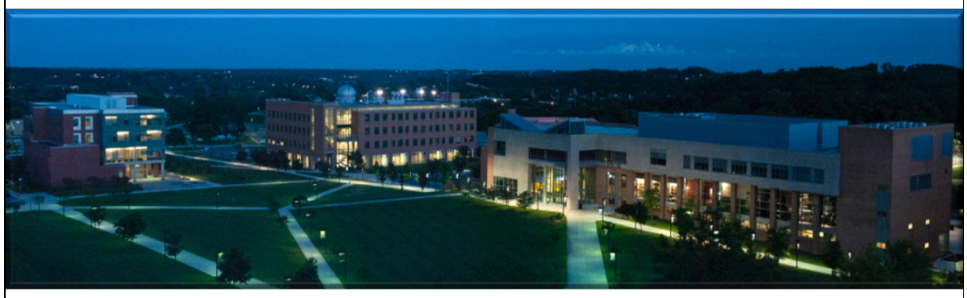
November 21, 2014

UMBC Research Forum



The Nexus of Social Sciences & Human Health

UMBC
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The Creative Destruction of Health Behavior Research

Keynote Speaker:

William Riley, Ph.D.

Acting Director,

Office of Behavioral and Social Sciences Research

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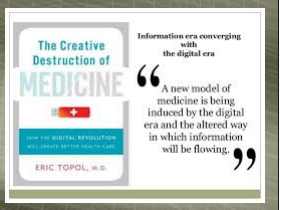
The Creative Destruction of Health Behavior Research



William Riley, Ph.D.
Acting Director, Office of Behavioral and Social Sciences Research
Chief, Science of Research and Technology Branch
National Cancer Institute

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
National Institutes of Health

Research Methods in a Data Poor Environment

- Priority is prospective design and data collection
- Limited data collection opportunities
- Predominately cross-sectional or minimally longitudinal designs
- Unable to assess or control myriad confounds
- Randomize to control

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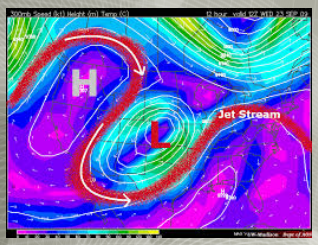
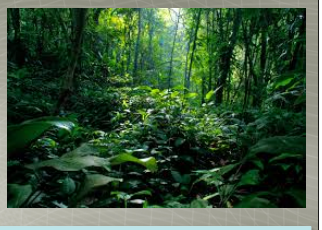
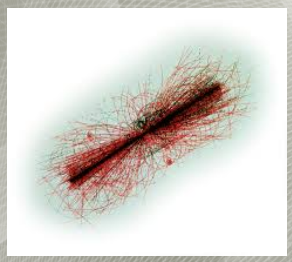
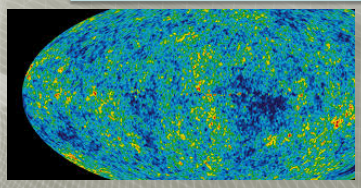
Research Methods in a Data Rich Environment





- Temporally Dense
- Noisy But Precise
- Computational
- Predictive





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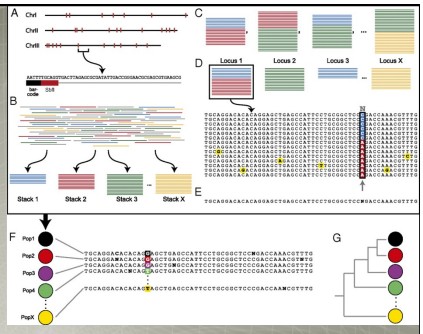
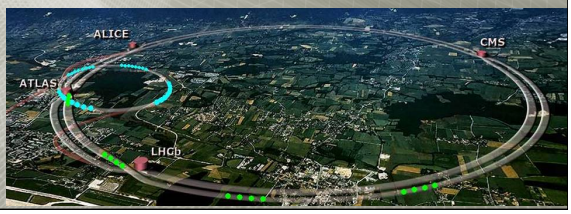
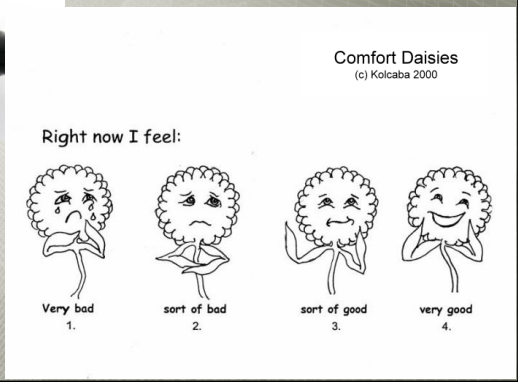


