PennState

The Methodology Center

ADVANCING METHODS, IMPROVING HEALTH

Annual Report

2016-17

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

For the past few years, The Methodology Center has been moving into an exciting new research area. Mobile health, or mHealth, is the use of mobile devices such as smartphones to measure health characteristics and deliver health interventions. The promise of mHealth is the ability to deliver individually tailored interventions to large numbers of people at relatively low cost. mHealth studies generate huge amounts of complex data, calling for new methods to maximize the amount of scientific knowledge gained from this research.

We are developing methods for the analysis of data from mHealth studies and for the empirical design of mHealth interventions. We collaborate with many of the nation's top researchers in fields such as smoking cessation, opioid-addiction recovery, autism, cardiovascular health, and HIV/AIDS. These collaborations produce important scientific advances that improve public health and serve as demonstration projects so that other researchers in the relevant fields can see the value of our methods.

In this year's Annual Report, we highlight a few of our most productive collaborations, and we introduce a few of our stellar trainees. As these demonstration projects and our former trainees spread out across the country, so do the reach and impact of the methods we develop.

I hope you enjoy learning about our work.

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

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

Our Largest Research Projects

Susan Murphy (right) collaborates with Inbal "Billie" Namum-Shani (left) and Daniel Almirall (center) on research into JITAIs. Almirall and Nahum-Shani lead research on SMART, which is based on work by Murphy.

Just-in-Time Adaptive Intervention (JITAI)

A JITAI determines when an intervention is needed based on data that are collected actively (like smartphone prompts that inquire about mood) or passively (like smartphone GPS data that indicate when a person is traveling in a vehicle). Principal Investigator Susan Murphy and her team are developing microrandomized trial designs and machine learning algorithms to create JITAIs that are responsive to each person's conditions and that learn over time what is effective or ineffective for each person.

2016 Highlight: *Susan Murphy elected to the National Academy of Sciences*

Sequential, Multiple Assignment, Randomized Trial (SMART)

SMART experimental designs provide high-quality data for constructing empirically validated adaptive interventions. Adaptive interventions are treatments that are individually tailored to meet a patient's changing needs. A SMART can be used to create adaptive interventions that improve outcomes while decreasing patient burden. Dozens of studies around the world are using SMART designs to address a wide range of health problems, including drug dependence, ADHD, alcoholism, and autism.

2015-16 Highlight: *NIDA R01 grant funding five more years of research to develop SMART*

Linda Collins (center) collaborates with Kari Kugler (right) and Kate Guastaferro (left) on the dissemination and application of MOST.

Multiphase Optimization Strategy (MOST)

MOST is a framework for engineering effective and efficient behavioral and biobehavioral interventions. MOST is an iterative process with three phases: preparation, optimization, and evaluation. By following MOST, intervention designers can understand which aspects of an intervention are working. By emphasizing careful resource management, MOST can maximize the gain of scientific information.

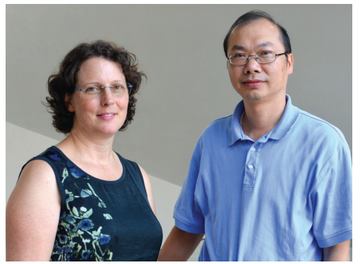
2016 Highlight: *Collaboration with Center for Drug Use and HIV/HCV Research at NYU on new grant to increase treatment engagement among minorities living with HIV*

Bethany Bray (right) and Stephanie Lanza (left) lead Center research on mixture models, including LCA.

Latent Class Analysis (LCA)

LCA allows 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. Over twenty years, we have developed longitudinal extensions of LCA, methods for LCA with a distal outcome, and other extensions of LCA. Our LCA software for SAS and Stata has allowed thousands of researchers to perform LCA on their data.

2015-16 Highlight: *Release of Stata functions to perform bootstrap likelihood ratio test and to estimate the association between a latent class variable and a distal outcome*

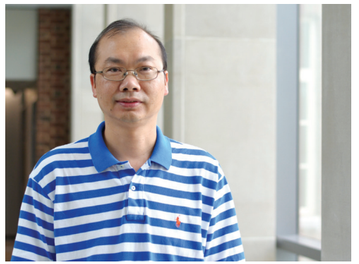


Stephanie Lanza (left) works to disseminate and expand TVEM, a statistical method developed by Runze Li (right).

