PennState
College of Health and
Human Development

The Methodology Center

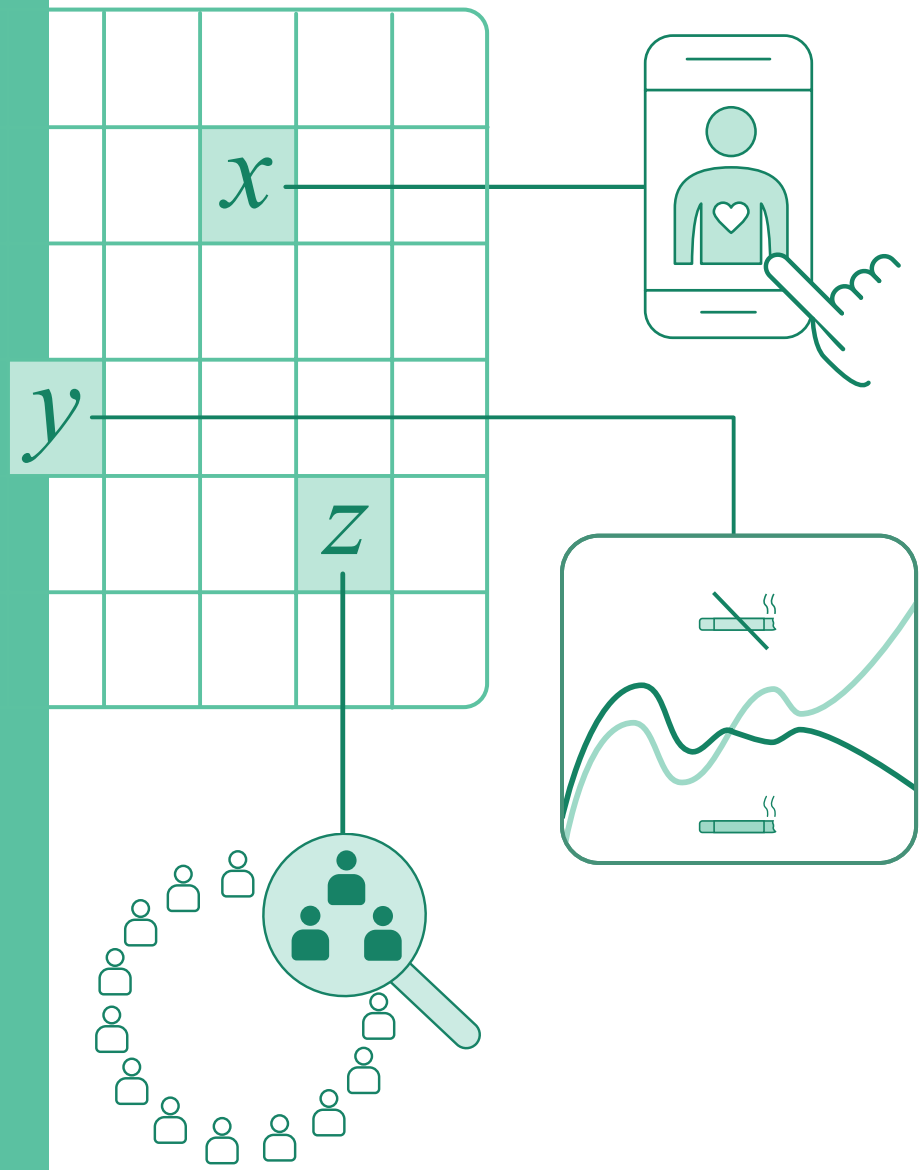
ADVANCING METHODS, IMPROVING HEALTH

annual report

2017 - 2018

our mission

is to advance public health by improving experimental design and data analysis in the social, behavioral, and health sciences. We draw upon and integrate methodological perspectives from a variety of disciplines, including statistics, engineering, psychology, and human development, to develop new quantitative methods for research focusing on vital public health issues, especially drug abuse and HIV.



from the director

The Methodology Center recently completed the second year of a five-year, P50 Center of Excellence grant from the National Institute on Drug Abuse. This grant serves as the cornerstone of our funding. The P50's research projects are in full swing, and we are very excited about the science that we are producing. We are developing new collaborations with statisticians and machine learning specialists, and together we are developing new statistical approaches to help address public health problems. We are also applying innovative methods to areas like HIV viral-load suppression and weight loss in new collaborations with experts in prevention and intervention. It is an exciting time for us as these collaborations begin to bear fruit.

