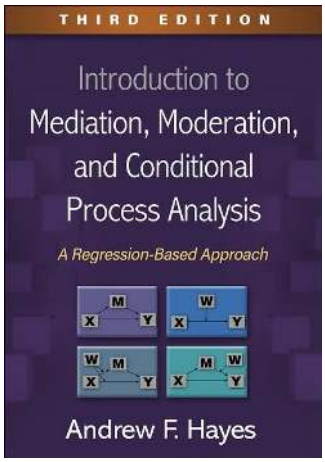
PROCESS: A Versatile Computational Tool for Observed Variable Mediation, Moderation, and Conditional Process Modeling

This paper has not been available from afhayes.com/public/process2012.pdf for almost a decade. It is no longer available because it is long ago outdated and should never be cited as support for the use of PROCESS. The proper citation for PROCESS is



Hayes, A.F. (2022). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (3rd Edition). New York: The Guilford Press.

Of course, don't cite this if you haven't read it. If you haven't read it, you probably shouldn't be using PROCESS, as it may not be doing what you think it is doing. If you'd rather not read the documentation or the book but would like to learn about PROCESS and how it works, consider taking a class from Andrew F. Hayes through the Canadian Centre for Research Analysis and Methods. For currently scheduled offerings, go to http://haskayne.ucalgary.ca/CCRAM

Introduction to Mediation, Moderation and Conditional Process Analysis

Leading expert Dr. Andrew Hayes, PhD will guide the learner through topics in the statistical analysis of mechanisms responsible for causal effects as well as their contingencies, popularly known as mediation and moderation analysis, as well as their integration as conditional process analysis. This introductory course is recommended to all levels of learners prior to taking *Mediation, Moderation and Conditional Process Analysis: A Second Course.*

UNIVERSITY OF CALGARY
HASKAYNE SCHOOL OF BUSINESS

Learning Objectives

In this course, you will learn about the underlying principles and the practical applications of mediation, moderation and conditional process analysis. It covers six broad topics:

1. Direct, indirect and total effects in a mediation model
2. Estimation and inference in single mediator models using ordinary least squares regression
3. Estimation and inference in models with more than one mediator
4. Moderation or “interaction” in ordinary least squares regression
5. Testing, interpreting, probing and visualizing interactions
6. The integration of mediation and moderation: Conditional process analysis

Who Will Benefit

This course will be helpful for researchers in any field —including psychology, sociology, education, business, human development, social work, public health, communication and others that rely on social science methodology —who want to learn how to apply the methods of moderation and mediation analysis using widely-used software such as SPSS, SAS and R. Learners are recommended to have familiarity with the practice of multiple regression analysis and elementary statistical inference. No knowledge of matrix algebra is required or assumed, nor is matrix algebra used in the delivery of course content. Learners should also have some experience with the use of SPSS, SAS or R, including opening and executing data files and programs.

Dates: **September 7, 2022**

Program Delivery: **Online, asynchronous**

Commitment: **3 weeks**

Investment: **$625 (Canadian dollars)**

Summary

Statistical mediation and moderation analyses are among the most widely used data analysis techniques in social science, health and business research. Mediation analysis is used to test hypotheses about various intervening mechanisms by which causal effects operate. Moderation analysis is used to examine and explore questions about the contingencies or conditions of an effect, also called "interaction." Increasingly, moderation and mediation are being integrated analytically in the form of what has become known as "conditional process analysis," used when the goal is to understand the contingencies or conditions under which mechanisms operate. An understanding of the fundamentals of mediation and moderation analysis is in the job description of almost any empirical scholar. In this course, you will learn about the underlying principles and the practical applications of these methods using ordinary least squares (OLS) regression analysis and the PROCESS macro for SPSS, SAS and R, invented by the course instructor and widely used in the behavioral sciences. This course is a companion to the instructor's book Introduction to Mediation, Moderation, and Conditional Process Analysis, published by The Guilford Press. A copy of the book is not required to benefit from the course, but it could be helpful to reinforce understanding.

Time Commitment and Course Delivery

This online course consists of a collection of 16 modules in the form of videos and exercises that can be completed with a time commitment of about 6-8 hours/week. You can participate at your own convenience; there are no set times when you are required to be online during the offering period, and you can rewind the videos and review modules completed at your leisure. Questions can be sent to the instructor and others in the class through a discussion board on the course delivery platform. The course can be accessed with any recent web browser on almost any computing platform, including iPhone, iPad and Android devices.