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 allows researchers to uncover changes in the relationships between variables. It enables researchers to model those relationships without assuming a parametric relationship between the variables.

2015-16 Highlight: *A year of rapid growth for TVEM, capped by a standing-room-only session on TVEM at the Society for Prevention Research 2016 Annual Meeting*



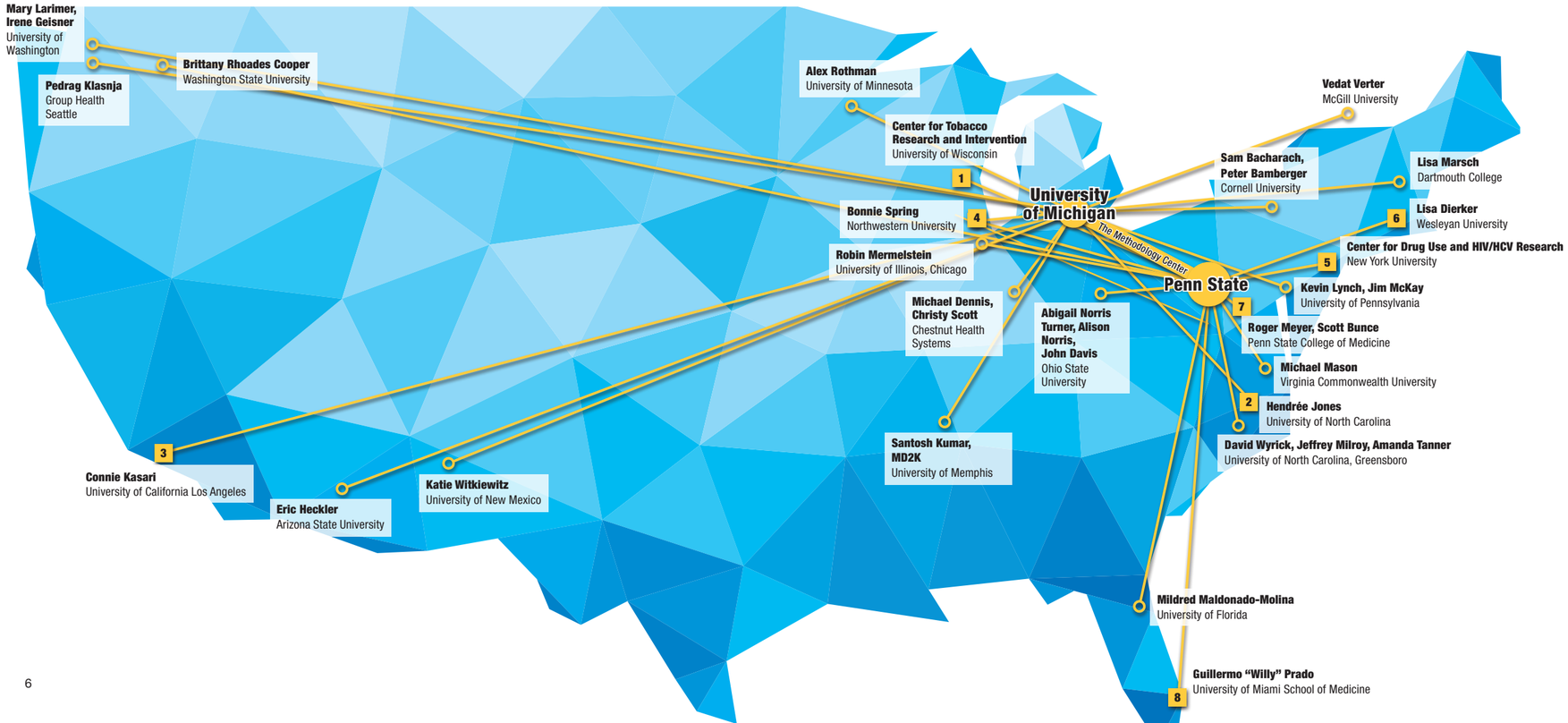
Runze Li leads the statistical research on variable screening and selection in massive data sets.

Variable Screening & 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 that enable researchers to select relevant variables from large data sets.

2016 Highlight: *Sixteen peer-reviewed articles published or accepted for publication*

Collaborations Around the Nation



The Methodology Center collaborates with top researchers to address a broad variety of health problems.

Here are a few examples of the depth and breadth of our collaborations.

