

Psychology 359: Advanced Research Methods in the Behavioural Sciences

Tentative Syllabus: Fall 2025

Lectures: Tuesdays and Thursdays, 2:00–3:15 in MacLeod Building MCLD 2002

Lab: Tuesdays 3:30–4:45 in Hennings Building HENN 201 (bring your laptop).

Instructor: [Jeremy Biesanz](#), Professor, 4351 CIRS.

Office hours Wed 12–1pm by appt.

Teaching Assistant: [Zhichun Qi](#). Office hours Wed 11-12 on Zoom.

Course Information and Objective

Psychology 359 is an introductory course dealing with the basics of behavioral statistics, experimental design, and computer applications. Students should have had at least the equivalent of a one-semester undergraduate course in behavioral statistics—this means that no instruction in elementary descriptive statistics is included in Psychology 359.

We will examine in depth the theoretical underpinnings of inferential statistics and selected inferential procedures (e.g., correlation and *t*-test and introduction to the general linear model). In addition to the statistical content covered in the lecture part of the course, some topics in experimental design, current research techniques, and issues in behavioral research, along with use of available open-source statistical software will be covered in both the lab and lecture components of the course.

This course is an advanced introduction to statistical methods in psychology with the following goals.

1. An understanding of the current issues facing Psychology and other scientific disciplines with respect to replicability and reproducibility. How has science and inference often been practiced and how should it be conducted instead?
2. Detailed understanding of best practices in data science with respect to laboratory research. We will focus on sustainable research workflows from idea conception through manuscript submission. The primary focus will be on best methods and practices for planning studies before collecting data and how to preserve and document data and analyses in a manner that would be compatible with open science.
3. Understanding and familiarity with open science. We will briefly cover pre-registration, open data, open materials, and reproducibility. By the end of the course you will be fully familiar with all of these and be able to implement these in your own research if and when needed.
4. A general introduction to statistical inference. Some of this should be review, but many of you will have covered this at different levels in previous courses. Here we will cover parameter estimation, sampling theory, hypothesis testing, confidence intervals, effect sizes, causal inference, statistical power, and understanding *p*-values. These are the basic inferential tools for all statistical analyses and for understanding your data. We will generally use the simple two-group experimental design (i.e., *t*-tests) while covering these topics.
5. An introduction to the open-source statistical computing language R. Many of the techniques and methods that we will cover are easily implemented in R but would require specialized (and expensive) software otherwise.

Class Discussion Board

The class discussion board will be on Piazza. I encourage you to use the discussion board to ask questions and solicit advice from your fellow students as well as your instructors. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. Find our class signup link at: [Piazza Signup Link](#).

Text

Navarro, D. (2016). *Learning Statistics with R: A Tutorial for Psychology Students and Other Beginners (Version 0.6)*. A pdf is available at [LSR](#).

Evaluation

Course student evaluation will consist of the following:

1. Problem sets (15%). Five problem sets will be assigned during the course. These will be separate from the work done in lab. Problem sets will be submitted online as pdf files through Canvass. Problem sets *will not* be equally weighted — problems sets with more points will carry more weight.
2. Two quizzes (25% each) and final exam (35%)

The overall class average is likely to be curved in a manner that reflects that this is a selective course. Consistent with previous years, I anticipate that the class average will be ~80% with a standard deviation of ~7.

Software

You will need a laptop or computer. The following software will be used extensively this term:

[R](#) will be the primary major statistical package that we will use. [R Studio](#) is an interface (and more) for R. TeX. Download site for [Mac](#) and for [Windows](#). General information [here](#). This is used to generate pdf files in R Studio.

Handouts, Additional Materials and Readings, and Datacamp

Throughout this term we will also make extensive use of [Datacamp](#) to learn R and R Markdown. Class materials will be made available through Canvas including readings, lecture notes, problem sets, and other class materials. I will also make extensive use of the Piazza discussion board on [Canvas](#) and encourage you to post questions there as well.

We will provide details on which courses (videos) to watch on the class [Canvas](#) discussion forum and in lecture/lab, particularly with respect to learning *R*. This will provide the essential training and background to complete the problem sets.

Strategy for the Course

It is critical to keep up with the course and the readings on a continuous basis. It is a good strategy to review your notes from the previous lecture before coming to class. In this way you will discover if parts of your notes are not clear can ask for clarification in class. I will look to you throughout the course for feedback about your level of understanding. *You should ask questions in class*. I highly encourage it! If you have a question, it is very likely that other students in the room have the same question. It helps to actively participate in class.

Topical Units

Best Data Science Practices (BDSP)

What is the ideal workflow? How can we achieve this? We will review the entire workflow and discuss and practice best practices in version control, data cleaning, dataset organization (tidy data), codebooks and documentation, reference managers, and archiving.

Review of Statistical Inference (RSI)

Here we will cover standard statistics distributions (e.g., normal, $t(df)$, $\chi^2(df)$, and $F(df_1, df_2)$), null hypothesis significance testing, and p -values.

