Perception Lab

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Table of contents

Welcome

Welcome to Prof. Dr. Lauren Fink's Perception Lab (PNB3EE3) course in the Dept. of Psychology, Neuroscience & Behaviour at McMaster University. This is a hands-on, skills-based course to expose you to the "real world" of research related to human perception. Throughout the course, you will research your own topic of interest (using primary scientific literature), design an experiment to test a hypothesis, pre-register your experiment in an industry-standard way, program (using computer code) your experiment, pilot test and simulate data for your experiment, and analyze data from your experiment (using computer code). Prior programming experience is not required but you must have a strong willingness to dive in and learn! We are here to help!

The course does not provide a thorough background on what Perception is. You already received that in your second year required coursework. Here, we are more focussed on research skills.

Learning Goals

Upon completing the course, you should be able to:

- Explain the fundamentals of human perception research, including how researchers can measure perceptual experience.
- Read, understand, and critique primary scientific research literature.
- Design and test your own research ideas, including programming basic web-based perception experiments.
- Understand best practices in open science and use relevant tools, like GitHub, R, and jsPsych.
- Work with data; visualize and analyze results.
- Write, discuss, and review primary research reports.

Course Structure

All course content and assignments will be posted on this website. However, you will turn in assignments through GitHub and/or Avenue to Learn. Don't worry, you don't need to know what GitHub is yet! We will discuss it in class on day one. The reason we use GitHub is

because many researchers around the world use GitHub every day in their scientific workflows, whereas Avenue is a tool somewhat specific to your undergraduate education. We feel that familiarizing you with GitHub early-on will benefit you as you look for research opportunities or even industry jobs in the future.

The course outline is here. It contains an overview of all assessment criteria and relevant institutional policies. A more detailed weekly schedule, with deadlines for each assignment is available here.

Every week in class, there will be a lecture component and a hands-on component. You are expected to come to class prepared for discussions about the assigned readings and with assignments completed. Often, we will go over assignments together and discuss any points of confusion. Attendance and participation in class and tutorial is important.

The website you are currently viewing is a Quarto book containing all materials for the couse. The book consists of markdown and executable code. A first draft was created for Winter Semester 2025. It is a work in progress and under continual development alongside iterations of the course.

Use the navigation bar at the left to view course contents by week (number) and topic. While most contents are nested within week, important documents (like the course outline) have their own top-level heading page.

Contributing

Teaching assistants and students are welcomed and encouraged to contribute to this course-Book – if you spot an error or see room for improvement, create a pull request and I'll be happy to review and incorporate the requested change.

Course Outline

Your browser does not support iframes. Download PDF

Weekly Schedule

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Resources

Below are resources organized by topic: jsPsych, R, and Experimental Design. If any of you come across a great resource not listed here, please feel free to create a pull request to add it!

jsPsych

- The online documentation is a great resource. For example, you can check out references like this one: https://www.jspsych.org/7.3/reference/jspsych-randomization/ or this one: https://www.jspsych.org/7.3/plugins/survey-multi-choice/
- This page links lots of additional tutorials and lectures you can watch: https://www.jspsych.org/7.3/tutorials/video-tutorials/
- You can also check out plugins written by other researchers. For example, here is a paper describing a psychophysics plugin: https://link.springer.com/article/10.3758/s13428-020-01445-w
  - And here is the code tutorial to accompany that paper: https://jspsychophysics.hes.kyushu-u.ac.jp/
- And here is a paper from the original authors of jsPsych, talking about a new simulation mode they have built: https://osf.io/preprints/psyarxiv/mq345
  - The code: https://jspsych.github.io/simulation-examples/

R

- R for Psych: https://glennwilliams.me/r4psych/
- R graphics cookbook: https://r-graphics.org/
- R for data science: https://r4ds.hadley.nz/
- All of the above are books with excellent tutorials that you can work through at your own pace. I highly encourage you to check out these resources, as they will show you how to do everything you could possibly need to do with your data this semester.

