyze your own data.

- 1) Go to [lab.TeLLab.org](http://lab.TeLLab.org)
- 2) Log in (or Register, if you haven't already)
- 3) On top right, click **Experiments**.
- 4) Choose **Stroop**. Choose **Stroop Test (Princeton 101)** by clicking the chain-link icon to start the experiment (fyi, the two-pages icon copies an editable version of the experiment to your account — you will use this when building your group's experiment next week).
- 5) *Participate in the experiment.*
- 6) On top right, click **MyHome** —> **MyExperiments**. On the left, under "Experiments Completed," and Stroop Test (Princeton 101), click **Long Format**. This will download your data as a .csv file.

### Analyze Your Own Data

- 1) Getting Started
  - Open your .csv data file into Excel.
  - Save your file with an informative name as a .xlsx file (e.g. LastName\_Stroop.xlsx)
  - Create a new worksheet (on bottom tabs, click "+" tab), and name it AnalyzeData. Copy and paste all the data into AnalyzeData worksheet. Then lock the original data to protect it from being updated (hold option key and click worksheet tab, select "Protect Sheet"), so you can easily reproduce your analyses from the beginning, if needed.

## 2) Viewing Raw Data

- Spend a few minutes orienting to the data file.
  - What information is in each column and row?
    - How do rows correspond to your experience in the experiment?
    - What rows are instructions, what rows are practice trials, and what rows are experiment trials?
  - Are there any columns that are useless (no info, or identical value in every row)?
    - If so, minimize these columns to lower the clutter.
  - What column contains a description of the stimuli?
  - What column contains response times? What is the unit of time being used?
  - Note that column K (frameName) codes for instructions, practice, and the two conditions.: image\_baseline cells are in trial rows that presented colored rectangles and no words, image\_inc are incongruent trials with mismatching ink and words; the “html” cells are in instruction rows, and image\_prac are practice trials.

## 3) Analyzing Your Data

- The trials in this experiment are grouped by condition into blocks. Incongruent trials were first, and baseline trials were second. Can you think of any way to improve on this design?
- Calculate the mean response time for each of your two experimental conditions, (using the =average function in Excel). Which condition has a faster response time? What is the standard deviation of the response times for each condition? Run a t-test over the response times for the two groups. It will output a p-value. Is the p-value less than .05 (i.e. significant)?
- Try running some exploratory analyses.

## Discuss Stroop & Experimental Design

Your lab instructor will now provide additional background on the Stroop task and cognitive control. If you are waiting for classmates to catch up, you can read ahead and start thinking about how to design a great experiment...

### Experimental Design

- The best experimental designs eliminate all differences — except for the independent variable (IV) — between two conditions.
- What were all the differences between the conflict (color words) and baseline (color rectangle) trials? Stimuli? Instructions? Practice? Task order?
- Any difference between conditions other than the independent variable is considered a potential confound. A confound might impact your results.
  - It could produce the same pattern of results that you hypothesized for a reason other than what you attempted to test.
  - Or, a confound could produce a pattern opposite to what you hypothesized, obscuring a real effect of your independent variable.
  - Which pattern do think is more problematic?
- Again, the best experimental designs eliminate all differences — except for the independent variable (IV) — between two conditions. How would you improve the Stroop Test experiment to eliminate potential confounds?

## Generalize With New Tasks and More Conflict

Participate in 3 more Interference tasks on TeLLab in the Stroop Test collection. Flanker Arrows (Princeton 101), Flanker Letters (Princeton 101), and Spacing Flanker Arrow (Princeton 101).

Which of these tasks felt like it produced the greatest amount of conflict and required the most cognitive control to overcome? (If you want to know whether your experience is consistent with your data, download your results and analyze them.)

