Fogarty International Center

Global mHealth Research Training Institute

June 6- 9, 2016

Center for Global Health Studies



NIH Fogarty International Center

NIH Fogarty International Center
Advancing Science for Global Health

Global mHealth Research Training Institute

Defining the Problem: Understanding & Changing Behavior

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The Road to Outcomes

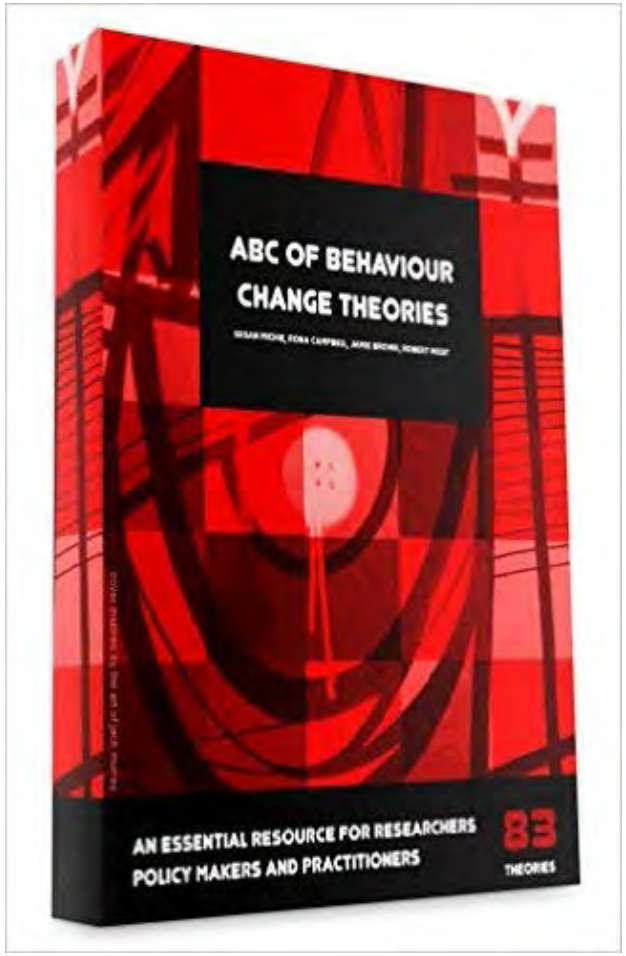
Is through precise specification of behavior & determinants

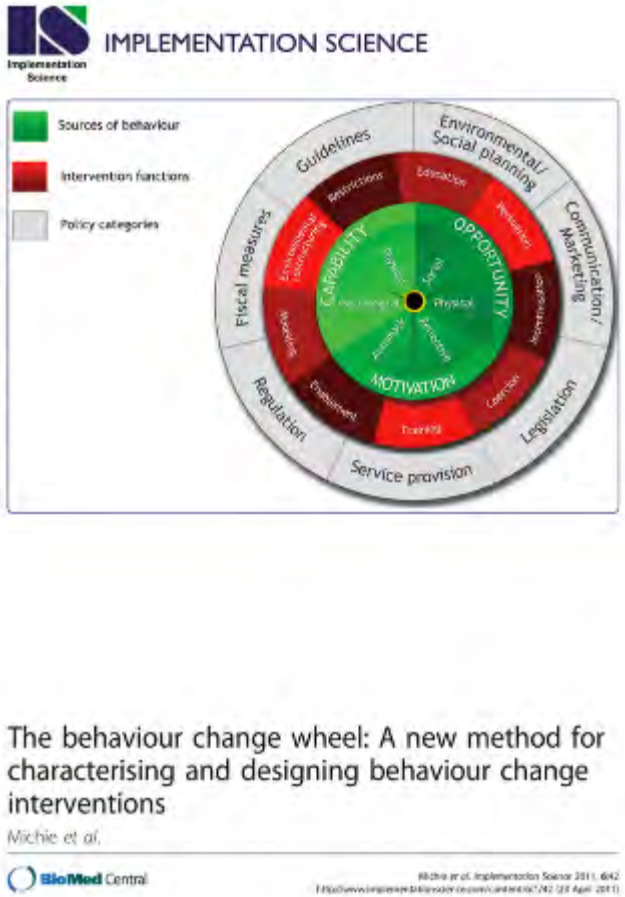
Causes of Obesity

Guiding Principles

What influences behavior?	Example
Emotion	Fear, desire, need, motivation, impulse
Cognition	Self-efficacy, beliefs, knowledge, attitudes
Personal Characteristics	Gender, age, ethnicity, cognitive development/abilities, SES
Social Environment (friends, peers, family)	Social Networks (norms, culture, what other people do)
Natural & Built Environment	Parks, Fast Food, Assesability, External cues
Macro-scale social environment	Economy, SES, policy
Own Behavior	Habits, breakfast
Genes & Metabolic Health	Insulin resistance, allergies, obesity

Theories and Principles





The behaviour change wheel: A new method for characterising and designing behaviour change interventions

Michie et al.

