**Western University**
**Psychology**
**PSY 9556B**
**Longitudinal Modeling**
**Winter 2023**
**SSC XXXX, Tuesdays 9:00am-12noon**

## Enrollment Restrictions

Enrollment in this course is restricted to graduate students in Psychology who have completed either PSY9555A/B or PSY9542A/B or PSY9545A as well as any student in another program (pending class size) who has completed one of the above-mentioned courses and 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 Information

Instructor: Paul F. Tremblay
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## Course Description

This advanced course focuses on various techniques within the domain of structural equation modeling and multilevel modeling to analyze repeated-measures, particularly longitudinal data. Topics within the SEM domain will include longitudinal measurement models, basic panel models with autoregressive and cross-lagged processes, latent growth curve models, growth mixture models (to investigate prototypical trajectories), longitudinal mediation models and multiple group models. Within the MLM domain, topics will include models for multiple repeated observations (e.g., diary data, ecological momentary assessment) and time-variant and time-invariant covariates. Other topics will include missing data techniques, improving the longitudinal component of randomized controlled trials, discontinuity regression models, power, and modeling approaches for non-continuously distributed outcome variables. The course involves hands-on projects in which students have the opportunity to analyze their own data, simulated data or data provided in class. Most of the examples in the lecture material are based on the software program Mplus, R, and SPSS Mixed Models but students are free to work in the software of their choice.

## Course Format

Lectures in person

## Course Learning Outcomes/Objectives

The objective of this course is to provide students with the necessary knowledge to design state-of-the art longitudinal (and related design) studies, conduct and interpret analyses using structural equation modeling and multilevel modeling approaches. This will be achieved from three angles: (1) comprehensive lectures that incorporate theory, design issues, and analytic procedures based on the most up-to-date methods (2) practice assignments that focus on three building blocks, (3) an individualized project that includes all stages from conceptualization, writing a proposal, conducting necessary main analyses, addressing missing data and statistical power, and writing and presenting the final report. I will provide lecture style presentations borrowing extensively from the readings, and therefore students are encouraged to immerse themselves in the readings on a weekly basis. By the end of the course, students should:

1. have developed a comprehensive knowledge of methods and concepts in longitudinal research.
2. be able to conduct longitudinal analyses including missing data analysis and power analyses.
3. be able to write an empirical research paper using longitudinal methods from start to finish.
4. be able to write competitive and novel pre-registered reports, proposed studies for their own graduate research, and proposals for training awards or project grants (e.g., CIHR, SSHRC).

## Course Materials

Articles and chapters in pdf (see lecture schedule) will also be available through the library and linked on the course OWL website. Additional resources including software documents and data files will also be available in the OWL website.

## Methods of Evaluation

| Assignment | Due date | Value | Topic |
|---|---|---|---|
| Lab1 | Feb 14 | 15% | Latent Growth Modeling (SEM) |
| Lab2 | Mar 7 | 15% | Diary data (MLM) |
| Lab3 | Mar 21 | 15% | Cross-lagged panel methods mini proposal |
| Project proposal | Feb 28 | 15% | |
| Project presentation | Mar 28 or Apr 4 | 15% | |
| Project paper | Apr 11 | 25% | |

See further details below

**55%: Individual research project**

The individual project will consist of a study involving repeated measures data with at least three time points. Students can use (1) their own data, (2) secondary data sets, or (3) simulated data that could also be used for power analyses. Many students in past related courses have used either of these three sources successfully. Although strictly not longitudinal, I will accept projects that administer multiple stimuli in a given session as long as you incorporate a test for order effects (e.g., fatigue, learning).

The project should include a longitudinal analytic procedure consisting of either a multilevel modeling or structural equation modeling approach and include an investigation of the relation between two variables across time. There are many options that could satisfy those criteria (e.g., a randomized controlled trial with a longitudinal component, an investigation of developmental trajectories with the influence of time invariant or time varying covariates, a cross-lagged panel model using the most recent recommendations, or a traditional intensive longitudinal data project (e.g., daily-diary, ecological momentary assessment).