Experimental Design

In case any of you need/want a little reminder of the basics of experimental design, here is a nice resource https://opentext.wsu.edu/carriecuttler/chapter/experiment-basics/

> I encourage you to click "content" in the top left of that link and read through any other sections of the book that you may need a refresher on.

The course textbook, Experimentology, is another great resource.

Week 1

Introduction

In the first week of the course, we will set ourselves up for success in the remainder of the course!

Our goals are to:

- introduce ourselves, and our research interests, to each other
- review some fundamentals of perception and experimental design
- become familiar with the utility of git and GitHub

Slides from this week are available here. NOTE: You need to log in to Avenue to access the slides.

> ! Assignments and Exercises
>
> **Before next class**
> Please work through the Environment Exercise (linked here).
> Additionally, please read chapters 1-4 from Experimentology:
>
> - Chapter 1: Experiments
> - Chapter 2: Theory
> - Chapter 3: Replication
> - Chapter 4: Ethics
> - Appendix B: Git and GitHub

Environment Exercise

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Background learning

Throughout this course, we will be working with code and data. It might be the first time you have ever done these things! That is exciting! Luckily, you do not need to start from scratch. There are many pre-made tools available to help you!

Before we get starting downloading and installing tools, it's important to understand some basics:

The difference between your local computer and the cloud:

- https://www.geeksforgeeks.org/difference-between-cloud-computing-and-traditional-computing/

Using the command line:

- https://tutorial.djangogirls.org/en/intro_to_command_line/
- https://www.freecodecamp.org/news/command-line-for-beginners/

  NOTE: read through this but don't worry about stepping through the scripting example at the end

Git vs. GitHub:

- https://www.theserverside.com/video/Git-vs-GitHub-What-is-the-difference-between-them
- https://experimentology.io/101-github.html

  NOTE: read through this but don't worry about stepping through the scripting example at the end

Setting up your local computing environment

Now that you've got the appropriate background reading out of the way, let's get started with the tools we will need for this course! Please follow the steps below before coming to the first class or tutorial.

1. Download an integrated development environment (IDE) for working with code. If you already have a preferred IDE, feel free to keep using that one! If this is your first time encountering the idea of an IDE, some nice options are:

- Visual Studio Code: https://code.visualstudio.com/
- R Studio: https://posit.co/downloads/

2. Using your terminal or console, make sure git is installed on your machine: https://github.com/git-guides/install-git

3. Sign up for a GitHub Education account using your McMaster email address: https://github.com/education

   NOTE: The application process for Github Education takes a few days, so please sign up as soon as you can. GitHub Education gives you lots of nice (free) perks and learning tools!

4. Depending on the IDE you have chosen and your comfort with the command line, you may not want to use any other tools (e.g., many IDEs have built-in integration for git and GitHub). If all of this sounds super confusing, you can use GitHub desktop OR Github CLI to streamline the process of pushing changes from your local machine to the GitHub cloud.

5. On your computer:

- create a new directory (folder) in your `Downloads/` location (or any other location that is not synced with an online cloud storage like iCloud or OneDrive). Name the new folder as 'PNB3EE3'
- within this folder, create another folder called 'Lastname_Firstname_assignments' – in my case, the folder would be called 'Fink_Lauren_assignments'
- within this folder create a file called 'environmentAssignment.html'
- open this file in the IDE you downloaded earlier (in step 1)
- in the environmentAssignment.html file, add the following lines:

```
<!DOCTYPE html>
<html>
<body>

<h1>My First Heading</h1>
```

```
<p>My first paragraph.</p>

</body>
</html>
```

- Now, replace "My First heading" with "What I learned today".
- Next, replace "My first paragraph" with a few things you learned by completing this tutorial.

6. Be sure to come to the first class with all of the above completed. During the first class, we will discuss all of these concepts further and show you how / where to submit this first exercise. If you've run into issues throughout this process, don't worry, we will help you troubleshoot any issues!

Week 2

Open Research

This week we will focus on recommended best practices for transparent and open research.

Our goals are to:

- review the replication crisis and the importance of open research practices
- understand the value of web-based experiments in Psychology
- introduce web technologies for conducting online experiments

Slides from this week are available here. NOTE: You need to log in to Avenue to access the slides.