BioMed Central

Susan Michie et al

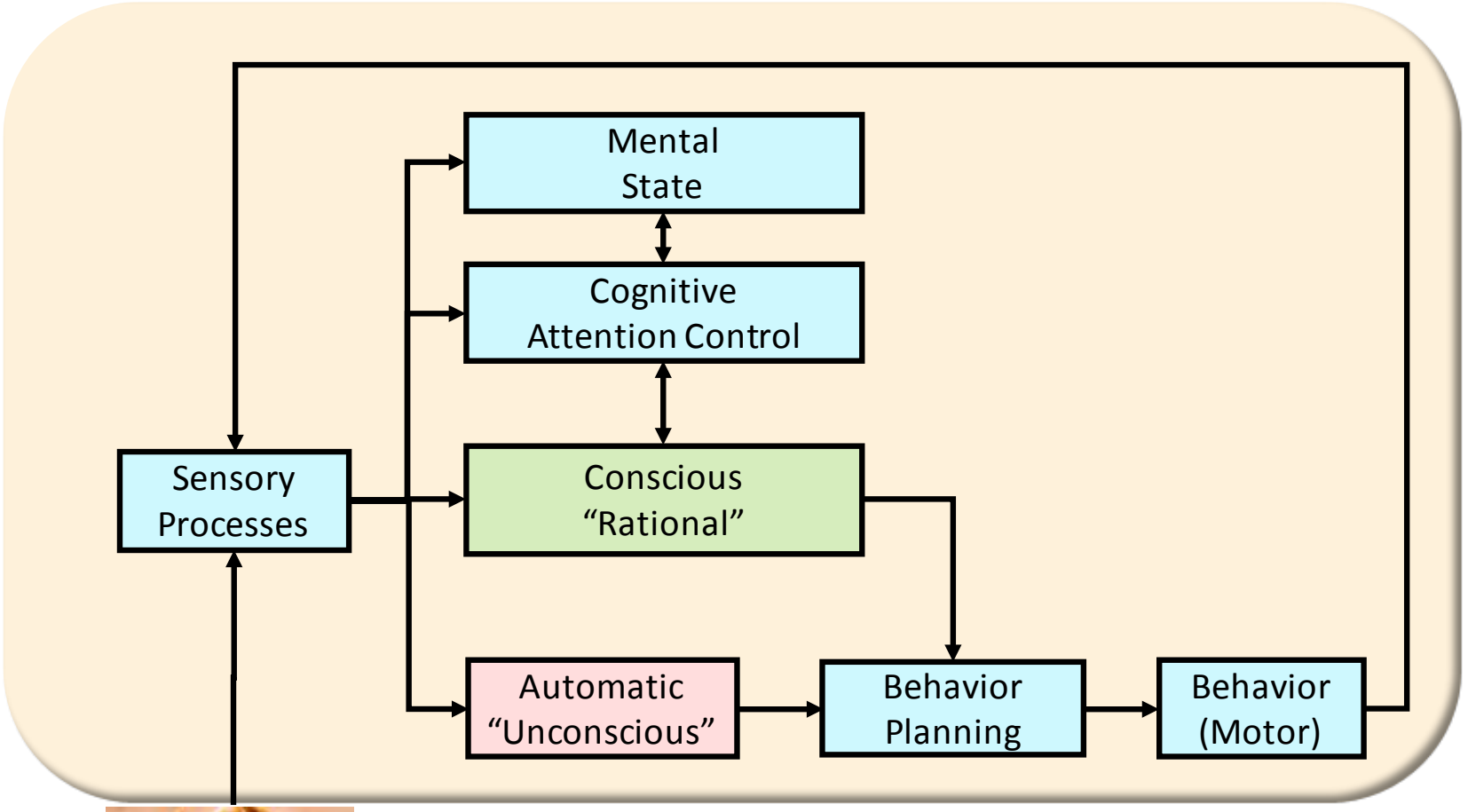
Key Terms: Behavioral Theories 101

- **Theory:**
  - Formalized set of concepts
  - Organizes observations and inferences
  - Explains and predicts behavior & outcomes.
    - (Sometimes called a 'Conceptual Model')
- **Model:**
  - Empirical, quantifiable, testable version of a theory
    - (Sometimes called a mathematical or statistical model)