The following milestones have worked successfully in the past and will be used in the course to help students stay on track:

1. **Research idea (by Jan 31, no evaluation)**. This is a preliminary step to have your project approved by the instructor. Ideally you will meet with me to describe the project, and we will fill out a form describing the structure of the data and sample size, a summary of the measures, and the proposed analytic procedure. The purpose of this step is to establish that your project is feasible.
2. **Research proposal (due Feb 28; 15%)**. A three to four-page max description of your project outlining your objectives, hypotheses, research design, description of data, and description of variables/measures, and analytic procedure.
3. **Presentation (March 28 or April 4; 15%)**. You will have 20 minutes (max) to do your presentation followed by a 5-10 min discussion. Two students will be assigned to comment and to ask questions first followed by questions from the rest of the class. You will be rated on the material in your slideshow (10%) as well your presentation itself (5%; ability to present and explain clearly). Your slides will be due the same day.
4. **Paper (due April 11, one week after the last class; 25%).** Your paper should generally be written as a manuscript for publication. Your introduction can be less elaborate than in publication manuscript but should include a section that describes the rationale, objectives and hypotheses and a brief review of the literature. As a guideline for length, previous projects have usually varied from 15-25 double spaced pages of main text, and you should include tables and or figures.

**45%: 3 lab/assignments**. You will have two weeks to complete an assignment (due at the beginning of class). These assignments will include data analysis, reporting, interpretation, discussion of results, and addressing specific questions. Late assignments include a 5% deduction per 24 hours, and assignments that are more than one week late will not be accepted for partial marks.
*Rules about working in groups*. I am supportive of students working in 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, and to make decisions about plausible strategies.

## Course Timeline

List of readings may be updated before start of the course. (***refers to advanced material). I realize that this list is quite extensive, and some articles are quite advanced.

**Jan 10. Overview of longitudinal research and various design issues**


Collins, L. M., & Graham, J. W. (2002). The effect of the timing and spacing of observations in longitudinal studies of tobacco and other drug use: temporal design considerations. *Drug and Alcohol Dependence*, *68*, S85-S96.

Hamaker, E. L., Mulder, J. D., & van Ijzendoorn, M. H. (2020). Description, prediction and causation: Methodological challenges of studying child and adolescent development. *Developmental Cognitive Neuroscience*, 46.

Hopwood, C. J., Bleidorn, W., & Wright, A. G. C. (2021). Connecting theory to methods in longitudinal research. *Perspectives on Psychological Science*, 1-11. https://doi.org/10.1177/17456916211008407

Little, T. (chapter 2) Design issues in longitudinal studies. Little Todd D. (2013). *Longitudinal Structural Equation Modeling*. New York: Guilford Press.

Petersen, I. T., Apfelbaum, K. S., & McMurray, B., (2022). Adapting open science and pre-registration to longitudinal research. Infant and Child Development, e2315. https://doi.org/10.1002/icd.2315

Ployhart, R. E., & Vandenberg, R. J. (2010). Longitudinal research: the theory, design, and analysis of change. *Journal of Management*, *36*, 94-120. doi: 10.1177/0149206309352110.

Ren, Y. et al. (2022). Analyses of repeatedly measured continuous outcomes in randomized controlled trials needed substantial improvements. *Journal of Clinical Epidemiology*, *143*, 105-117. https://doi.org/10.1016/j.jclinepi.2021.12.007


**Jan 17. Missing data mechanisms and analysis**


Enders, C. K. (2010). *Applied missing data analysis*. Guilford Press. (second edition available in August, 2022. Look through the chapters and select the relevant material to your work).

Enders, C. K. (2011). Missing not at random models for latent growth curve analyses. *Psychological Methods*, 16, 1–16. https://doi.org/10.1037/a0022640

Woods, A., et al. (currently under review). Best practices for addressing missing data through multiple imputation.

Zhang, Y. et al. (2017). A systematic survey on reporting and methods for handling missing participant data for continuous outcomes in randomized controlled trials. *Journal of Clinical Epidemiology*, *88*, 57-66.


**Jan 24. Change scores, residualized scores, and latent change scores**


Castro-Schilo, L., & Grimm, K. J. (2018). Using residualized change versus difference scores for longitudinal research. *Journal of Social and Personal Relationships*, *35*, 32-58.

Jennings, M. A., & Cribbie, R. A. (2016). Comparing pre-post change across groups: guidelines for choosing between difference scores, ANCOVA, and residual change scores. *Journal of Data Science*, *14*, 205-230.

McArdle, J. J. (2009). Latent variable modeling of differences and changes with longitudinal data. *Annual Review of Psychology*, *60*, 577-605.