In this year's Annual Report, we introduce our outreach initiatives. We focus on some of the resources that are designed to help health researchers around the nation understand and apply the methods we develop. We also introduce a few of the researchers who have taken advantage of our trainings and resources and describe their excellent work.

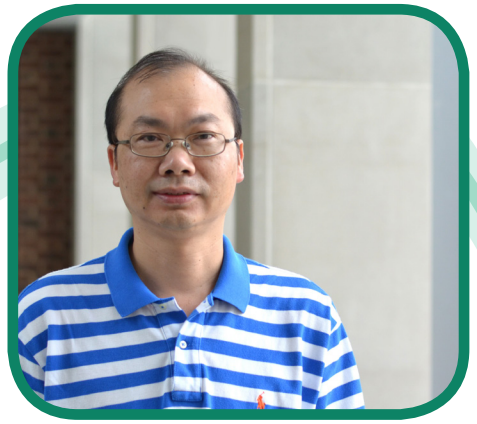
The other topic of this report is our research on optimizing health interventions. This is the focus of my own research, and I am very pleased to share a bit about what my collaborators and I are doing. During the coming year, the optimization project will release several new training resources. In the fall semester, we will release a video introduction to the multiphase optimization strategy (MOST). I will also host a 1 & 1 online training; see pages five and six for more information about 1 & 1s and other resources. Finally, we are planning a five-day training on MOST for May 14-18, 2018 in Bethesda, Maryland.

For information about new resources and opportunities as they come up, related to MOST and all the other research topics in the Center, sign up for our electronic newsletter at the bottom of our webpage, methodology.psu.edu.

Thank you for taking a few minutes to learn about our research!

Linda M. Collins
Director, The Methodology Center
Distinguished Professor, Human Development and Family Studies
Professor, Statistics

current research



Variable Screening and Selection

In genetic studies there may be hundreds of subjects and hundreds of thousands of variables. Nearly all techniques for exploratory data analysis break down when the number of variables exceeds the sample size. High-dimensional variable-screening procedures allow researchers to narrow the subset of variables for analysis. We developed two SAS procedures and an R package that enable researchers to select relevant variables from large data sets. Runze Li and his research team are using data from a study of mice to explore behavioral phenotypes associated with subsets of genes.

Latent Class Modeling

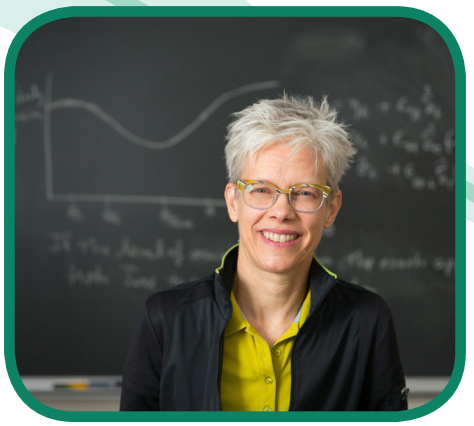
Latent class analysis (LCA) enables researchers to detect unobservable (latent) subgroups within a population. By expanding LCA models, we make it possible for intervention scientists to better target the subgroups who will benefit the most. Bethany Bray and her research team are working to develop extensions of various latent class models. Over twenty years, we have developed longitudinal extensions of LCA, methods for LCA with a distal outcome, and other extensions of LCA.