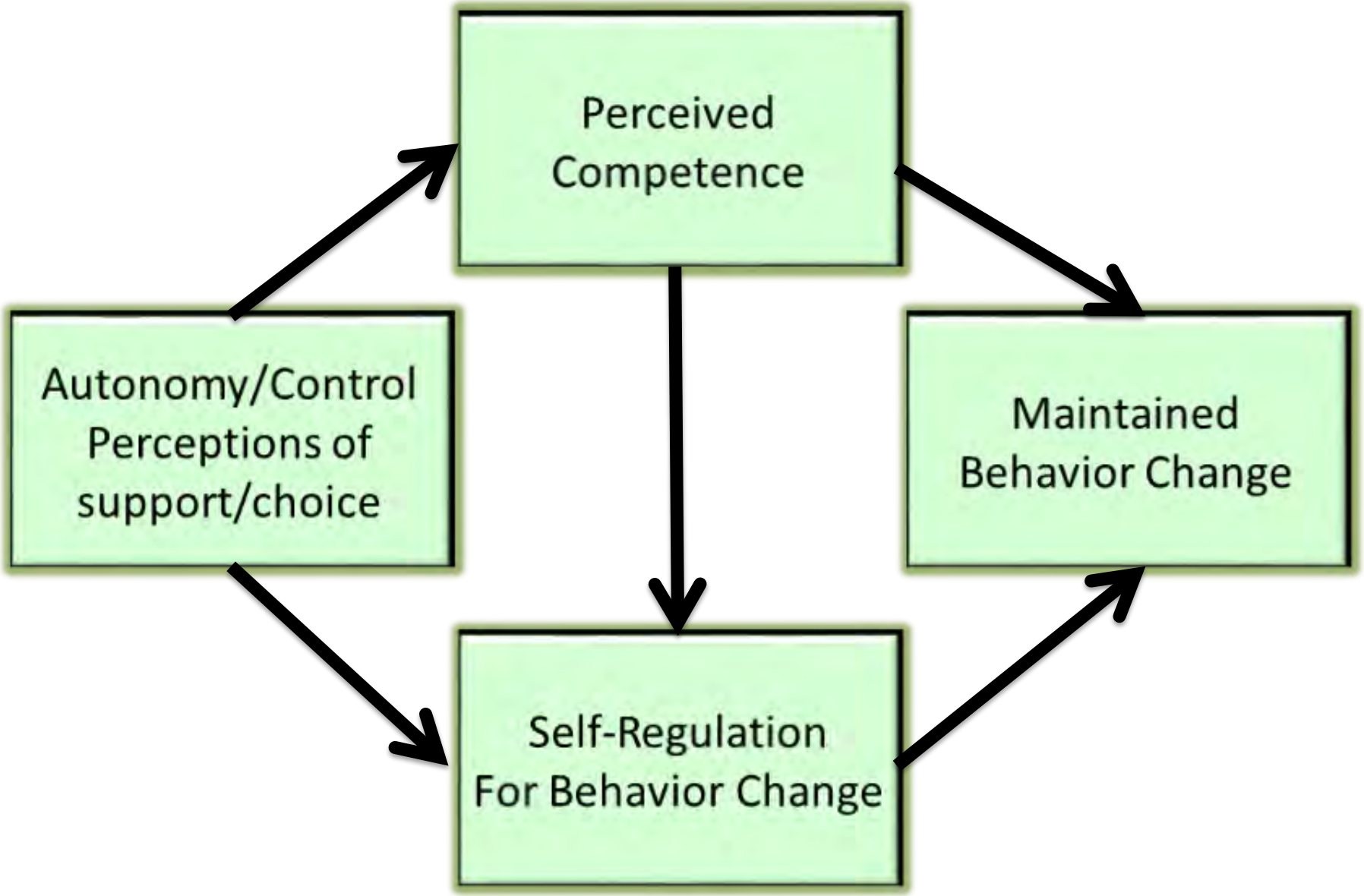
Key Terms: Behavioral Theory 101

- **Construct**:
  - a hypothetical, explanatory concept which is not directly observable (intelligence, motivation, fear, anger)
- **Variable**:
  - What we measure
  - Some are immediately observable (age, height, hours spent watching TV), some are constructs made measurable using 'operational definitions'
- **Mechanism of Change**