> ❗ Assignments and Exercises
>
> **Before next class**
> Please work through the jsPsych 1 assignment (linked here).
>
> > NOTE: this assignment will require substantial reading and thought - do not put it off until the last minute!
>
> Additionally, please continue thinking about a topic in Perception research (broadly defined) that is of interest to you for your individual project.
> Required reading from Experimentology:
>
> - Chapter 5: Estimation
> - Chapter 6: Inference
> - Chapter 7: Models

jsPsych Assignment 1

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The purpose of this assignment is to get you more familiar with web technologies and why we might want to use the web for perception-related experiments.

This is more of a reading, thinking, and practicing exercise. There is no final document to submit besides the reflection questions below. That means that, yes, you could fake doing this assignment by answering the questions below. But–I assure you–your performance in the course will hugely benefit from you taking the time to go through the steps outlined below. We will use jsPsych in the remainder of the course and if you do not form a solid foundation now, all future assignments will be more difficult!

Your tasks

Read these 2 journal articles:

This article provides context for why web-based research is important in psychology.

> Reips, U. D. (2021). Web-based research in psychology. Zeitschrift für Psychologie. Available from: https://psycnet.apa.org/fulltext/2022-17584-002.pdf

This article introduces jsPsych–a tool for web-based research.

> De Leeuw, J. R. (2015). jsPsych: A JavaScript library for creating behavioral experiments in a Web browser. Behavior research methods, 47, 1-12. Available from: https://link.springer.com/article/10.3758/s13428-014-0458-y
>
> NOTE: You do not need to go through the tutorial included in the text (We will do a more up to date tutorial later!)

Read ALL of these short blog posts:

All of these provide basic background information on web technologies and programming.

How does the internet work?

- https://developer.mozilla.org/en-US/docs/Learn_web_development/Howto/Web_mechanics/How_does_the_Internet_work

HTML, CSS, and javascript

- https://medium.com/@ankurdhamija83/web-development-basics-understanding-the-concept-of-html-css-and-javascript-1fc24a07719f

No-code introduction to programming

- https://jaeyoungson.com/posts/2021-07-12-no-code-intro-programming/

What is javascript?

- https://developer.mozilla.org/en-US/docs/Learn_web_development/Core/Scripting/What_is_JavaScript
- https://developer.mozilla.org/en-US/docs/Learn_web_development/Core/Scripting/A_first_splash

jsPsych plugins

- https://www.jspsych.org/7.0/overview/plugins/
- https://www.jspsych.org/7.0/plugins/list-of-plugins/

Answer these questions

Please answer the following questions (in <= 1 paragraph). Each answer is worth two points. 2 points will be awarded if the answer is coherent and without errors. 1 point will be awarded for a partially correct answer. 0 points for an empty or almost completely incorrect answer. This assignment is worth 8% of your final grade in the course. Generative AI (e.g., chatGPT) should not be used to complete any part of this assignment. These questions should not be difficult if you have read the materials above. If you are having trouble, consider revisiting the readings.

1. What is the difference between closed-source, proprietary code and open-source code?
2. Why should psychologists care about web technologies and open source code?

3. Please briefly describe the difference between HTML, CSS, and javascript. What do each of these do?
4. How would you define data types? Why are they important in computer programming?
5. Imagine you want to program an experiment where participants need to complete 2 tasks, 10 times each. Using pseudo code, please describe how you would program this task. If you need an example of pseudo code, be sure you have read the no-code introduction to programming above.
6. Imagine you want to use the visual-search-circle plugin in a jsPsych experiment. Please provide the HTML code required to load jsPsych and this particular plugin. HINT: your answer should only be four lines of code!

To submit your answers to these questions, please use the following form: https://forms.office.com/r/Y5wtA5B3GS

Week 3

Open data

This week we will get into the weeds about data. Danica Evering from McMaster's Research Data Management Services will join us for a lively discussion and in-class exercise using one of McMaster's recently developed data exploration tools.