Computing

Computer applications will focus on the use of ordinary least squares regression and the PROCESS macro for SPSS, SAS and R developed by the instructor that makes the analyses described in this class much easier than they otherwise would be. This is a hands-on course, so maximum benefit results when learners can follow along with analyses using a laptop or desktop computer with a recent version of SPSS Statistics (version 23 or later), SAS (release 9.2 or later, with PROC IML installed) or R (version 3.6; base module only. No packages are used in this course). Learners can choose which statistical package they prefer to use. STATA users can benefit from the course content, but PROCESS makes these analyses much easier and is not available for STATA.

Learning Outcomes

Upon completing this course, you will be able to

- Statistically partition one variable's effect on another into its primary pathways of influence, direct and indirect
- Understand modern approaches to inference about indirect effects in mediation models
- Test competing theories of mechanisms statistically through the comparison of indirect effects in models with multiple mediators
- Understand how to build flexibility into a regression model that allows a variable's effect to be a function of another variable in a model
- Visualize and probe interactions in regression models (e.g., using the simple slopes/spotlight analysis and Johnson-Neyman/floodlight analysis approaches)
- Integrate models involving moderation and mediation into a conditional process model
- Estimate the contingencies of mechanisms through the computation and inference about conditional indirect effects
- Determine whether a mechanism is dependent on a moderator variable
- Apply the methods discussed in this course using the PROCESS procedure for SPSS, SAS and R
- Talk and write in an informed way about the mechanisms and contingencies of causal effects

Faculty

DR. ANDREW HAYES, PHD

Dr. Andrew Hayes is a quantitative methodologist and holds a PhD in Psychology from Cornell University as well as a BA in Psychology from San Jose State University. His research and writing on applied statistical methods has been published in such journals as Psychological Methods, Multivariate Behavioral Research, Behavior Research Methods, British Journal of Mathematical and Statistical Psychology, Psychological Science, Journal of Educational and Behavioral Statistics, American Behavioral Scientist, Communication Monographs, Journal of Communication and Australasian Marketing Journal, among many others. He is the author of Introduction to Mediation, Moderation, and Conditional Process Analysis (2018) and Regression Analysis and Linear Models (2017), both published by The Guilford Press, and Statistical Methods for Communication Science (2005), published by Routledge. He also invented the PROCESS macro for SPSS, SAS and R (processmacro.org) that is widely used by researchers examining the mechanisms and contingencies of effects. He teaches courses on applied data analysis and also conducts online and in-person workshops on statistical analysis to multidisciplinary audiences throughout the world, most frequently to faculty and graduate students in business schools but also in education, psychology, social work, communication, public health and government researchers. His work has been cited over 130,000 times according to Google Scholar and he has been designated a Highly Cited Researcher by Clarivate Analytics in 2019, 2020 and 2021. Visit his website to learn more (afhayes.com).

Register Now

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Mediation, Moderation and Conditional Process Analysis: A Second Course

Leading expert Dr. Andrew Hayes, PhD will guide learners through key topics in causal analysis focusing on advanced applications and methods of mediation, moderation and conditional processanalysis. It is recommended that learners take Part 1: Introduction to Mediation, Moderation and Conditional Process Analysis prior to enrolling in the advanced course.

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Learning Objectives

This second course on mediation, moderation and conditional process analysis continues where the introductory course concludes. Upon completing this learning program, you will have a more detailed understanding of the following topics:

1. Serial mediation and serial moderated mediation
2. Mediation, moderation and conditional process analysis with a multi-categorical cause or moderator
3. Estimating, probing, and interpreting models with two moderators
4. Testing, visualizing, and probing three-way interaction (moderated moderation)
5. Partial, conditional and moderated moderated mediation
6. Using PROCESS and the creation of custom models in PROCESS

Who Will Benefit

This course will be helpful for researchers in any field —including psychology, sociology, education, business, human development, social work, public health, communication and others that rely on social science methodology —who want to learn how to apply the latest methods in moderation and mediation analysis using readily-available software packages such as SPSS, SAS and R. Because this is an advanced course, participants should either be familiar with the contents of the first edition of Introduction to Mediation, Moderation, and Conditional Process Analysis and the statistical procedures discussed therein, or should have taken the first course through Haskayne School of Business Executive Education or other vendors in the recent past. Participants should also have experience using syntax in SPSS, SAS or R and a good working knowledge of multiple linear regression. No knowledge of matrix algebra is required or assumed, nor is matrix algebra ever used in the course. Some prior use of PROCESS is desirable but not required, as a review of the use of PROCESS syntax is included in one of the course modules.

