Systems Science Applications in the Behavioral and Social Sciences

Opportunities and Challenges at the National Institutes of Health

Patricia L. Mabry, Ph.D.
Office of Behavioral and Social Sciences Research
National Institutes of Health

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Outline

✓ Background on OBSSR at NIH
✓ Why we are supporting systems science for behavioral and social science research (BSSR)
✓ OBSSR and NIH funding opportunities and activities in systems science
✓ Gaps and opportunities in BSSR-SS
✓ Discussion
Background
Patty's brief bio

1997  PhD, Clinical Psychology
      statistical methods, family systems theory

1998  Research Associate
      Small Business Innovative Research Grants (SBIR)

1998-2002  Post Doc (Clinical)
          Assistant Professor
          Tobacco cessation research, measurement, complexity

2001-2005  IPA to Tobacco Control Research Branch
          Contractor (SAIC)
          transdisciplinary research, team science
          measurement, system science

2005-now  Senior Advisor
          interdisciplinary research, systems science
OBSSR in the NIH Context

NIH budget: ~ $31B

BSSR @ NIH: ~ $3.5B

27 Institutes & Centers (ICs):

- National Institute on Aging
- NIDCD
- NIAMS
- NICHD
- NIDDK
- NIAAA
- National Institute of Mental Health
- National Institute on Drug Abuse
- National Institute of Environmental Health Sciences
- NIAID
- NIGMS
- NIMH
- National Institute of Diabetes and Digestive and Kidney Diseases
- National Heart, Lung, and Blood Institute
- National Library of Medicine
- National Institute of Neurological Disorders and Stroke
- National Institute on Alcohol Abuse and Alcoholism
- Fogarty International Center

Division of Program Coordination, Planning, & Strategic Initiatives

Office of Behavioral and Social Science Research

~ $28 M

http://www.nih.gov/about/organization.htm
The OBSSR Mission:

**Stimulate** behavioral and social science research across NIH

**Integrate** behavioral and social science research more fully into the NIH health research

**Improve** understanding, treatment, and prevention of disease
Some New Directions for OBSSR

Planning for the next generation of behavioral and social sciences research

- The next generation of measurement, data, and analytic methods
- Delivering services in a reforming health care system
- Training the next generation of research investigators
Why are we supporting "Systems Science?"
The Complex Problem Space of Human Health

Macro social level

Global economic and geopolitical level
National and state level
Community and workgroup level
Individual, family, and social group level

Micro biological level

Organ level
Cellular level
Molecular level
Genomic level

Lifespan

Figure 1. Health as a continuum between biological and social factors across the lifespan. (Adapted from Glass & McAtee, 2006).
Evolving Landscape in BSSR

Technology

- Computational power
- Cell phone/smart phone ubiquity
- Social media – Facebook, Twitter, YouTube
- GIS – behavior in context
- Sensors and wireless transmission
- Point of sale data
- Nanotechnology
Methods drive the questions that can be asked

Research questions should drive methods

Value of old methods

Need additional methods that address complexity
What is Systems Science?

“Systems science” refers to a family of methodologies

SS methodologies

- enable the study of complex problems
- represent the complexities of a problem in a tractable form by simplifying it while retaining the salient characteristics
- address the “big picture” of a complex problem as well as the components that make up the system
- complement traditional linear, reductionist methods

Modeling and simulation characterize much if not most of the systems science methodologies
Some General Characteristics of SS Methodologies

SS methods are designed to capture:

- Dynamic behavior of the system (change over time)
- Bidirectional relationships (aka feedback loops)
- Non-linearities (threshold behavior, worse-before better)
- Time-delayed effects

SS methods can help detect:

- Unintended consequences
- Emergent properties – individual behavior leads to aggregate outcome
- Gaps in existing knowledge; sensitivity analysis can tell us how important they are

Enable virtual experimentation – *in silico* laboratories

Can generate hypotheses for empirical testing
Systems Science approaches appreciate the complexity, context, dynamic nature, and emergent phenomena associated with the problem under study.