Our goals are to:

- understand what is meant by open data, as well as potential barriers to publishing open data
- discuss best practices in data management
- explore the wealth of datasets freely available online

Slides from this week are available here. NOTE: You need to log in to Avenue to access the slides.

> ! Assignments and Exercises
>
> **Before next class**
> Work on jsPsych Assignment 2
> Required reading from Experimentology:
>
> - Chapter 8: Measurement
> - Chapter 9: Design
> - Chapter 10: Sampling

jsPsych Assignment 2

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Assignment instructions

The goal of this assignment is to familiarize you with the basics of setting up experiments in jsPsych.

There are multiple steps to this assignment.

1. Create a new folder for this assignment called "JsPsych_2_assignment".
    - Hint: Create this folder inside your local clone of the Github repository so the changes are tracked by git.
2. Complete the Hello World tutorial. Use 'Option 2: Download and host jsPsych' and follow the same directory structure as shown in the example.
    - Note that in the class, we completed this tutorial with Option 1.
3. Complete the Reaction Time tutorial. Please use the downloaded JsPsych library (`MyExperiment/jspsych/`) from previous step to import jspsych scripts instead of using the CDN method.
    - If you are struggling with this tutorial, or you just want some additional reinforcement of the concepts you are learning, watch this video tutorial. Towards the very end of the video the speaker also shows how to import JsPsych scripts from the local machine.
4. Create a copy of the reaction time tutorial and name the file `myNewExperiment.html`
5. Make sure that both your experiment html files and the related assets (images) are inside the `MyExperiment/` folder (created in step 2), which should also contain your downloaded JsPsych library inside `jspsych/`.
6. Make the following changes to the new experiment (myNewExperiment.html):
    - Make the diameter of the orange circle half of its current diameter.

- Change the blue circle to a blue square.
- At the end of the experiment, add feedback regarding how fast participants' reaction times were for the blue squares vs. orange circles.

7. Add a `README.md` file to this folder so that we can understand anything critical to making your code run.
8. Push all changes to your GitHub repository.

Week 4

Experimental Design

This week we will focus on various aspects of experimental design and continuing adding to our jsPsych knowledge.

Our goals are to:

- understand the choices involved in experimental design
- program a first basic experiment in jsPsych
- continue discussing perception research

Slides from this week are available here. NOTE: You need to log in to Avenue to access the slides.

! Assignments and Exercises

Before next class
In tutorial and next class we will go over this data visualization exercise (linked here).

NOTE: Reading Ch. 15 will help you with the exercise!

Required reading from Experimentology:

- Chapter 11: Preregistration
- Chapter 12: Data Collection
- Chapter 13: Project Management
- Chapter 14: Writing
- Chapter 15: Visualization

Additionally, please continue thinking about a topic in Perception research (broadly defined) that is of interest to you for your individual project.

Data Visualisation Exercise

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While learning how to code experiments and collect data is a huge part of studying human perception, another massively important aspect is learning how to think about data, visualise it, summarize it, and talk about it.

In this exercise, you should use the programming language of your choice (e.g., R, Python, etc.) to do the following:

1. Create a new notebook, in which you will conduct all of your analyses. Name your file `dataVisualisation_analyses.[file ext here]`
2. Load in the `assignments_dataVis_dataset.csv` file.
3. Print summary statistics for each condition in the data set (e.g., mean, standard deviation)
4. Visualize the results of each condition. At very least, you should plot y as a function of x for each condition. You are welcome to create as many plots as you like. Try to apply the visualization best practices presented during lecture. Please create your plots in line in your notebook.
5. In a text cell in your code notebook, answer the following questions:

- What can be concluded from the dataset?
- What did you find most challenging about this assignment?
- What did you learn in completing this assignment? What are you still curious about?
- Why is it important to visualize data?

6. Make sure your code can run from start to finish, without error. Include your notebook file within the assignments folder of your personal repository. Please also include a pdf or html version of your notebook in your repository, in addition to the python or R version.

   NOTE you do not need to re-include the dataset in your submission.