Dates: October 12, 2022
Program Delivery: Online, asynchronous
Commitment: 3 weeks
Investment: $625 (Canadian dollars)

Summary

Statistical mediation and moderation analyses are among the most widely used data analysis techniques.

Mediation analysis is used to test various intervening mechanisms by which causal effects operate. Moderation analysis is used to examine and explore questions about the contingencies or conditions of an effect, also called "interaction." Conditional process analysis is the integration of mediation and moderation analysis and used when one seeks to understand the conditional nature of processes (i.e. "moderated mediation")

In his book, Introduction to Mediation, Moderation, and Conditional Process Analysis: A RegressionBased Approach, Dr. Hayes describes the fundamentals of mediation, moderation and conditional process analysis using ordinary least squares regression. He also explains how to use PROCESS, a freely-available and handy tool he invented that brings modern approaches to mediation and moderation analysis within convenient reach. This online course picks up where the first introductory course leaves off. After a review of basic principles, it covers material in the second edition of the book not covered in the first course, as well as new material not available in the book.

Time Commitment and Course Delivery

This online course consists of a collection of 10 modules in the form of videos and exercises that can be completed with a time commitment of about 6-8 hours/week. You can participate at your own convenience; there are no set times when you are required to be online during the offering period, and you can rewind the videos and review modules completed at your leisure. Questions can be sent to the instructor and others in the class through a discussion board on the course delivery platform. The course can be accessed with any recent web browser on almost any computing platform, including iPhone, iPad and Android devices.

Computing

Computer applications will focus on the use of ordinary least squares regression and the PROCESS macro for SPSS, SAS and R developed by the instructor that makes the analyses described in this class much easier than they otherwise would be. This is a hands-on course, so maximum benefit results when learners can follow along with analyses using a laptop or desktop computer with a recent version of SPSS Statistics (version 23 or later), SAS (release 9.2 or later, with PROC IML installed) or R (version 3.6; base module only. No packages are used in this course). Learners can choose which statistical package they prefer to use. STATA users can benefit from the course content, but PROCESS makes these analyses much easier and is not available for STATA.

Learning Outcomes

Upon completing this course, you will be able to:

- Estimate and interpret mediation models with mediators operating in serial
- Conduct a conditional process analysis with models with more than one mediator (serial and parallel)
- Understand the concept of differential dominance and appreciate its value in theory and research
- Estimate and interpret relative direct, indirect, and total effects in a mediation model with a multicategorical (more than 2 groups) independent variable
- Test, visualize, probe and interpret moderation (interaction) in a model with a multi-categorical independent variable or moderator
- Conduct a conditional process analysis with a multi-categorical independent variable
- Distinguish mathematically and in use the additive (dual moderation) and multiplicative (moderated moderation) model that includes two moderators of the effect of a variable
- Test, visualize, and interpret partial, conditional, and moderated moderated mediation
- Use PROCESS in more advanced ways, such as how to modify a numbered model or create a custom model

Faculty

DR. ANDREW HAYES, PHD

Dr. Andrew Hayes is a quantitative methodologist and holds a PhD in Psychology from Cornell University as well as a BA in Psychology from San Jose State University. His research and writing on applied statistical methods has been published in such journals as Psychological Methods, Multivariate Behavioral Research, Behavior Research Methods, British Journal of Mathematical and Statistical Psychology, Psychological Science, Journal of Educational and Behavioral Statistics, American Behavioral Scientist, Communication Monographs, Journal of Communication and Australasian Marketing Journal, among many others. He is the author of Introduction to Mediation, Moderation, and Conditional Process Analysis (2018) and Regression Analysis and Linear Models (2017), both published by The Guilford Press, and Statistical Methods for Communication Science (2005), published by Routledge. He also invented the PROCESS macro for SPSS, SAS and R (processmacro.org) that is widely used by researchers examining the mechanisms and contingencies of effects. He teaches courses on applied data analysis and also conducts online and in-person workshops on statistical analysis to multidisciplinary audiences throughout the world, most frequently to faculty and graduate students in business schools but also in education, psychology, social work, communication, public health and government researchers. His work has been cited over 130,000 times according to Google Scholar and he has been designated a Highly Cited Researcher by Clarivate Analytics in 2019, 2020 and 2021. Visit his website to learn more (afhayes.com).