"Nearly all the grandest discoveries of science have been but the rewards of accurate measurement." Lord Kelvin, 1872

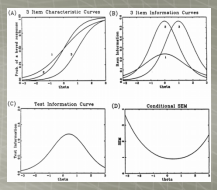


Previous State of Behavioral Measurement



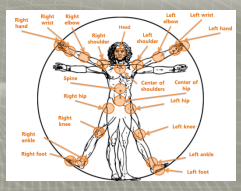
Technological Advances in Behavioral Measurement

- Item Response Theory (IRT) and Computer Adaptive Testing (CAT)



- Ecological Momentary Assessment (EMA)

- Passive Sensor Technologies



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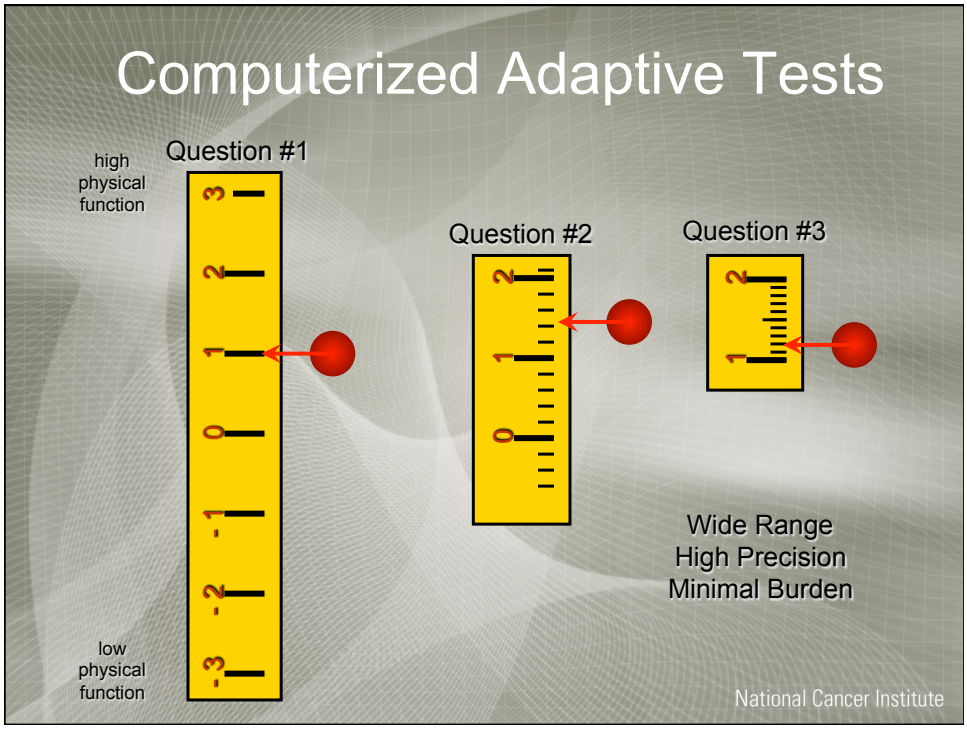
Computerized Adaptive Tests
high physical function
Question #1
Question #2
Question #3
low physical function
Wide Range
High Precision
Minimal Burden
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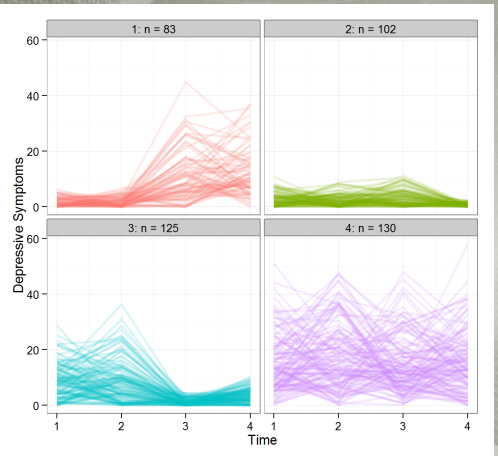
Ecological Momentary Assessment