7. Be sure to push your changes to GitHub.

Tips & Tricks

Use this as an opportunity to get more familiar with your programming language of choice and to explore the fundamentals of data visualization! It is my understanding that your PNB coursework already involves R. I also know there is a Python for PNB course some of you may have taken. If you find yourself needing a refresher on either of these languages, there are so many great online resources! Here is a resource on R essentials and here is one on python essentials. There are even more helpful links listed on the course Resources page.

I highly recommend doing all of your coding in R markdown, Quarto, or a jupyter notebook. Such notebooks allow you to combine natural language with code. Why would you want to do that? Well, imagine you need to communicate your findings to someone else, or you want someone else to be able to reproduce the exact analyses you did. By writing code, creating detailed descriptions, and plotting figures in line, everything you need to do can all be in one place! In research jargon, we sometimes refer to this as a "reproducible workflow" – if you're interested in learning about such workflows, here is a primer. Note that there are many types of notebooks to choose from, for example, Jupyter Notebooks, Google Collab Notebooks, and R Notebooks. Choose whichever one you are familiar with or which seems most intuitive to you!

Under no circumstances should you alter the raw data file. If you need the data table in a different format, read in the provided file and manipulate the dataframe within your programming environment. DO NOT create new raw data files that need to be read in.

Try to be efficient with your code. If you find yourself copying and pasting the same chunk of code and changing one variable name each time, there is likely a much better way to do things. Here are some issues to look out for and some ways to mitigate them.

Week 5

Pre-registration

Everything we've discussed so far in the course should have prepared you for this week: Pre-registration. Pre-registration is the act of publishing an experimental design, data collection, and analysis plan, before conducting an experiment.

After reading week, you will turn in the Pre-registration assignment. This week we prepare you with everything you will need to complete that assignment! You still have a few weeks to refine your experimental design and interests. Be sure you are simultaneously researching your topic of interest and working on this pre-registration between now and the submission deadline.

Our goals are to:

- understand what pre-registration is and when and why to do it
- discuss what goes into a pre-registration
- begin developing a pre-registration for your own experiment

Slides from this week are available here. NOTE: You need to log in to Avenue to access the slides.

Maya Flannery's guest lecture slides are available here: https://pnb3ee3-w24.github.io/openScience/open-science.html#/title-slide

! Assignments and Exercises

Before next class
Please begin the pre-registration assignment (linked here).

> NOTE: this assignment will require substantial effort - do not put it off until the last minute!

Come to next class with at least the Background section of the preregistration completed. Remember to read Experimentology:

- Chapter 11: Preregistration
- Chapter 12: Data Collection

- Chapter 13: Project Management
- Chapter 14: Writing
- Chapter 15: Visualization

Pre-registration Assignment

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In this assignment, you should pre-register an experiment that you will later create using jsPsych. In other words, your experiment should be one that involves an individual using a web browser, not, for example, a social group experiment.

Objectives:

- Describe the background motivation for your project. Think about how your experiment is positioned in the literature.
- Describe the proposed experimental methods in sufficient detail that others will be able to recreate the experiment you are proposing.
- Think through and describe the analyses you will conduct once you have your data, as well as how you will collect your data and from whom.

Submission requirements:

- Fill out this standard OSF pre-registration template with your research plans. I have created a markdown version of this document for you so that you do not need to worry about copy-pasting the OSF template into your markdown notebook. Please use the markdown template here.
- In the 'Description' section, be sure to provide the context and relevant background literature for your experiment. Have you appropriately motivated your experiment in the context of those that have come before it? What have others done? Why is there still more work to be done? What are previous studies missing? You need to define your research gap! Your description should be clear to a trained non-expert. Please be sure to provide at least 10 references from peer-reviewed academic journals. This background section should be 3-5 paragraphs.

    > NOTE: there are a few different approaches to incorporating references into a notebook. We will discuss together in class.