1. Center-to-Center collaboration: **University of Wisconsin Center for Tobacco Research and Intervention (UW-CTRI)**. Drs. Michael Fiore, Timothy Baker, Megan Piper, and others at UW-CTRI became the first research group to follow the multiphase optimization strategy in a large-scale smoking intervention. Their first round of funding resulted in three experiments with 80 different conditions in the field simultaneously. They are now refining the intervention.

2. Dr. Hendrée Jones of The University of North Carolina at Chapel Hill works with Susan Murphy to implement sequential, multiple assignment, randomized trials to develop innovative, effective, cost-effective ways to prevent drug abuse among pregnant women.

3. Dr. Connie Kasari of The University of California Los Angeles works with Daniel Almirall and Susan Murphy to implement sequential, multiple assignment, randomized trials to develop the most appropriate adaptive interventions for children with autism spectrum disorder who are minimally verbal.

4. Dr. Bonnie Spring of Northwestern University collaborates with Inbal "Billie" Nahum-Shani, Linda Collins, and Susan Murphy on several projects that combine technology with innovative experimental designs in order to promote weight loss.

5. Center-to-Center collaboration: **Center for Drug Use and HIV/HCV Research** at New York University. Dr. Marya Gwadz and others are working with Linda Collins to build an optimized intervention that will improve treatment engagement among African-American and Hispanic people living with HIV/AIDS.

6. Dr. Lisa Dierker of Wesleyan University collaborates with Stephanie Lanza and Runze Li to apply novel analytic methods to uncover the mechanisms that lead young people to start and escalate smoking.

7. Drs. Roger Meyer and **Scott Bunce** of Penn State College of Medicine are working with Stephanie Lanza and others at Penn State to improve treatment outcomes for patients recovering from opioid dependence. By following patients for seven months, researchers will track changes in the patients' brain reward systems from initial detoxification through residential care and a follow-up period.

8. Dr. Guillermo "Willy" Prado of the University of Miami School of Medicine and Bethany Bray are using latent class analysis to investigate differential treatment effects of the Familias Unidas intervention, a culturally sensitive program to prevent substance abuse and HIV-risk behavior among Hispanic youth.

mHealth: Always There When It's Needed

Smartphones and mobile sensors (like Fitbits) can collect massive amounts of data, and these data can be used to help people change their behavior to achieve their long-term goals. Information, including location, mood, activity, and stress, can all be obtained unobtrusively or passively. Methodology Center researchers are working to expand and improve methods for mHealth studies and interventions so that mHealth can provide maximum benefit to the highest number of people.

Measuring Drinking From Moment to Moment

Historically, studies of heavy drinking have relied on self-reports, but there are several problems with people's reports of their own drinking. First, heavy drinking disrupts the memory. Second, drinking games, which are often part of heavy drinking episodes among young adults, can obscure the amount of alcohol ingested. Finally, it can be hard to figure out the concentration of alcohol in a particular drink. Only recently has technology become available to measure the accuracy of self-reported data on drinking.

New data + new methods = new answers


Michael Russell

A new study at the Methodology Center by Michael Russell combines ecological momentary assessment (EMA) of self-reported alcohol use with continuous data from ankle


An alcohol monitor used in the BAC study

bracelets that measure blood alcohol content (BAC) through contact with the skin. By applying innovative methods to these two data types, Russell will investigate the accuracy of using EMA self-reports as a proxy for actual BAC. He will also seek to identify time points during a drinking episode when an intervention delivered via smartphone might curb heavy drinking and the associated negative health outcomes. Once this pilot project is complete, Russell intends to apply for a larger grant to extend the research and develop a JITAI.

Intervention in Your Pocket

In just-in-time, adaptive interventions (JITAIs), continuously collected data from a mobile device and/or wearable sensor are combined with each participant's preferences and characteristics to select an appropriate intervention whenever and wherever it is needed. Realistically, a clinician can only check in with participants at appointed times, but people generally carry their smartphones, and those phones contain a lot of information about when each person is or is not at risk. By leveraging these data, JITAIs can help people exercise more, avoid drug use, stop smoking, and more.