**Jan 31. SEM approach (Auto regression, Latent Growth Modeling and Growth Mixture Modeling)**

Atkins, D. C., Baldwin, S. A., Zheng, C., Gallop, R. J., & Neighbors, C. (2013). A tutorial on count regression and zero-altered count models for longitudinal substance use data. Psychology of Addictive Behaviors, 27 (1), 166-177. doi: 10.1037/a0029508

Fuhrmann, D., van Harmelen, A.-L., & Kievit, R. A. (2021). Well-being and cognition are coupled during development: A preregistered longitudinal study of 1,136 children and adolescents. *Clinical Psychological Science*, 1-17, doi: 10.1177/21677026211030211

Reilly, S. E., Downer, J. T., & Grimm, K. J. (2022). Developmental trajectories of executive functions from preschool to kindergarten. *Developmental Science*. https://doi.org/10.1111/desc.13236

Rioux, C., Stickley, Z. L., & Little, T. D. (2021). Solutions for latent growth modeling following COVID-19 related discontinuities in change and disruptions in longitudinal data collection. *International Journal of Behavioral Development*, *45*, 463-473.

Wang, M., & Bodner, T. E. (2007). Growth mixture modeling: Identifying and predicting unobserved subpopulations with longitudinal data. Organizational Research Methods, 10 (4), 635-656.

**Feb 7. SEM approach continued (Longitudinal Measurement Invariance)**

Fried, E. I., van Borkulo, C. D., Epskamp, S., Schoevers, R. A., Tuerlinckx, F., & Borsboom, D. (2016). Measuring depression over time . . . or not? Lack of unidimensionality and longitudinal measurement invariance in four common rating scales of depression. *Psychological Assessment*, *28*, 1354. https://doi.org/10.1037/pas0000275

Mackinnon, S. P., Curtis, R., & O'Connor, R. M. (2022). A tutorial in longitudinal measurement invariance and cross-lagged panel models using Lavaan. *Meta-Psychology*, *6*, MP.2020.2595. https://doi.org/10.15626/MP.2020.2595

**Feb 14. MLM approach (longitudinal, diary, EMA, event-contingent designs)**

Curran, P. J., & Bauer, D. J. (2011). The disaggregation of within-person and between-person effects in longitudinal models of change. *Annual Review of Psychology*, *62*, 583-619.

***Lüdtke, O., Marsh, H. W., Robitzsch, A., Trautwein, U., Asparouhov, T., & Muthén, B. (2008). The multilevel latent covariate model: A new, more reliable approach to group-level effects in contextual studies. *Psychological Methods*, *13*, 203–229. https://doi.org/10.1037/a0012869

Quené, H., & van den Bergh, H. (2004). On multi-level modeling of data from repeated measures designs: a tutorial. *Speech Communication*, *43*, 103-121.

**Feb 21. MLM approach continued**

Hoffman, L., & Walters, R. W. (2022). Catching up on multilevel modeling. *Annual Review of Psychology, 73,* 659-689. https://doi.org/10.1146/annurev-psych-020821-103525

Howard, A. L. (2021). A guide to visualizing trajectories of change with confidence bands and raw data. *Advances in Methods and Practices in Psychological Science*, *4(4)*, 1-13.

Saeed, S., Moodie, E. E. M., Strumpf, E. C., & Klein, M. B. (2018). Segmented generalized mixed effect models to evaluate health outcomes. *International Journal of Public Health*, *63*, 547-551.

**Feb 28. SEM II Cross-lagged panel designs with latent intercepts and structural residuals and other related methods**

Bollen K., & Curran, P. (2004). Autoregressive latent trajectory (ALT) models. A synthesis of two traditions. *Sociological Methods & Research*, *32*, 336-383. doi: 10.1177/0049124103260222

Curran, P.J., and Hancock, G.R. (2021). The challenge of modeling co-developmental processes over time. *Child Development Perspectives,* 15, 67-75. http://doi.org/10.1111/cdep.12401

Curran, P. J., Howard, A. L., Bainter, S. A., Lane, S. T., McGinley, J. S. (2014). The separation of between-person and within-person components of individual change over time: A latent curve model with structured residuals. *Journal of Consulting and Clinical Psychology*, *82*, 879-894.

Glad, K. A., Stensland, S., Czajkowski, N. O., Boelen, P. A., & Dyb, G. (2022). The longitudinal association between symptoms of posttraumatic stress and complicated grief: A Random intercepts cross-lag analysis. *Psychological Trauma: Theory, Research, Practice, and Policy*, *14*, 386-392. https://doi.org/10.1037/tra0001087

**Mar 7. Continued**

Andersen, H. K. (2021, December 16). Equivalent approaches to dealing with unobserved heterogeneity in cross-lagged panel models? Investigating the benefits and drawbacks of the latent curve model with structured residuals and the random intercept cross-lagged panel model. *Psychological Methods*. Advance online publication. http://dx.doi.org/10.1037/met0000285

Grimm, K. J., Helm, J., Rodgers, D., & O'Rourke, H. (2021). Analyzing cross-lag effects: A comparison of different cross-lag modeling approaches. Child & Adolescent Development, 11-33.