- Clearly and thoroughly describe your research materials and design, with no ambiguity or omission.
- Make sure your stated hypotheses are clearly motivated by the background literature / theory you provide. Planned analyses must logically follow from the stated hypotheses. Your answers should be clear, logical, and thorough.
- For sections about sample size and data collection methods, write as if you were designing an ideal experiment, with no limitations on who / how you can reach people. We are interested in how well you can think through an ideal experiment.

Assessment Criteria

A full rubric for this assignment is in the course outline.

Week 6

AI in the Research Cycle

This week we will discuss and experiment with ways AI may or may not be reshaping research practices

Our goals are to:

- engage critically with AI hype
- understand the ecosystem of available AI tools
- discuss risks AI poses to the scientific ecosystem
- interact with AI in the context of our own research interests

Slides from this week are available here. NOTE: You need to log in to Avenue to access the slides.

> ❗ Assignments and Exercises
>
> **Before next class**
> Continue researching topic of interest
> Work on pre-registration

Week 7

Programming your experiment

This week we will discuss how to translate your pre-registered experimental design into experiment presentation code in jsPsych. First we will map out the full experiment in pseudo code, then we will get into the weeds of how to implement the experiment in jsPsych. We will also discuss the importance of instructions and the user interface of the experiment.

Our goals are to:

- continue refining knowledge of jsPsych
- develop instructions for proposed tasks
- think through output variables and data formatting
- program an experiment from start to finish

Slides from this week are available here. NOTE: You need to log in to Avenue to access the slides.

> ! Assignments and Exercises
>
> **Before next class**
> Begin working on the Experiment Code assignment. You will have two weeks to get this completed.
>
> > NOTE: this assignment will require substantial effort - do not put it off until the last minute!
>
> If you are struggling with this assignment, go back to the previous jsPsych readings and assignments; don't be afriad to ask your peers or instructors for help!

Experiment Presentation Code

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Many tools exist for creating research experiments. Some of these tools are GUI-based (GUI stands for graphical user interface), meaning that the user (you, the researcher!) only needs to point and click and drag things around. However, such tools hide what's going on "behind the scenes."

For the sake of this course, and your own development as a researcher, it is important to understand how code works. Why? Well, you need to understand the limitations of your methods and you need to be able to communicate with others. For example, even if you never write code again after this course, you might have a human programmer or even chatGPT write code for you–how do you know what to ask for? You at least need to be able to describe and discuss how code works and understand how to use code to accomplish tasks.

Some people in your class may have more programming experience than others - that is great! You can all learn from each other! Coding is a social process. I encourage all of you to work together, to learn from each other, and review each others' work. If you need more convincing that coding is social, read this. And if you want to explore that linked book further, you will find some great recommendations for writing good research code (though note that the book is mostly focussed on Python).

For this assignment, your experiment code should:

- be written in jsPsych
- follow the experimental design plan outlined in your previously submitted pre-registration
- be well commented
- be modular (if you want some examples, read this)
- run from start to finish in the browser without error
- output all data required for subsequent analyses in an organized fashion (i.e., variable names are logical; all data you want to analyse are saved)
- provide an intuitive user experience

Assessment

A full rubric for the poster presentation is in the course outline.

Week 8

Creating a research poster

This week we will provide you with background knowledge and skills required for the final poster presentation (happening during the last week of the course).

Our goals are to:

- understand the function of a research poster
- discuss norms in designing and presenting posters
- explore tools for creating posters
- workshop the beginnings of your research poster

Slides from this week are available here. NOTE: You need to log in to Avenue to access the slides.

> ! Assignments and Exercises
>
> **Before next class**
> Finish up your Experiment Code assignment, due before the next class!
>
> > NOTE: this assignment will require substantial effort - do not put it off until the last minute!
>
> If you are struggling with this assignment, go back to the previous jsPsych readings and assignments; don't be afriad to ask your peers or instructors for help!

Week 9

Data Analyses

This week we will focus on data analysis. You have already coded your experiment and made sure that all of the data you need from the experiment is properly output. Now its time to analyze simulated data from your experiment!

Our goals are to:

- understand the importance of simulating data and planning analyses
- review data visualization best practices
- apply statistical knowledge from other required courses
- workshop the beginnings of your analysis notebook

Slides from this week are available here. NOTE: You need to log in to Avenue to access the slides.