“Systems Science” methodologies include, but are not limited to:

- Computational/mathematical modeling and simulation
- Microsimulation
- Agent-based modeling
- System Dynamics modeling
- Network Analysis
- Discrete Event Simulation

Related Terms:

- Complexity science
- Complex adaptive systems
- Non-linear dynamics
Modeling as the New Paradigm for Research?

The Epistemology of Mathematical and Statistical Modeling

A Quiet Methodological Revolution

Joseph Lee Rodgers
University of Oklahoma

A quiet methodological revolution, a modeling revolution, has occurred over the past several decades, almost without discussion. In contrast, the 20th century ended with various grand theories. There are many reasons for this, but one possible explanation is that the modeling approach provides a more realistic and flexible perspective on the complexity of human behavior. Psychologists study role models. These disparate concepts share in common that they are all simplifications of a complex reality. The airplane model does not fly.
Reconciling Traditional and Systems Science Methods

Traditional Approach in BSSR: Null Hypothesis Significance Testing (p < .05)
- Assumptions that cannot be violated
- Precise – greater specification of the model

Systems Science Approaches
- Assumptions are stated up front
- Sensitivity analysis used to evaluate parameter uncertainty

Combined Use
- Mathematical models can generate hypotheses to be tested statistically
- Statistical models can provide input to mathematical models
Systems Science Activities at NIH
Relevant FOAs

PAR-11-314/314 Systems Science and Health in the Behavioral and Social Sciences (R01, R21)

PAR-10-136/137 Behavioral and Social Science Research on Understanding and Reducing Health Disparities (R01, R21)

PAR-11-203 Predictive Multiscale Models for Biomedical, Biological, Behavioral, Environmental and Clinical Research (Interagency U01).

http://obssr.od.nih.gov/pdf/Funding_opportunity_Announcements_in_systems_science_Nov_2012.pdf

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Finding NIH Funding Opportunity Announcements (FOAs)

Search the NIH Guide to Grants and Contracts to find FOAs

- Search on keywords
Research Portfolio Online Reporting Tools (RePORT)

- [http://projectreporter.nih.gov/reporter.cfm](http://projectreporter.nih.gov/reporter.cfm)

- Clear Query first
- Can search on keyword
- Can narrow by NIH Spending Category (Behavioral and Social Science), but this may be too limiting
- Can select only a particular Funding Opportunity Announcement (FOA)
- Can see who NIH Program Officer and IC are (click details tab)
- Can find relevant publications – click publications tab
- Can identify collaborators
OBSSR Activities in Systems Science
Videocasts to Educate and Raise Awareness

Systems Methodologies for Solving Real-World Problems: Applications in Public Health

Network Analysis: Using Connections and Structures to Understand and Change Health Behaviors

Agent Based Modeling: Population Health from the Bottom Up

System Dynamics Modeling: Population Flows, Feedback Loops and Health

http://obssr.od.nih.gov/training_and_education/training.aspx
Annual ISSH Training

Los Angeles, CA Date: TBD

http://obssr.od.nih.gov/training_and_education/issh/index.html
Network on Inequality, Complexity and Health (NICHI)

PI: George Kaplan, University of Michigan
Project Officer: Helen Meissner, OBSSR
Contract # HHSN276200800013C

NICHI is a multidisciplinary network of researchers collaborating to bring complex systems approaches to health disparities and population health.

Specific tasks of the network include:
• developing an inventory of areas of health disparities research that appear amenable to the application of complex systems approaches,
• identifying data needs, analytical challenges, and areas where strategic development is particularly promising
• illustrating the importance of complex systems approaches to the understanding of links among biological, behavioral, social, community, environmental and policy determinants of health disparities and population health.


November 4, 2012
Cooperative agreement with NICHD and OBSSR with cofounding from Johns Hopkins University.

Purpose: to conduct domestic and international research and training to better understand the causes and prevention of childhood obesity as well as of other lifestyle related non-communicable chronic diseases, through the use of systems science approaches.