Multiphase Optimization Strategy (MOST)

MOST is a framework for engineering effective and efficient health interventions. MOST enables intervention designers to understand which parts of an intervention are contributing to improved health. MOST also enables intervention designers to manage resources efficiently. See pages nine and 10 for more on MOST.

Time-Varying Effect Modeling (TVEM)

TVEM is a flexible tool that can answer questions about associations over time. It can be used with multiple data types, including intensive longitudinal data, panel data, and cross-sectional data. TVEM enables researchers to model relationships between variables without assuming a parametric relationship between those variables. Stephanie Lanza leads our research to extend and apply this method. Researchers are applying TVEM to better understand processes associated with quitting smoking, heavy episodic drinking, marijuana use disparities by race, and more.



Adaptive and Just-In-Time Adaptive Interventions

Adaptive interventions are treatments that are tailored to meet a patient's individual and changing needs. A just-in-time adaptive intervention (JITAI) is a special kind of adaptive intervention that provides treatment to people exactly when and where it is needed by using mobile technology like smartphones. Susan Murphy and her research team are developing methods for improving the development of JITAIs and adaptive interventions. Their methods are being used in trials around the world to build empirically validated interventions to address a wide range of health problems, including drug dependence, attention-deficit/hyperactivity disorder, alcoholism, and autism.

Photo: John D. & Catherine T. MacArthur Foundation

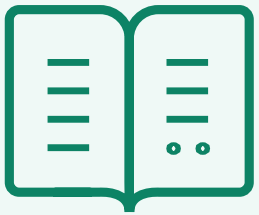
Analysis of Intensive Longitudinal Data

The Methodology Center has developed methods for the analysis of intensive longitudinal data for more than a decade. Walls and Schafer's 2006 book, *Models for Intensive Longitudinal Data* has been cited hundreds of times. Our research into time-varying effect modeling (TVEM)—which is now its own area of research—originally was developed by Runze Li for the analysis of intensive longitudinal data. Currently, research associate Michael Russell is leading a project to develop and apply new methods to analyze ecological momentary assessment data from a study to validate self-reported alcohol use behavior.

outreach

At The Methodology Center, we work to disseminate new methods using a broad array of traditional and nontraditional channels. Recently, we have been developing a larger set of online resources at **methodology.psu.edu**.

SCIENTIFIC DISSEMINATION



Publications

56

In 2016, The Methodology Center published 56 articles in a broad range of journals. Publications include highly technical articles that propose new statistical methods and applications of methods to current public health issues.

Conferences

87

The Methodology Center presented our research 87 times at conferences during 2016. This allowed us to share our work with methodologists, statisticians, and public health researchers who are addressing substance use, HIV, and more.

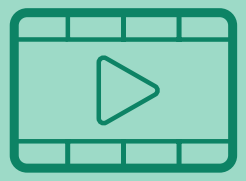
INSTRUCTOR RESOURCES

Teachers' Corners

NEW!

Teachers' Corner is a new initiative that consolidates materials for instructors of graduate-level methods courses, allowing them to incorporate innovative methods into their courses. The Teachers' Corner for latent class analysis (LCA) is online now.

RESEARCHER RESOURCES



Introductory Videos

NEW!

Our introductory videos are a quick way for scientists to become acquainted with a new method. Once scientists know they are interested, they can move on to reading articles in our reading lists or listening to a relevant podcast.

1 & 1

NEW!

1 & 1 is a new initiative to provide access to our methodological experts via video conference. Each 1 & 1 comprises a one-hour introduction to a method followed by an hour of Q&A between the presenter and the workshop participants.

Podcasts

28

As of 2017, the Center boasts a library of 28 podcasts that introduce a specific researcher's work or a specific method. Podcasts are released about three times per year and usually include a host and one or two scientists discussing research.