> ❗ Assignments and Exercises
>
> **Before next class**
> Begin working on your analysis code. You will have two weeks to complete this assignment.
>
> > NOTE: this assignment will require substantial effort - do not put it off until the last minute!
>
> If you are struggling with this assignment, go back to the previous data visualization assignment, as well as materials from the statistics courses you have already taken for your degree. Don't be afriad to ask your peers or instructors for help!

Data analysis code

PNB 3EE3; Fink

In the age of Open Science and Reproducability, it is becoming fairly standard practice that analysis code is submitted alongside papers for publication. The idea is that the papers' claims rely on the analysis code and others should be able to reproduce the results exactly. With this goal in mind, the code you write to analyse the data from your experiment should be well-documented and reproducible.

For the sake of this course, the easiest way to accomplish the goal of creating understandable, reproducible code is to use the 'notebook' format, which allows you to intersperse chunks of code with chunks of text (markdown). There are many notebooks to choose from: Jupyter Notebooks, Google Collab Notebooks, R Notebooks, etc. You are free to use whichever tool is most comfortable for you.

Below are some examples of final analysis repositories from my own research (that are *hopefully* reproducible on your machine!):

- https://github.com/lkfink/Kentler_MIM_Behavior
- https://github.com/lkfink/pupilTutorial
- https://github.com/lkfink/Dundun2_labels
- https://github.com/janatalab/GEM-Experiments-POC
- https://github.com/lkfink/CMQ

None of these are perfect (I am still learning too!); they are here to provide some examples/inspiration.

> SIDENOTE: it is a bit beyond the scope of this course, but worth pointing out that one reason code intended to be reproducible might no longer be is due to changes in, e.g., function, package, language, or operating system versions, compared to when the code was originally written and run. Tools like Docker and Code Ocean provide solutions to this very real problem! They "containerize" your code in the computational environment you developed it in (e.g., with specific operating system, python verison, package versions, etc.).

What to do for this assignment

Your analysis code should follow your pre-registered data analysis plan. Be sure to write the code for all the analyses you proposed, including any exploratory analyses (as registered or now desired). Also be sure to include visualizations. In addition to visualizing your main findings, you might also want to produce visuals to ensure your data meet certain assumptions (e.g., is variable X normally distributed?) or that your experimental conditions were balanced as intended.

You should organize your analysis notebook logically, providing headings and descriptive text, notes, and comments where necessary. Someone unfamiliar with your analysis plan should be able to look at your notebook and understand what is going on and what it means.

You will run your analysis code on data we will simulate together in class for your experiment.

Assessment

A full rubric for the poster presentation is in the course outline.

Week 10

Peer Review

This week we will focus on critiquing each other's planned analyses and poster drafts.

Our goals are to:

- continue refining our understanding of what goes into a research poster
- continue refining our understanding of data analysis and visualization
- practice giving effective peer feedback
- learn from each others' comments

Slides from this week are available here: [NOTE: Will be updated as course progresses]

! Assignments and Exercises

Before next class
Finish your analysis code. It is due before the next class!

> NOTE: this assignment will require substantial effort - do not put it off until the last minute!

If you are struggling with this assignment, go back to the previous data visualization assignment, as well as materials from the statistics courses you have already taken for your degree. Don't be afriad to ask your peers or instructors for help!
Continue preparing for your final poster presentation. Be sure to come to the next class with a draft of your poster. It's ok if the analysis section isn't done yet, but most other aspects can be completed by now.

Poster Presentation Assignment

Perception Lab will culminate with each student giving a 6 minute poster presentation (4 minute presentation + 2 mins for discussion). The poster is your chance to integrate everything you have learned throughout the course. It should include background motivation for your pre-registered experiment, your proposed methods, your statistical results + data visualizations from your simulated data, and a discussion about the implications of your research.