JHGCCO work includes modeling and simulation methods, spatial analysis guided by behavioral models, and basic science to better understand and capture food intake, body weight, and metabolism regulation.
Envision Comparative Modeling Network on Childhood Obesity Policy

Co-Directors:
Patty Mabry (OBSSR) and Regina Bures (NICHD)

- Envision is a network of 11 research teams focused on modeling obesity policy.
- The purpose is to compare and contrast models which differ in their methodological underpinnings and span an array of policy-relevant research questions related to obesity

www.nccor.org/envision
Santa Fe, New Mexico
March 17-20, 2013

SYSTEMS THINKING AND DESIGN IN HEALTH BEHAVIOR RESEARCH

http://www.aahb.org/Mtgs_Future.php
April 2-5, 2013
Washington, DC

CFP – Extended deadlines
Paper registration: November 6, 2012
Paper/Poster full submission: November 14, 2012


www.sbp2013.org
Communicating with the Systems Science BSSR community

Publications


http://www.tandfonline.com/toc/hrhd20/8/1

http://www.ploscompbiol.org/article/info%3Adoi%2F10.1371%2Fjournal.pcbi.1002616
Communicating with the Systems Science BSSR community


Call for Papers on
Systems Science Applications in
Health Promotion and Public Health

Manuscripts due: May 1, 2012

Health Education & Behavior (HE&B), in collaboration with the Office of Behavioral and Social Sciences Research (OBSSR), the Fogarty International Center (FIC), the National Cancer Institute (NCI), the National Institute on Dental and Craniofacial Research (NIDCR), and the National Institute on Aging (NIA), at the National Institutes of Health (NIH), intends to publish a special issue of the journal devoted to the topic of systems science. This issue will showcase the application of various systems science methodologies to health promotion and public health research questions. Particular methodologies of interest include, but are not limited to: system dynamics modeling, agent-based modeling, network analysis, microsimulation, operations research, and various engineering approaches.

The goal of the special issue is to acquaint the readership of HE&B with the potential for systems science methodologies to address population health problems and to showcase current efforts in this area. We expect the special issue will appeal to researchers, public health practitioners, and policymakers.

For more information on what the term “systems science” encompasses, see the following NIH funding announcement, PAR-08-224: [http://grants.nih.gov/grants/guide/pa-files/PAR-08-224.html](http://grants.nih.gov/grants/guide/pa-files/PAR-08-224.html). Note that although this funding announcement has expired, its summary of systems science remains relevant.
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Contact: Patty Mabry, Listowner
mabryp@od.nih.gov
Gaps and Opportunities in Systems Science
Model Verification and Validation

Verification
- Does the model do what it was intended to do?

Validation
- Not “is the model right or wrong?”
- Under what conditions is the model designed to perform?
- How well does the model perform under those conditions?
- Conditions include: population, research question, timeframe, assumptions

Guiding principles or best practices are needed
VVUQ – Initial Plans

Workshop FY13
Special journal issue FY14
Consensus report FY14-15

Partners

• NIH
• NSF
• DOD: ONR, AFRL, AFOSR, ARL
How does stress get “under the skin”?

Is there a biological basis for behaviors transmitted across generations?

How do social, behavioral, and biological forces interact to influence addictive behavior?
Integrating knowledge, data:

- Genome, metabolome, microbiome, proteome, etc.
- Exposure: toxins, disease, protective factors, social environment
- In context: GxG, GxE, ExE, cumulative exposure, critical periods, order effects, epigenetics, intergenerational transmission
The Future of Systems Science

NIH-FDA Tobacco Regulatory Science
- Family Smoking Prevention and Tobacco Control Act 2009
- FDA Center for Tobacco Products
- Population Assessment of Tobacco and Health (PATH)

The Science of Dissemination and Implementation

mHealth – NIH Public Private Partnership

NIH-NSF Big Data

The Exposome

Community engagement, policy relevant research
Final Thought

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Discussion