Commonly used Statistical Tests (CST)

We will examine and focus on the t -test and correlation in depth. We will consider different versions of these tests (e.g., assuming that groups have different variances, correlations with categorical variables and rank-order associations). These statistical models will be used for the rest of the course for inference, effect size estimation, and study planning.

Best Reporting Practices (BRP)

How do we estimate effect sizes? How do we determine the uncertainty associated with effect sizes? We will cover standardized effect sizes and approaches to determining confidence intervals for effect size estimates.

Study Design and Planning (SDP).

What is statistical power? How can we estimate statistical power for a new study? Why is retrospective statistical power not a useful concept?

Current Crisis in Science (CCS)

Although sometimes referred to as the crisis in Psychology (or more focused on specific areas), it is clear that science in general has a problem with how business as usual has been conducted. We will review the crisis, discuss problematic practices, and solutions to these problems.

General Linear Model (GLM)

We will examine how to analyze continuous as well as categorical independent variables in the multiple regression framework. This will be a basic introduction to the general linear model, focusing on the interpretation of regression coefficients, how to extract specific information from analytical models, as well as how to examine assumptions and diagnostics and understand and conduct robust analyses. We will cover single and two predictor models as well as interactions between continuous variables.

| Week | Topics and LSR Chapter |
|---------------|---|
| 1. Sept 4 | Introduction and Overview |
| 2. Sept 9–11 | Inferences and hypothesis testing. (LSR 11) |
| 3. Sept 16–18 | Probability distributions and p -values. (LSR 9) Normal and Central Limit Theorem Video |
| 4. Sept 23–25 | t -tests for independent groups and correlations. (LSR 13) |
| 5. Oct 2 | Measures of association. (LSR 12) |
| 6. Oct 7–9 | Inference, errors, and the fragility of p -values. Quiz 1 Oct 7 in Lab Simmons et al. (2011), Why Most Research is Wrong |
| 7. Oct 14–16 | Effect size estimates, confidence intervals, statistical power (LSR 10) Cumming (2013), Lakens (2013), Funder and Ozer (2019) |
| 8. Oct 21–23 | Sample size justifications Lakens (2022), Lemmons et al. (2025) |
| 9. Oct 28–30 | Introduction to the general linear model. (LSR 15) |
| 10. Nov 4–6 | Introduction to the general linear model (cont.) Quiz 2 Nov 4 in Lab |
| 11. Nov 13 | Resampling (bootstrapping) Beasley and Rodgers (2009), LaFleur and Greevy (2009) |
| 12. Nov 18–20 | Interactions Baron and Kenny (1986) |
| 13. Nov 25–27 | Rubin and Holland’s Causal Inference Framework West et al. (2000) |
| 14. Dec 2–4 | Mediation Biesanz et al. (2010), MacKinnon on Traditional and Causal Mediation |

Table 1: Tentative Outline for the Fall 2025 Term.

LSR refers to the Learning Statistics with R textbook.

Additional readings for each week may be made available on Canvas.

References

- Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51, 1173–1182. <https://doi.org/10.1037/0022-3514.51.6.1173>
- Beasley, W. H., & Rodgers, J. L. (2009). Resampling methods. In R. Millsap & A. Maydeu-Olivares (Eds.), *The SAGE handbook of quantitative methods in psychology* (pp. 362–386). SAGE Publications Ltd. <https://doi.org/10.4135/9780857020994>
- Biesanz, J. C., Falk, C. F., & Savalei, V. (2010). Assessing mediational models: Testing and interval estimation for indirect effects. *Multivariate Behavioral Research*, 45, 661–701. <https://doi.org/10.1080/00273171.2010.498292>
- Cumming, G. (2013). The new statistics: Why and how. *Psychological Science*, 25, 7–29. <https://doi.org/10.1177/0956797613504966>
- Funder, D. C., & Ozer, D. J. (2019). Evaluating effect size in psychological research: Sense and nonsense. *Advances in Methods and Practices in Psychological Science*, 2, 156–168. <https://doi.org/10.1177/2515245919847202>
- LaFleur, B. J., & Greevy, R. A. (2009). Introduction to permutation and resampling-based hypothesis tests*. *Journal of Clinical Child & Adolescent Psychology*, 38, 286–294. <https://doi.org/10.1080/15374410902740411>
- Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for *t*-tests and ANOVAs. *Frontiers in Psychology*, 4, 1–12. <https://doi.org/10.3389/fpsyg.2013.00863>
- Lakens, D. (2022). Sample size justification. *Collabra: Psychology*, 8. <https://doi.org/10.1525/collabra.33267>
- Lemmons, M., Abolghasem, Z., & Biesanz, J. C. (2025). A closer look at sample size justifications: What do researchers actually report? *Unpublished Manuscript*.
- Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological Science*, 22, 1359–1366. <https://doi.org/10.1177/0956797611417632>
- West, S. G., Biesanz, J. C., & Pitts, S. C. (2000). Causal inference and generalization in field settings: Experimental and quasi-experimental designs. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 40–84). Cambridge University Press.