Western University
Psychology
PSY 9551A
Experimental Design, Data Analysis, and Sample Size Calculation
Fall 2025
SSC 5220, 9:00-12:00 noon

Enrollment Restrictions

Enrollment in this course is restricted to graduate students in Psychology as well as any student in another program (pending class size) who has obtained special permission to enroll in this course from the course instructor as well as the Graduate Chair (or equivalent) from the student's home program.

Instructor and Teaching Assistant Information

Instructor: Paul F. Tremblay
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Teaching Assistant TBD
Email TBD

Course Description

This course covers advanced experimental design, analysis of variance, and the general linear model. We begin with principles of descriptive and inferential statistics including sample size calculations for precision of estimates and statistical power using simulation procedures and software applications. The course includes methods of data inspection, visualization, and methods for handling missing data and non-normal outcomes such as robust statistics and bootstrapping. We then cover the main research designs and their associated ANOVA models for one-way, factorial, within-subjects, mixed between-within designs, and hierarchical designs. Also covered in these topics is the distinction between fixed and random factors, effect size estimates for meta-analysis, and power calculations. The course work consists entirely of lab assignments that provide hands-on training in generating hypotheses and designs, conducting power analyses and analyzing data, interpreting and reporting results. Demonstrations are provided using various software (e.g., R, Jamovi, SPSS).

Course Format

Lectures in person

Course Learning Outcomes/Objectives

Upon completion of this course, students should be able to:

1. Design studies with interactions and a mix of between- and within-subjects factors.
2. Conduct a sample size calculation for statistical power of an effect in any design or for precision of confidence intervals.
3. Conduct analyses and report results including tests, diagnostics, effect size, and visuals.
4. Make sound decisions about how to proceed with missing data and violations of assumptions using options such as robust statistics, bootstrapping, and improving measurement scale of outcome variable.

Course Materials

The following textbooks are optional and can serve as secondary resources.

Hahs-Vaughn, D. L. & Lomax, R. G. (2020). *An introduction to statistical concepts. Fourth Edition*. Routledge. 978-1138650558 (available online Western Libraries; can download pdf chapters)

Lakens Daniël (2022). Improving Your Statistical Inferences. Retrieved from https://lakens.github.io/statistical_inferences/

A list of supplementary articles and book chapters (available online through the library system or in the OWL course website) are listed below by lecture topics. These are additional resources that are discussed in the course and may serve you beyond this course in your own research.

Methods of Evaluation

The course work consists entirely of **6 equally weighted (~16.5% each)** lab assignments provided every two weeks starting Sep 18. You will have two weeks to complete each assignment. These assignments provide hands-on training by having you generate hypotheses, analyze data, interpret and report results, conduct simulations, write mini research proposals, or evaluate published research. My lectures and demonstrations include presentations in R (and the related Jamovi software) and SPSS. Students are allowed to work in any software package or programming language of their choice including any not mentioned above (e.g., SAS, Stata, Python or MATLAB).

Assignment reports will typically consist of a two double-spaced page write-up including a short method section, results section including tables and/or figures, interpretation and discussion of results, answers to specific questions, and an appendix with analysis output.

Late assignments will receive a 5% deduction per 24 hours. Assignments that are more than one week late will not be accepted for partial marks unless you have contacted me to request an extension.

Rules about working in groups. I am supportive of students working in pairs or groups to conduct the analyses and discuss the assignments. However, you are required to write your own report with no duplication from your colleagues' work. The assignments will often require you to choose a subset of variables, to make decisions about plausible strategies, or to describe research ideas from your own area of interest. Also, some questions will ask you to design your own hypothetical research designs. As a result, it is unlikely that two students will work with the exact same material.

Assignment	Assigned and Due date	Topic
Lab1	Sep 17 - Oct 1	Data inspection, visualization, scales of measurement
Lab2	Oct 1 - Oct 15	Simulation to understand Type I error rate and power
Lab3	Oct 15 - Oct 29	Sample size calculation for power and precision
Lab4	Oct 29 - Nov 19	Factorial ANOVA, interactions and power analysis
Lab5	Nov 19 - Dec 3	Split plot (mixed factor/RCT) ANOVA
Lab6	Dec 3 - Dec 17	Running a small meta-analysis in Jamovi or R

Each of these assignments will be provided to you, two weeks prior to the due date.

Course Timeline

Week	Date	Topics	Book chapters*
1	Sep 10	Overview, causality, scales of measurement	HV&L 1
2	Sep 17	Data inspection, visualization, missing data analysis	
3	Sep 24	Sampling distributions, confidence intervals	HV&L 2, 3, 4; L 7
4	Oct 1	Inferential statistics (NHST), error rates, power	HV&L 5, 6; L 1, 2
5	Oct 8	t-tests, effect size estimation, robust stats, bootstrap	HV&L 7; L 6
6	Oct 15	Sample size calculation for power and precision	L 8, 9
7	Oct 22	Experimental design and one-way ANOVA	HV&L 9, 11, 12
8	Oct 29	Factorial ANOVA and interactions	HV&L 13
	Read Wk		
9	Nov 12	Repeated measures and analysis of change	HV&L 15
10	Nov 19	Split plot (mixed factor) ANOVA and hierarchical designs	HV&L 15
11	Nov 26	Adding continuous covariates to your designs	HV&L 14
12	Dec 3	Introduction to meta-analysis	L 11

*HV&L: Hahs-Vaughn & Lomax (2020); L: Lakens (2022)

Additional resources for lecture topics (list may be slightly updated before start of course)

Sep 10.