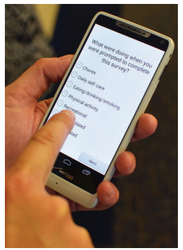
Assisting people in recovery who are on the verge of lapse


Susan Murphy

Susan Murphy is collaborating with Drs. Christy Scott and Michael Dennis of Chestnut Health Systems on improving an intervention for individuals with a history of substance use disorders. The intervention provides individuals recovering from substance abuse or dependence with a smartphone that contains a special app. The app prompts participants six times per day to answer questions about a range of variables, including their level of craving, risk factors for substance use, level of physical pain, and exposure to drugs and/or alcohol. Using data provided by the participant and data passively collected by the phone, the future app might deliver helpful risk-reducing suggestions to the person whenever high risk is indicated. The data can also be used to improve scientists' understanding of how pain affects relapse: Investigators will assess whether and how pain moderates the effect of the interventions on substance-use craving. Investigators will also examine other complicated relationships, such as whether recommending craving-reduction exercises during the day has an impact on substance-use craving in the evening. The researchers will develop methods for building JITAIs, create an adaptive intervention, and increase knowledge about the way pain management influences participants' ability to avoid substance use lapses.

Helping cardiac patients get moving

In another new study, HeartSteps, researchers are developing a JITAI that encourages physical activity among people recovering from a cardiac event. Researchers identified five times throughout the day when people are most likely to engage in physical activity. The HeartSteps app uses passively collected data to determine how to tailor and whether or not to provide tailored physical activity suggestions. The suggestions are tailored based on the participant's current location, time of day, quality of the weather, and day of the week. Also, suggestions are not delivered to participants if they are already exercising. By rating each prompt, participants help improve the quality of future suggestions for all participants.



Answering a question in an mHealth app

Solving the mHealth Dropout Problem

One of the barriers to widespread use of mHealth apps is that dropout rates are famously high: Around 75 percent of mHealth apps have been abandoned by the tenth use. The HeartSteps project includes two pilot phases, and following those it will run for a full year. During that time apps will deliver more than 300 suggestions to each participant. This means that scientists must reduce dropout by improving the quality, variety, and salience of the HeartSteps suggestions, relative to other apps. In initial pilot testing, some participants reported feeling like they had a relationship with the app when messages were encouraging and appropriate. When, however, they received the same message multiple times, they reported feeling betrayed. HeartSteps requires a massive number of unique messages, so the investigators are "crowdsourcing" early phases of message authoring using the Amazon Mechanical Turk website. Any improvement to the dropout rate could be a benefit to a broad range of future interventions.

As mHealth becomes a more important tool for helping people manage behavior, Methodology Center researchers will continue to explore and develop new methods to improve the quality of mHealth research and care. By combining new types of data with the appropriate methods, science will help people manage drug use, smoking, physical activity, eating, and other behaviors that influence healthy living.

Trainees

The Future of Prevention and Methodology

The Prevention and Methodology Training (PAMT) program trains doctoral students and postdoctoral researchers in integrating innovative research methods and drug abuse and HIV prevention science. The National Institute on Drug Abuse (NIDA) has funded PAMT continually since 2005. In 2016, NIDA awarded five more years of funding to the program. Over its first eleven years, fifty-three young prevention researchers and methodologists were trained through PAMT. PAMT is a collaboration with our sister center at Penn State, the Bennett Pierce Prevention Research Center, and is directed by Linda Collins and Denni Fishbein. Below are some of the many excellent scientists we have worked with in PAMT.

Phylicia Bediako

PAMT: 2014–2016
Postdoctoral Researcher, University of Miami

Dr. Bediako's research is focused on sexual and reproductive health issues for underserved populations in global settings. Her most current projects are centered around sexual decision making and risk taking among low-income youth in South Africa. She has published two peer-reviewed papers and currently has two papers under review (both first-authored) at journals such as *Journal of Racial and Ethnic Health Disparities* and *Journal of Immigrant and Minority Health.*

Megan Schuler

PAMT: 2014–2015
Marshall J. Seidman Fellow in Health Care Policy, Harvard Medical School

Dr. Schuler's research focuses on the application of advanced statistical methods to study the effectiveness of substance use treatment, barriers to treatment, and comorbidity of substance use and mental health disorders. She has published ten peer-reviewed papers (seven first-authored) in journals such as *American Journal of Epidemiology, Drug and Alcohol Dependence, Health Services and Outcomes Research Methodology,* and *Psychiatric Services.*

Daniel "Max" Crowley

PAMT: 2010–2012
Assistant Professor in Human Development and Family Studies, Penn State