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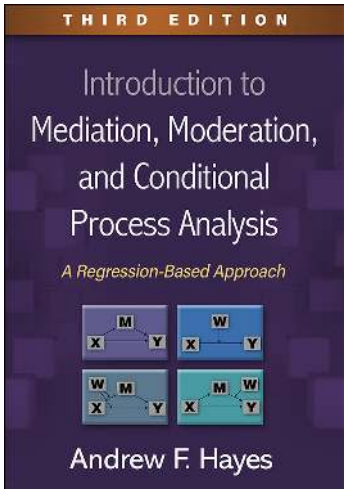

2022, Hardcover
7" x 10", 732 Pages, $75.00

e-Book Coming Soon
www.guilford.com/p/hayes3

Introduction to Mediation, Moderation, and Conditional Process Analysis

THIRD EDITION

A Regression-Based Approach

Andrew F. Hayes

"I know I speak for organizational researchers and graduate students everywhere when I say how much PROCESS, and prior editions of this book, have contributed to making some of the more difficult parts of the research process accessible and fun. I look forward to using the third edition in my own research, and (again) buying a copy for all my graduate students. Adding to the appeal of the third edition are features such as the new code for R users—now available for every example in the book—and techniques to analyze the strength of two specific direct effects that differ in sign. Hayes has made an immense contribution with his continual updates to PROCESS, and shows in his writing and his workshops that he is a gifted teacher."
— **Julian Barling**, **PhD**, FRSC, Distinguished University Professor and Borden Chair of Leadership, Smith School of Business, Queen's University, Canada

"This book would make an excellent companion text to accompany a course on regression analysis that also addresses mediation and moderation, two topics of enormous practical utility. It can also serve as a useful reference for more experienced researchers and methodologists wanting to learn about mediation, moderation, and advanced applications. Reading this book is like taking an immersive workshop on mediation and moderation analysis, with the author right there to explain everything."
— **Kristopher J. Preacher**, **PhD**, Department of Psychology and Human Development, Peabody College, Vanderbilt University

"I have used this text for several years in my graduate-level statistics classes. It makes the teaching of mediation and moderation much easier, and the associated PROCESS code makes conducting these analyses much less tedious. Colleagues have found this book and PROCESS very helpful in their research endeavors, and several of my students have used PROCESS in their theses and dissertations. The third edition has all of the things I liked about the earlier editions, plus some nice new stuff—the inclusion of R code will be helpful to those who do not have access to SAS or SPSS, and I especially enjoyed the more detailed discussion of unstandardized, standardized, and partially standardized coefficients. I recommend this book without reservation."
— **Karl L. Wuensch**, **PhD**, Department of Psychology, East Carolina University

"This book is a staple on my bookshelf and a text that I recommend to all my students who are interested in quantitative research. The impressive third edition now includes code and examples for R. Making the incredibly flexible and useful analytic tools of PROCESS available for a free, open-source statistical software program is a huge contribution to the field. This is a most useful book for advanced graduate courses that focus on regression, as well as for faculty."
— **Michael D. Broda**, **PhD**, School of Education, Virginia Commonwealth University

Acclaimed for its thorough presentation of mediation, moderation, and conditional process analysis, this book has been updated to reflect the latest developments in PROCESS for SPSS, SAS, and, new to this edition, R. Using the principles of ordinary least squares regression, Andrew F. Hayes illustrates each step in an analysis using diverse

examples from published studies, and displays SPSS, SAS, and R code for each example. Procedures are outlined for estimating and interpreting direct, indirect, and conditional effects; probing and visualizing interactions; testing hypotheses about the moderation of mechanisms; and reporting different types of analyses. Readers gain an understanding of the link between statistics and causality, as well as what the data are telling them. The companion website (*www.afhayes.com*) provides data for all the examples, plus the free PROCESS download.

Find full information about this title online: www.guilford.com/p/hayes3