Hamaker, E. L., Kuiper, R. M., & Grasman, R. P. P. P. (2015). A critique of the cross-lagged panel model. *Psychological Methods*, 20, 102-116.

Mulder, J. D., & Hamaker, E. L. (2021). Three extensions of the random intercept cross-lagged panel model. *Structural Equation Modeling: A Multidisciplinary Journal*, *28(4)*, 638-648.

Usami, S., Murayama, K., & Hamaker, E. L. (2019). A unified framework of longitudinal models to examine reciprocal relations. *Psychological Methods*, *24*, 637-657.

**Mar 14. Mediation in longitudinal design**

Berli, C., Inauen, J., Stadler, G., Scholz, U., & Shrout, P. E. (2021). Understanding between-person interventions with time-intensive longitudinal outcome data: Longitudinal mediation analysis. *Annals of Behavioral Medicine*, *55*, 476-488.

Cole, D. A., & Maxwell, S. E. (2003). Testing mediational models with longitudinal data: Questions and tips in the use of structural equation modeling. *Journal of Abnormal Psychology*, 112, 558-577.

Goldsmith K. A., MacKinnon, D. P., Chalder, T., White, P. D., Sharpe, M., & Pickles, A. (2018). Tutorial: The practical application of longitudinal structural equation mediation models in clinical trials. *Psychological Methods*, *23*, 191-207.

Maxwell, S. E., & Cole, D. A. (2007). Bias in cross-sectional analyses of longitudinal mediation. *Psychological Methods*, *12*, 23–44.

McNeish, D., & MacKinnon, D. P. (under review). Intensive longitudinal mediation in Mplus.

Tofighi, D., Hsiao, Y.-Y., Kruger, E. S., MacKinnon, D. P., Van Horn, M. L., & Witkiewitz, K. (2019). Sensitivity analysis of the no-omitted confounder assumption in latent growth curve mediation models. *Structural Equation Modeling: A Multidisciplinary Journal*, 26, 94-109,

Wu, W., Carroll, I. A., & Chen, P.-Y. (2018). A single-level random-effects cross-lagged panel model for longitudinal mediation analysis. *Behavioral Research*, *50*, 2111-2124.

**Mar 21. Dynamic panel models (this is a fairly new advanced procedure)**

Armstrong, B., Covington, L. B., Unick, G. J., & Black, M. M. (2019). Featured article: Bidirectional effects of sleep and sedentary behavior among toddlers: A dynamic multilevel modeling approach. *Journal of Pediatric Psychology*, *44*, 275-285.

***Asparouhov, T., & Bengt Muthén (2019): Comparison of models for the analysis of intensive longitudinal data. *Structural Equation Modeling: A Multidisciplinary Journal*, 1-23. doi: 10.1080/10705511.2019.1626733

***Asparouhov, T., Hamaker, E. L., & Muthén, B. (2018). Dynamic structural equation models. *Structural Equation Modeling: A Multidisciplinary Journal* , *25*, 359–388. https://doi.org/10.1080/10705511.2017.1406803

McNeish, D., & Hamaker, E. L. (2020). A primer on two-level dynamic structural equation models for intensive longitudinal data in Mplus. *Psychological Methods*, *25*, 610–635. https://doi.org/10.1037/met0000250

McNeish, D., Mackinnon, D. P., Marsch, L. A., & Poldrack. R. A. (2021) Measurement in intensive longitudinal data. *Structural Equation Modeling: A Multidisciplinary Journal*, *28*, 807-822. doi: 10.1080/10705511.2021.1915788

**Mar 28. Power Analysis**

Arend, M. G., & Schäfer, T. (2019). Statistical power in two-level models: A tutorial based on Monte Carlo Simulation. *Psychological Methods*, *24*, 1-19.

Lafit, G., Adolf, J. K., Dejonckheere, E., Myin-Germeys, I., Viechtbauer, W., & Ceulemans, E. (2021). Selection of the number of participants in intensive longitudinal studies: A user-friendly Shiny App and tutorial for performing power analysis in multilevel regression models that account for temporal dependencies. *Advances in Methods and Practices in Psychological Science*, *4*, 1-24.

Muthén, L. K., & Muthén, B. O. (2002). How to use a Monte Carlo study to decide on sample size and determine power. *Structural Equation Modeling*, *9*, 599-620.

Petras, H. (2016). Longitudinal assessment design and statistical power for detecting an intervention impact. *Prevention Science*, *17*, 819-829.

**Apr 4. PRESENTATIONS**

## 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

## 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.