Ginexi EM et al. The Promise of Intensive Longitudinal Data Capture for Behavioral Health Research. Nicotine & Tobacco Research 2014 16 (4): S73-S75.

Growth Mixture Models: Elkhart Group Ltd

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Sensor Technologies

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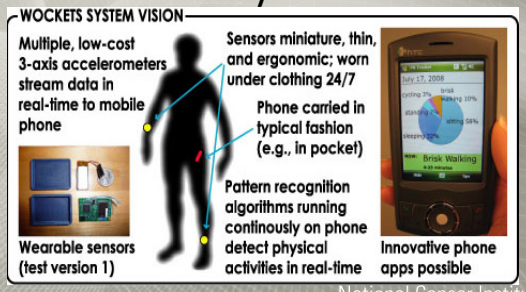
Population Scale Activity Measures

- Population-scale measurement of physical activity
- Miniature, low-cost devices that measure human motion using redesigned accelerometers in a user-friendly format



Stephen Intille, PhD,
Northeastern University
NHLBI, U01HL091737

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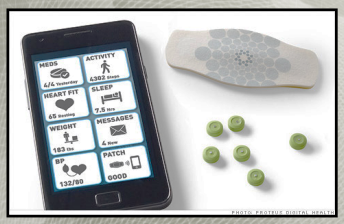
Emerging Technologies and Assays for Adherence Monitoring

Xhale SMART "breathalyzer" for GRAS drug taggants

Drug (metabolite) concentrations via hair samples or dried blood spots



Proteus pill microchips and sensor

GlowCaps

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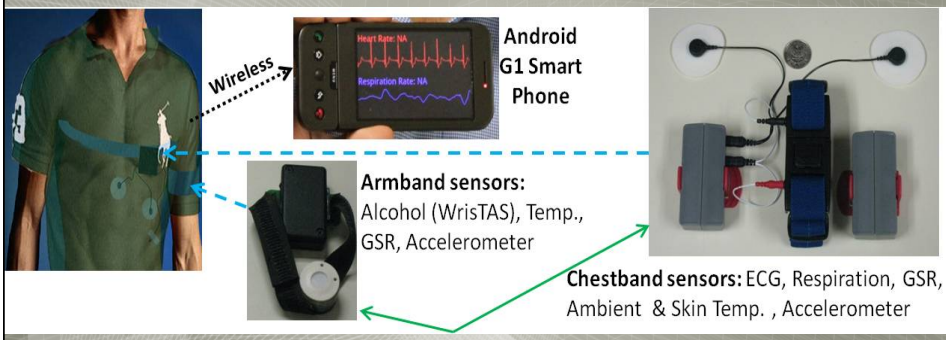
Psychophysiology



Autosense
Santosh Kumar
University of Memphis

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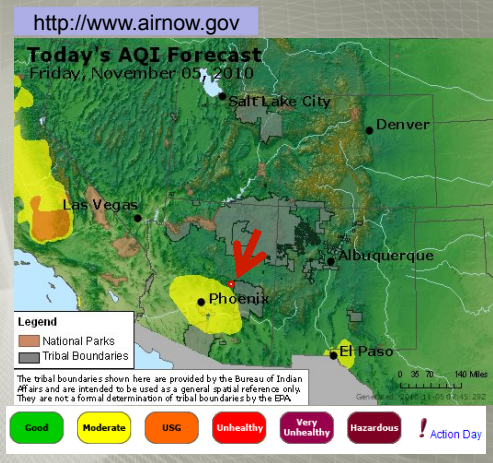
Wearable Chemical Sensor System