Appelbaum, M., Cooper, H., Kline, R. B., Mayo-Wilson, E., Nezu, A. M., Rao, S. M., & Clinic, C. (2018). Journal article reporting standards for quantitative research in Psychology: The APA Publications and Communications Board Task Force Report. *American Psychologist*, *73(1)*, 3–25. http://dx.doi.org/10.1037/amp0000191

Smith, E. R. (2014). Research design. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology. 2nd edition.* (p. 27–48). Cambridge University Press.

Sep 17.

Baraldi, A. N., & Enders, C. K. (2010). An introduction to modern missing data analyses. *Journal of School Psychology*, *48*, 5–37. doi: 10.1016/j.jsp.2009.10.001

DeCarlo, L. T. (1997). On the meaning and use of kurtosis. *Psychological Methods*, *2*, 292-307.

Field, A. P., & Wilcox, R. R (2017). Robust statistical methods: A primer for clinical psychology and experimental psychopathology researchers. *Behaviour Research and Therapy*, *98*, 19-38. http://dx.doi.org/10.1016/j.brat.2017.05.013

Sep 24.

Cumming G., & Finch, S. (2005). Inference by eye. Confidence intervals and how to read pictures of data. *American Psychologist*, *60*, 170-180. doi: 10.1037/0003-066X.60.2.170

Oct 1.

Amrhein, V., Greenland, S., & McShane, B. (2019). Retire statistical significance (Comment). *Nature*, *567*, 305-307.

Oct 8.

Kelley, K., & Preacher, K. J., (2012). On effect size. *Psychological Methods*, *17*, 137-152. doi: 10.1037/a0028086

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *frontiers in Psychology*. doi: 10.3389/fpsyg.2013.00863

Lakens, D., Scheel, A. M., & Isager, P. M. (2018). Equivalence testing for psychological research: A Tutorial. *Advances in Methods and Practices in Psychological Science*, *1*, 259-269. doi: 10.1177/2515245918770963

Stanton, J. M. (2021). Evaluating equivalence and confirming the null in the organizational sciences. *Organizational Research Methods*, *24*, 491-512. doi: 10.1177/1094428120921934

Oct 15.

Lakens, D., & Caldwell, A. R. (2021). Simulation-Based Power Analysis for Factorial Analysis of Variance Designs. *Advances in Methods and Practices in Psychological Science*, *4(1)*. https://doi.org/10.1177/2515245920951503

Maxwell, S. E., Kelley, K., & Rausch, J. R. (2008). Sample size planning for statistical power and accuracy in parameter estimation. *Annual Review of Psychology*, *59*, 537-563. doi: 10.1146/annurev.psych.59.103006.093735

Oct 22.

Sauder, D. C., & DeMars C. E. (2019). An Updated recommendation for multiple comparisons. *Advances in Methods and Practices in Psychological Science*, *2*, 26-44. doi:10.1177/2515245918808784

Oct 29.

Spinner, B., & Gabriel, R. M. (1981). Factorial analysis of variance with unequal cell frequencies. *Canadian Psychology*, *22*, 260-270.

Pierce, C. A., Block, R. A., & Aguinis, H. (2004). Cautionary note on reporting eta-squared values from multifactor ANOVA designs. *Educational and Psychological Measurement*, *64*, 916-924. doi: 10.1177/0013164404264848

Nov 12.

Atkinson, G. (2001). Analysis of repeated measurements in physical therapy research. *Physical Therapy in Sports*, *2*, 194-208. doi: 10.1054/ptsp.2001.0071

Nov 19.
Kim, S., & Lee, K. (2023). Development and evaluation of an online mental health program for traumatized female college students: A randomized controlled trial. *Archives of Psychiatric Nursing*, *43*, 118-126.

Nov 26.
Miller, G. A., & Chapman, J. P. (2001). Misunderstanding analysis of covariance. *Journal of Abnormal Psychology*, *110*, 40-48. doi: 10.1037//0021-843X.110.1.40
Wright, D. B. (2006). Comparing groups in a before-after design: when t test and ANCOVA produce different results. *British Journal of Educational Psychology*, *76*, 663-675. DOI:10.1348/000709905X52210

Dec 3.
Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., Mcdonald, S., … Mckenzie, J. E. (2021). PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. BMJ. British Medical Journal (International Ed.), 372, n160–n160. https://doi.org/10.1136/bmj.n160
Pigott, T. D., & Polanin, J. R. (2020). Methodological Guidance Paper: High-Quality Meta-Analysis in a Systematic Review. *Review of Educational Research*, *90(1)*, 24–46. https://doi.org/10.3102/0034654319877153
Schäfer T., & Schwarz, M. A. (2019). The Meaningfulness of effect sizes in psychological research: Differences between sub-disciplines and the impact of potential biases. *Frontiers in Psychology, 10*, 813. doi: 10.3389/fpsyg.2019.00813

Statement on Academic Offences

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com).

Health/Wellness Services

Students who are in emotional/mental distress should refer to Mental Health@Western http://www.uwo.ca/uwocom/mentalhealth/ for a complete list of options about how to obtain help.

Accessible Education Western (AEW)

Western is committed to achieving barrier-free accessibility for all its members, including graduate students. As part of this commitment, Western provides a variety of services devoted to promoting, advocating, and accommodating persons with disabilities in their respective graduate program.

Graduate students with disabilities (for example, chronic illnesses, mental health conditions, mobility impairments) are strongly encouraged to register with Accessible Education Western (AEW), a confidential service designed to support graduate and undergraduate students through their academic program. With the appropriate documentation, the student will work with both AEW and their graduate programs (normally their Graduate Chair and/or Course instructor) to ensure that appropriate academic accommodations to program requirements are arranged. These accommodations include individual counselling, alternative formatted literature, accessible campus transportation, learning strategy instruction, writing exams and assistive technology instruction.