Software

13

In support of innovative research, we issued 13 software releases in the last year. Our website offers over 20 downloads for platforms like SAS, Stata, and R. We also offer several web applets for performing calculations right on the web.

methods in action

Dr. Connie Kasari is Professor of Human Development and Psychology and a researcher in the Center for Autism Research and Treatment at UCLA. Her research focuses on diagnosis and treatment of children with autism spectrum disorder (ASD). As part of her goal of "creating interventions that are successful, backed by research, and able to be implemented in every day settings," she collaborates with Susan Murphy and Daniel Almirall on trials to develop adaptive interventions that improve language usage or social connectedness among children with ASD.

Kasari began work with Murphy in 2009 on a study that used iPads to facilitate communication among minimally verbal, school-aged children with ASD. To determine how to improve language skills most effectively, the researchers developed a sequential, multiple assignment, randomized trial (SMART). A SMART provides data that enable scientists to build empirically based rules for how and when an intervention should change. Since that time, Kasari has worked with Almirall on two more adaptive interventions for children with ASD. In one, the research team is using a SMART to develop an adaptive intervention that uses three different evidence-based interventions to improve verbal communication. Their most recent collaboration is a pilot study to guide the development of a school-wide intervention to improve social connectedness and academic engagement among school-aged children with ASD.

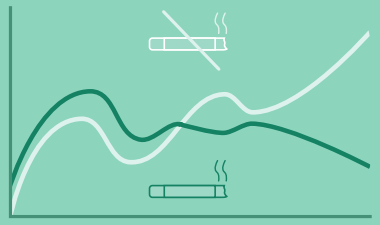
"If we want our research to make a real-world impact, we need to learn how to improve outcomes for the greatest number of kids. This requires science that answers questions such as 'What do we do next for a child who—after 6 weeks on a treatment—is not improving as much as he could?' By working closely with Susan Murphy and Danny Almirall, we have been able to answer questions such as this."

Dr. Stephanie Fitzpatrick is an Investigator at the Kaiser Permanente Center for Health Research and has a background in clinical health psychology. Her research focuses on incorporating interventions for obesity and chronic disease management into primary care practice. After attending the 2009 Methodology Center Summer Institute: Latent Class and Latent Transition Analysis by Linda Collins and Stephanie Lanza, Fitzpatrick began to incorporate latent class analysis (LCA) in her research. Most recently, she used LCA in the article, "Application of latent class analysis to identify behavioral patterns of response to behavioral lifestyle interventions in overweight and obese adults," in the *International Journal of Behavioral Medicine* (2015). Her current research includes a grant from the National Institute of Diabetes and Digestive and Kidney Diseases to apply LCA to existing behavioral clinical trial data sets. The project goal is to identify subgroups of individuals who maintain healthy behavior changes for a year and determine baseline predictors of sustained behavior change.

Fitzpatrick has participated in two Methodology Center Summer Institutes. She has published two articles that use latent class models to examine issues related to obesity and has a third article currently under review.

"The Methodology Center provides awesome training and resources in LCA and LTA that makes it easy to understand these analytic approaches and apply in my own work. Bethany Bray, Stephanie Lanza, and Linda Collins have been great supporters and a major help in this area of my research."

"The training at the Methodology Center really set me up well to independently apply TVEM and disseminate the findings through conference presentations and publications."



Dr. Sarah Dermody is Assistant Professor in the School of Psychological Science at Oregon State University. She studies processes contributing to substance use risk and associated interventions, and health disparities based on gender, sexuality, and co-occurring mental health disorders. Specifically, her work focuses on identifying ways to intervene with problematic substance use and disparities in health risk processes.

As a graduate student at the University of Pittsburgh, Dermody developed an F31 NIH grant proposal to examine the effects of nicotine reduction in cigarettes on alcohol use. She wanted to examine whether the effects of the intervention on drinking would change over time. This led her to The Methodology Center's time-varying effect modeling (TVEM) software. Dermody worked with Stephanie Lanza on her successful grant proposal.

Dermody then participated in a one-credit course on TVEM taught by Lanza. After this training, she authored the tutorial paper, "Modeling the complexity of dynamic, momentary interpersonal behavior: Applying the time-varying effect model to test predictions from interpersonal theory," in the *Journal of Research in Personality* (2017). In this article, she applied TVEM to examine dynamic interpersonal processes for the first time.