What software to use

You are free to use whatever software tool you like for this assignment. If you have gotten really into coding in R and reproducible workflows throughout this course, you could use posterdown; this blog post will give you a quick intro. Or, if you are really sick of code and dealing with unfamiliar tools, you can use powerpoint to make your poster. McMaster library provides free powerpoint poster templates; note that you will need to be logged in via VPN and macid. You are also welcome to explore other online resources and find something that suites your own aesthetic preferences, or to develop your own poster from scratch. Just be sure that the visual design is intuitive, fonts and font sizes are readable, etc. The software you use does not factor into your grade for this assignment. Just be sure your visual design, content, and spoken presentation meet the assessment criteria in the provided rubric.

Shreshth's poster assets link

Download from here

Assessment

A full rubric for the poster presentation is in the course outline.

Examples

Here are some recent examples from the BEAT Lab. Your poster by no means needs to look like these! Feel free to choose whatever color schemes / templates you like! You will see that even within the same lab, there are very different styles of presenting a poster!

This is a vertically-oriented poster: Your browser does not support iframes. Download PDF

This is a horizontally-oriented poster, created in Quarto: Your browser does not support iframes. Download PDF

This is a horizontally-oriented poster, created in Inkscape: Your browser does not support iframes. Download PDF

Week 11

Iteration

In case you haven't realized by now, research, writing, data analyses, etc. all require multiple rounds of iteration. In this class we will discuss how your idea of research has evolved throughout the course, and how your pre-registration might require changes based on what you have learned after programming your experiment and simulating data.

Our goals are to:

- understand the importance of iteration in all aspects of scientific research
- iterate on poster drafts
- practice poster presentations with peers
- learn through peer feedback

Slides from this week are available here: [NOTE: Will be updated as course progresses]

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>
> **Before next class**
> Your final poster presentation will happen next class.

Wrap-up

Congratulations! You've made it to the final week of the course! I hope you are proud of your efforts and all you've accomplished throughout this term! You engaged in industry-standard best practices in open research, from experiment pre-registration to programming an experiment, to analyzing data. You also got to explore a research topic of your own choosing! You might, for example, want to take the pre-registration from this course and use it to guide an independent or thesis project next semester or academic year.

This week you get to show off all you've learned about your topic and your experiment and data analysis plan through your final poster presentation. We all look forward to seeing them!

Feedback

We continually seek to improve this course! If there are aspects of this book or any of the assignments that can be improved, please feel free to suggests changes via a pull request or issue on GitHub or directly to Dr. Fink via email.

Reflection

If you would like to recieve 1 bonus percentage point towards your final grade, you can include a reflection in your individual repository. Further instructions are here.

Final Reflection

PNB 3EE3; Fink

Your final reflection is a moment to pause and think about all that you have learned throughout the semester and to consider how it might affect your future.

For each of the bullet points below, please write responses of at least 4 sentences. Feel free to create longer responses. As always, be sure to be clear and concise; these should not be "stream of consciousness" responses. Iterating and editing always make writing stronger.

Questions to address

- How has your understanding of *perception* changed from day 1 of class?
- How has your idea of what *research* is changed from day 1 of class?
- What research skills have you most developed during the course? What skills would you most like to develop in the future?
- What aspects of the pre-registration process did you find most difficult? Why? What apects of the pre-registration process do you find most important? Why? Do you think researchers should be required to pre-register their research? Why or why not? (there is no *right* answer here!)
- How does your experience designing and programming an experiment inform how you understand the research articles you read?
- Are there any aspects of the course you would recommend the instructors change? How can we make the course better for future students? What aspects of the course should stay the same? Why?

Assessment

Completing this reflection exercise will earn you 1 bonus percentage point towards your final grade in the course (e.g., if you are at an 89% and complete this reflection, you will be at a 90%).

Please include your responses in your individual GitHub repository in a file named 'reflection_lastName.[ext]' You can include your responses in a markdown file, html doc, pdf - whatever you like! For example, my file might be called 'reflection_Fink.pdf'

IMPORTANT: Generative AI (e.g., chatGPT) should not be used to complete this assignment. If we suspect use of generative AI, no bonus will be granted.