Dr. Crowley investigates early education and the prevention of health inequalities and criminal behavior through evidence-based resource investments in childhood and adolescence. In 2013, he was invited to become a National Bureau of Economic Research Crime Research Fellow. He has published twelve peer-reviewed papers (eight first-authored) in journals such as *Journal of Adolescent Health, Prevention Science,* and *Criminology & Public Policy.*

Melissa Lippold

PAMT: 2008–2010
Assistant Professor, School of Social Work, University of North Carolina–Chapel Hill

Dr. Lippold researches the role that parent-youth relationships play in the prevention of adolescent risky behavior and the promotion of adolescent physical health. She also investigates how parent and child characteristics influence variability in parenting behaviors. She has published nineteen peer-reviewed papers (thirteen first-authored) in journals such as *Journal of Research on Adolescence, Journal of Family Psychology, Journal of Adolescent Health,* and *Prevention Science.*

Jennifer Kam

PAMT: 2007–2009
Assistant Professor, Department of Communication, University of California–Santa Barbara

Dr. Kam's research uses the stress-coping-resilience framework to investigate experiences related to ethnic/racial identity that may place adolescents at risk for adverse psychological and behavioral health outcomes. Her goal is to identify messages that can discourage substance use, particularly when adolescents face stressors related to ethnic/racial identity and immigration/acculturation processes. In 2016, she received the Early Career Award from the Interpersonal Communication Division at the National Communication Association–the premier association in her field. Dr. Kam has published twenty-eight peer-reviewed papers (nineteen first-authored) in journals such as *Communication Research, Journal of Communication, Prevention Science,* and *Journal of Research on Adolescence.*

Michael Cleveland

PAMT: 2005–2007
Associate Professor of Human Development, Washington State University

Dr. Cleveland researches innovative methods to study adolescent and young adult substance use, with an emphasis on alcohol use and abuse. His methodological interests include latent transition analysis, structural equation modeling, and multi-level modeling. He has served as a co-investigator on many grants from the National Institutes of Health. Dr. Cleveland recently began a National Institutes of Health-funded project to adapt a parent-based intervention to better serve African American youth and their families. He has published forty-three peer-reviewed papers (ten first-authored) in journals such as *Addictive Behaviors, Journal of Studies on Alcohol and Drugs, Alcoholism: Clinical and Experimental Research,* and *Prevention Science.*

Donna Coffman

PAMT: 2005–2007
Assistant Professor of Epidemiology and Biostatistics, Temple University

Dr. Coffman's current work focuses on advancing and applying statistical learning methods for large, complex data to address cutting-edge research questions related to health behaviors. She has been the principal investigator of multiple NIH grants and project director of a scientific component on The Methodology Center's P50. Currently, she has a grant through the Big Data to Knowledge (BD2K) initiative to receive training and conduct research in computational methods for analyzing data from wearable sensors. She received the Early Career Award from the Society for Prevention Research in 2014, and she has published over fifty peer-reviewed papers (seventeen first-authored) in journals such as *Statistics in Medicine, Epidemiology, Childhood Obesity, Psychological Methods,* and *Prevention Science.*

Megan Patrick

PAMT: 2005–2007
Research Associate Professor, Institute for Social Research, University of Michigan

Dr. Patrick's research focuses on the development and consequences of adolescent and young adult risk behaviors, including alcohol use, drug use, and risky sexual behaviors. She works to improve the prevention of health risk behaviors, statistical methods for modeling behavior and behavior change, and web-based survey methodology. Dr. Patrick has been principal investigator on eight NIH grants and is a co-investigator on several others, including "Monitoring the Future" (funded by NIDA). She was awarded the University of Michigan Research Faculty Recognition Award in 2015. She has published eighty-eight peer reviewed papers (forty-seven first-authored) in journals such as *Prevention Science, Drug and Alcohol Dependence, JAMA Pediatrics,* and *Journal of Adolescent Health.*

53 former trainees

16 postdoctoral fellows completed training

37 predoctoral fellows completed training

90% of trainees go on to research careers

8 National Research Service Awards from the National Institutes of Health

400+ peer-reviewed publications

700+ conference presentations

Staying Connected

Each month, we gather for a meeting where we share our achievements over the past month. Each individual sets his or her own short and long term goals, and we track everyone's progress. This lets us share each other's successes and stay in touch with what is going on around The Methodology Center. And for fun, when we meet our goals, we get a fresh baked cookie!

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.

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