MOST

Multiphase Optimization Strategy

What would an engineer do?

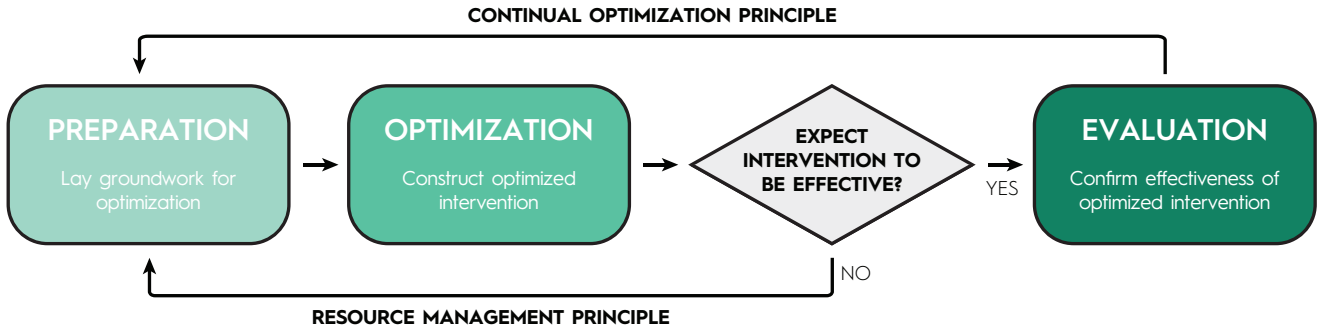
Imagine that Company A manufactures widgets. Their current widgets are too brittle, so Company A wants to manufacture widgets that are more flexible. If they were to approach this problem the way behavioral scientists traditionally have approached designing health interventions, they might develop a new manufacturing process by improving all of the factors under their control at once: say, changing the materials used, increasing the heating temperature and duration, reducing the cooling temperature, and increasing the cooling duration. Then they would conduct an experiment to test whether the new manufacturing process produced widgets that were more flexible than the old ones.

In reality, Company A would never follow that protocol because that type of experiment wouldn't reveal which of the changes to the manufacturing process actually improved the widgets. What if one of the changes actually decreased flexibility, but its damage was offset by positive changes? In order to understand the consequence of each aspect of the manufacturing process, engineers would conduct experiments that allow them to examine the effect that each aspect of the process has on the final product. Methodology Center Director Linda Collins and her collaborators developed the multiphase optimization strategy (MOST) to bring this type of understanding to the development of health interventions. MOST enables intervention designers to understand which components are contributing toward the success or failure of an intervention.

What is MOST?

MOST is a comprehensive, engineering-inspired framework for optimizing and evaluating behavioral, biobehavioral, and biomedical interventions. MOST comprises three phases: preparation, optimization, and evaluation. During preparation, investigators lay the groundwork for optimization by developing a conceptual model of how they think the intervention will function, identifying the optimization criterion and potential intervention components, and (as needed) pilot testing the components. During optimization, investigators conduct an optimization trial using the most efficient means available. Possible designs include factorial experiments (the type most often used in engineering); sequential, multiple assignment, randomized trials (SMARTs); and micro-randomized trials. Then, the information produced by the optimization trial is used to decide what will be included in the intervention. During evaluation, a randomized controlled trial (RCT) is performed to establish whether the optimized intervention is a real improvement over the existing intervention or standard-of-care treatment. MOST is iterative, providing the opportunity for continual, cumulative improvement. Once an optimized intervention has been deployed, investigators can return to the preparation phase and develop an even better intervention, possibly based on a different criterion. Just as a widget manufacturer might develop a more flexible widget and then want to manufacture that widget more cheaply, intervention developers should plan for continual improvement.