- Chemical exposure varies by context, need personal exposure
- Selective detection of VOCs (hydrocarbon and acid vapors)
  - Sensitive: ppb – ppm
  - Real-time: sec. – min.
  - Spatially resolved
  - Wearable: cell phone size
  - Cell phone based interface



Nongjian Tao, Arizona State University, NIEHS, U01 ES016064

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Implantable Biosensors

- Measurement of analytes (glucose, lactate O2 and CO2) that indicate metabolic abnormalities
- Miniaturized wireless implantable biosensor that continuously monitors metabolism
  - Inserted by needle subcutaneously
  - Operated remotely using a PDA
  - Multi-analyte sensor
  - One month continuous monitoring

Diane J. Burgess, University of Connecticut NHLBI, R21HL090458

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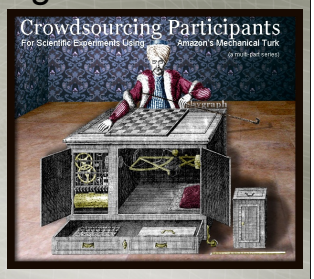
New Modalities for Prospective Data Collection

- Citizen Science and Crowdsourcing Efforts
  - Mechanical Turk for:
    - Volunteer Data Collection and Sharing (Quantified Self)
    - Cognitive Testing of Survey Items
    - Environmental Field Assessments
- Opt-In Internet Panels
  - See Summary Report of the AAPOR Task Force on Nonprobability Sampling
  - See Roshwalb et al. (2012)Towards the use of Bayesian credibility intervals in online survey results. NY: Ipsos Public Affairs



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Archival Big Data Sources in the Behavioral Sciences
"Digital Breadcrumbs" (Pentland, MIT)

- Behavioral Data Traces gleaned from consumer-based data sources
  - Social Media (Twitter, Facebook)
    - Twitter opens up its 200 million users with 500 million tweets per day to researchers (2/10/2014)
  - Internet Searches (Google)
  - Cell phone Use (# calls and texts)
  - Cable Box Data (hours of TV)
  - Auto Black Box data (miles driven, seat belt use)

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NIH BD2K

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BD2K: Programmatic Areas

1) Facilitating Broad Use of Biomedical Big Data
2) Developing and Disseminating Analysis Methods and Software for Biomedical Big Data
3) Enhancing Training for Biomedical Big Data
4) Establishing Centers of Excellence for Biomedical Big Data

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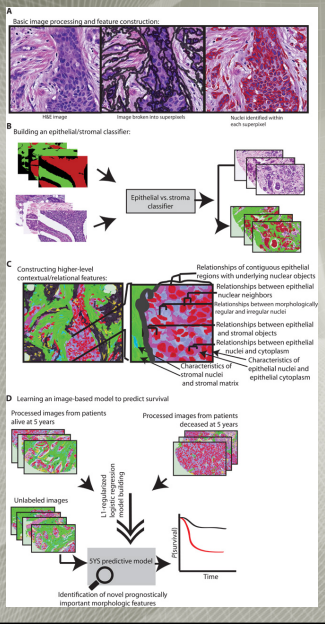
Big Data Analytics – Pattern Recognition



Beck et al., Sci Transl Med 2011; 3:1-11

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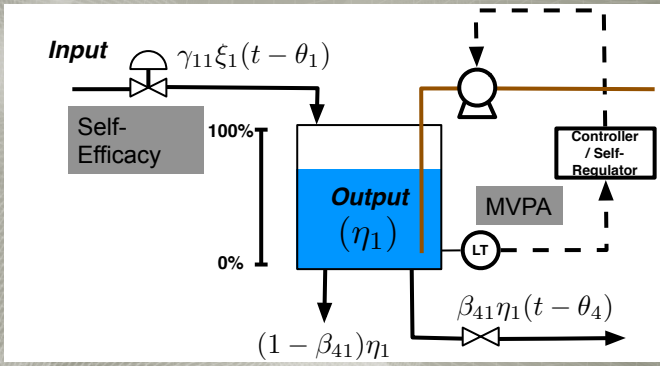
Big Data Analytics
Computational Modeling