Interference tasks provide an excellent design for a variety of research questions:

### A) Perceptual Automaticity

If you want to know whether a certain kind of information is automatically processed, even when you are trying to ignore the stimuli, the signature slowed reaction times of conflict can provide a window into this automaticity. From extensive learning we automatically process letters, words, and certain symbols (like arrows). What information do we automatically process from faces: emotion? identity? age? What information do we automatically process from objects: living versus non-living? real world size? safe versus dangerous? How could you test these questions with a flanker interference task?

### B) Selective Attention

What properties of stimuli can we use to effectively filter out information and ignore irrelevant items? If the flankers are distant from the central item, does that reduce conflict? If the flankers are a different color than the central item, does that reduce conflict? If the flankers are above and below versus on the left and right, does that change the amount of conflict? Which Gestalt grouping principles produce the greatest difficulty for isolating the central stimulus?

### C) Response Associations

Some responses are easier to associate with stimuli than others, either from instinct or learning (or both). You might be faster to make a forward reaching response for food stimuli, and a backward motion response to snake stimuli. If you need to respond to something on the top of the screen by pressing the down arrow, and the bottom of the screen by pressing the up arrow, it might slow you down (compared top-up, bottom-down). An experiment can directly test stimulus-response associations. However, for this experiment we will be controlling for such potential associations by holding the response options constant between conditions.

## Groups Design a New Interference Experiment

You will be assigned to a group to design a new experiment.

### Choose a Question

Consider the kinds questions categorized above as Perceptual Automaticity and Selective Attention, while controlling for Response Associations. What kind of question do you want to investigate? What specific cognitive processing are you most interested in? What task and stimuli are best suited to exploring your question?

## Design Your Conditions

In an interference task you usually compare 2 (or more) experimental conditions. For example you might compare performance on trials with all matching stimuli (often called Congruent) to trials with mismatching stimuli (Incongruent), testing to see if the mismatch generates conflict and slower reaction times. You also might want to include a baseline condition with a single stimulus on the screen — this lets you test if multiple matching stimuli or sources of information, provides an advantage over a single stimulus, or a disadvantage if extra stimuli are simply distracting. For more sophisticated designs, you might test levels of conflict (e.g. comparing incongruent flankers that appear near the central item to those that appear further away). Your experimental conditions are different precisely in terms of the independent variable you are testing. In every other way, you want the conditions to be similar — i.e. controlled. After selecting your key independent variable, consider how you will equate/control all other aspects of the trials between your two (or more) conditions.

## Understand Your Design

What pattern of results do you expect to obtain? What are alternative possible patterns of results (draw figures to explore)? How would you interpret each possible pattern of results? Which pattern(s) would be the most informative and interesting? It's most exciting to run a new experiment when you aren't certain how the results will turn out — this is an opportunity for discovery!

# Homework

## Stimuli, Instructions, and Experimental Design Figures

For your lab homework this week, you will be working with your group to finalize ALL details of your experimental design, instructions, and stimuli. Before next lab you will finish creating all your stimuli, write task instructions, and make 2 figures that clearly summarize your experimental design. Bring these completed materials with you to next week's lab.

### Stimuli

You should design stimuli for every single trial in your experiment, with each trial created as an image file 640x480 pixels in size. (You will probably present the same trial multiple times, intermixed with other trials in a random order.)

To create stimuli, you can use whatever software you like. However, we recommend **Creating** your trials as slides in Keynote (or Powerpoint), then **Exporting** as (or Save as) Images to .png format, and then opening and **Resizing** all the image files to 640x480 pixels.

### Instructions

Write clear, concise instructions for your experimental task. Look at example experiments for guidance.

### Two Experimental Design Figures

The purpose of your experimental design figures is to clearly and concisely communicate what your experiment is testing. One of the figures should include sample stimuli and condition information. A second figure can communicate the task sequence (e.g. blocked by condition like the Stroop task, randomly intermixed trials like the Arrow flanker task, or the second figure can communicate the possible patterns of results for the experiment. Some samples are below, but your design might be a little more complex (e.g. more than two conditions).