MOST always uses optimization criteria selected by the scientist. The criterion selected for a project may be to develop a cost-effective intervention, the briefest intervention that achieves a minimum level of effectiveness, or any other reasonable goal. MOST relies on resource management by strategic use of highly efficient experimental designs. MOST is designed to be practical and can advance the improvement of interventions without requiring a dramatic increase in research resources. Several projects following MOST are addressing a broad array of health problems, from obesity to HIV to substance use.

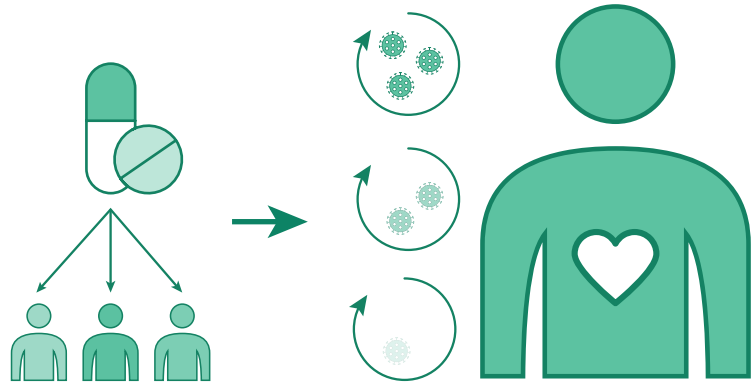


Improving treatment engagement among people living with HIV

In one current project, funded by a five-year grant from the National Institute on Drug Abuse, Collins is collaborating with Marya Gwadz, Director of the Transdisciplinary Research Methods Core in the Center for Drug Use and HIV Research at New York University. The objective of the project is to use MOST to increase treatment engagement among African-American/Black and Hispanic people living with HIV. Gwadz and Collins are targeting people who are not consistently engaged in HIV primary care.

"At least half of people living with HIV in the U.S. are neither sufficiently engaged in HIV primary care nor taking antiretroviral therapy," said Gwadz. "In particular, African-American/Black and Hispanic people are less likely to be well-engaged along the HIV care continuum than their White peers and, as a result, have lower rates of HIV viral suppression, greater morbidity, and earlier mortality from HIV."

The research team is examining five components that are candidates for inclusion in the final intervention. Each component is intended to promote engagement in both HIV treatment and primary care, either through skill building or by providing support to participants. The overall goal of the intervention is to decrease the amount of HIV virus that exists in each participant's immune system until the virus can be said to be "suppressed." By following MOST, the researchers will ensure that each component included in the final intervention is contributing to viral suppression and treatment engagement.



Wise use of resources

Two principles drive decisions made during MOST: the resource management principle and the continual optimization principle. The resource management principle states that experiments should be designed to extract the maximum amount of useful knowledge in the most efficient manner. The continual optimization principle states that optimization is a process that always offers the possibility of further improvement. Thus a new and improved version of any intervention can be under development even as the current generation of the intervention improves public health. As more and more projects follow MOST, the science of building interventions can move forward more quickly, and we can better address HIV, obesity, opioid abuse, smoking, and the other daunting health problems of our time.

fond farewell

For over two decades, Tina Meyers served as The Methodology Center's administrative support coordinator. During that time, she was Center Director Linda Collins' right hand. Tina took care of all the things we never knew we needed to keep the Methodology Center running smoothly. Everyone who has ever met her knows how warm she is and what a joy she is to work with. Tina retired on June 30, 2017, and we wish her great success and happiness during her well-earned retirement. We already miss her!

Congratulations, Tina!

TO LEARN MORE ABOUT THE METHODOLOGY CENTER, VISIT **methodology.psu.edu.**

our funding

Research at The Methodology Center is funded by grants from the National Institutes of Health, primarily the National Institute on Drug Abuse, the National Cancer Institute, the National Institute of Diabetes and Digestive and Kidney Diseases, and the National Institute on Alcohol Abuse and Alcoholism. The Methodology Center also receives significant support from Penn State's College of Health and Human Development.