The fluid analogy depicts accumulation-depletion of the output (*MVPA*) as a result of changes in the input (*self-efficacy*). A controller / self-regulator relying on a sensed value of the output attempts to compensate for the input change, resulting in potentially significant variability.

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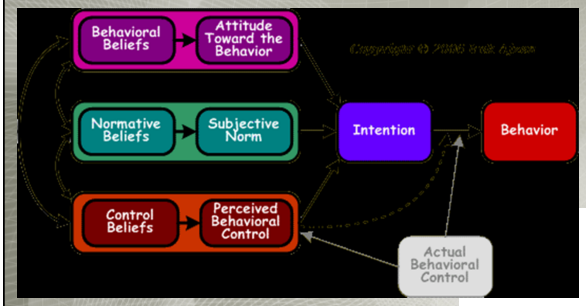
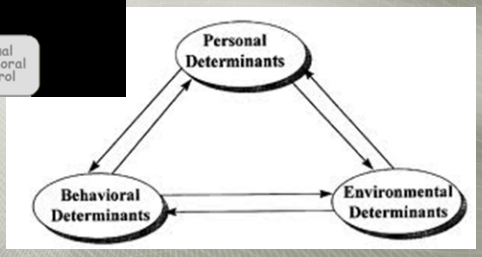
What We Mean by "Model"?
Conceptual Model





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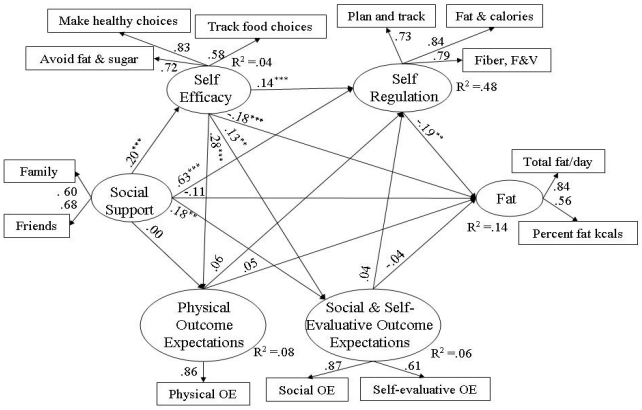
What Do We Mean by "Model"? Statistical Model

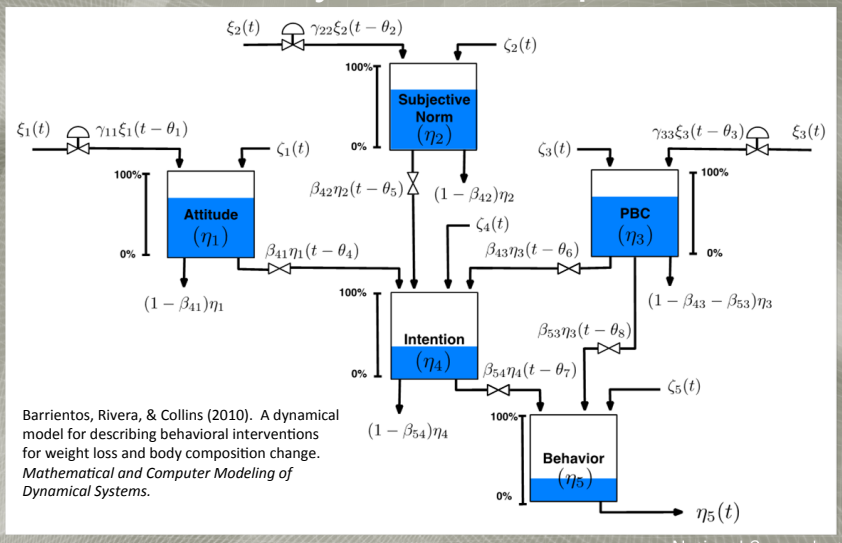


Anderson-Bill et al., J Med Internet Res 2011;13(1):e28

Concept of Computational Dynamic Modeling of Social and Behavioral Phenomena is Not New

- Weiner (1948) Cybernetics: On Communication and Control of Animals and Machines. MIT Press.
- Hanneman (1988) Computer-Assisted Theory Building: Modeling Dynamic Social Systems. Sage Publications.
- Barbera & Albertos (1996) Psychological Human Behavior: A Systems Approach. In Moreno-Diaz & Mira-Mira, Brain Processes, Theories, and Models. MIT Press.

Theory of Planned Behavior from a Control Systems Perspective



Barrientos, Rivera, & Collins (2010). A dynamical model for describing behavioral interventions for weight loss and body composition change. *Mathematical and Computer Modeling of Dynamical Systems.*

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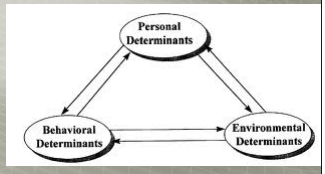
Social Cognitive Theory (SCT)

- Dominant, influential theory of health behavior (Bandura, 1986)
- Lineage from Social Learning Theory
- Core Concepts:
  - Triadic reciprocity (reciprocal determinism)
  - Self-efficacy - Perceived ability to succeed in specific situations
  - Outcomes expectancy - Perceived likelihood that performing the behavior will result in expected outcomes
  - Cue to Action – stimulus that prompts behavior



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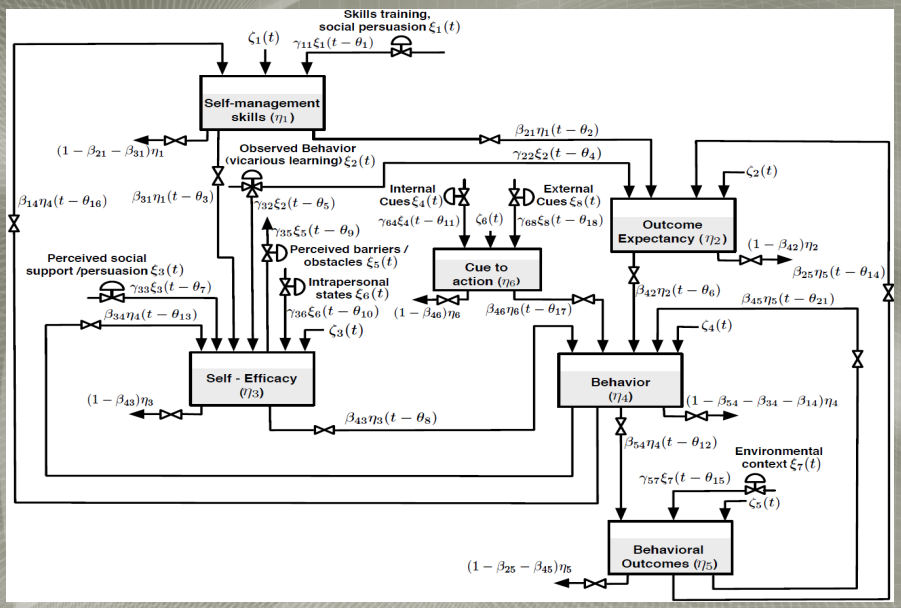
Control Systems Model of SCT



Advantages of Computational Models

- Requires explicit and detailed system identification (even if only as hypothesis) and provides simulation capabilities
- Model is testable via precise and temporally dense data collection
- Ability to test “controllers” and their impact on the model to build JITAIs
- Utilize a series of N-of-1 trials to optimize the intervention
- Ability to be pre-emptive, not just reactive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