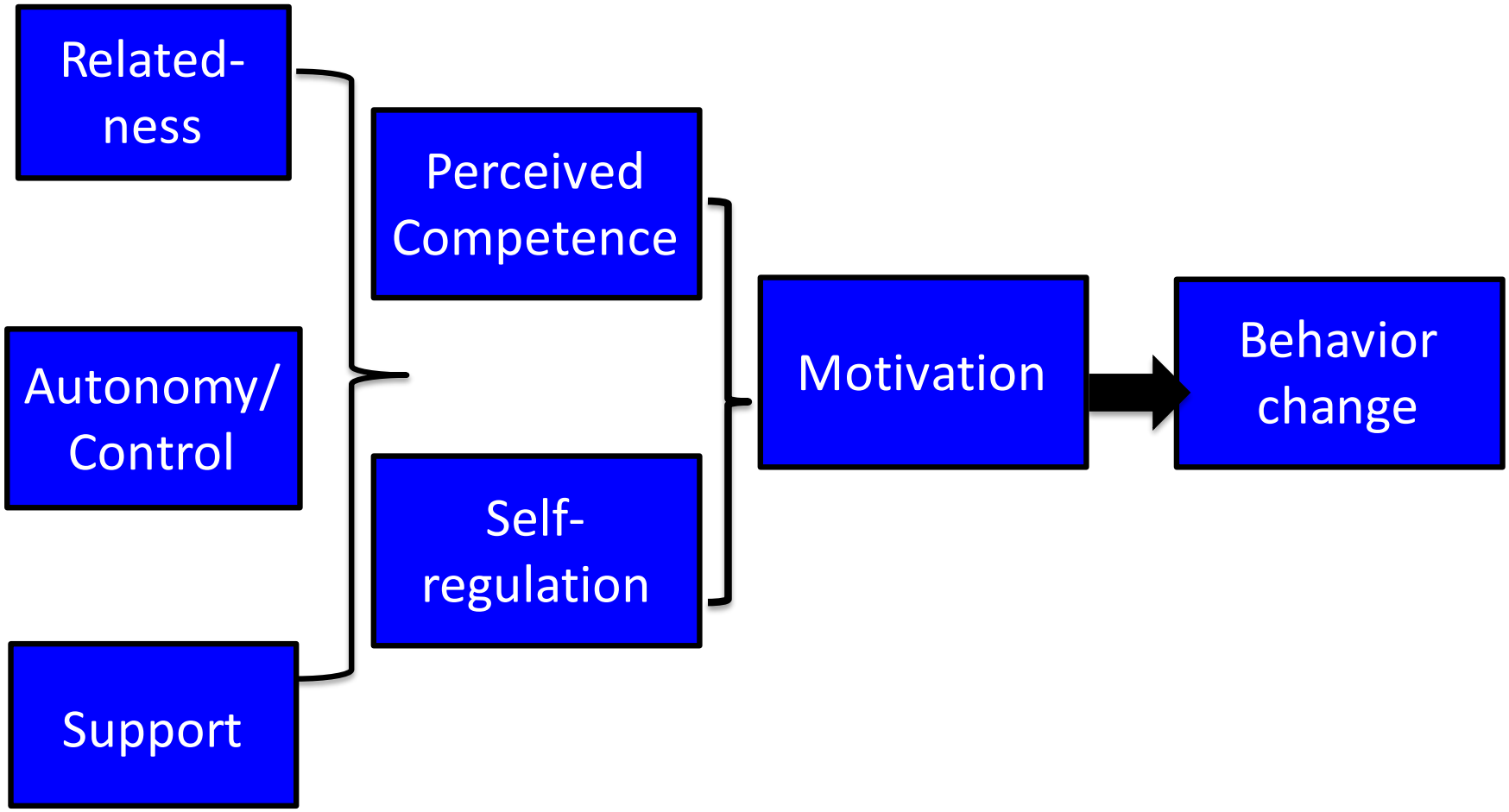
Theory: Dual Process of Behavior Control



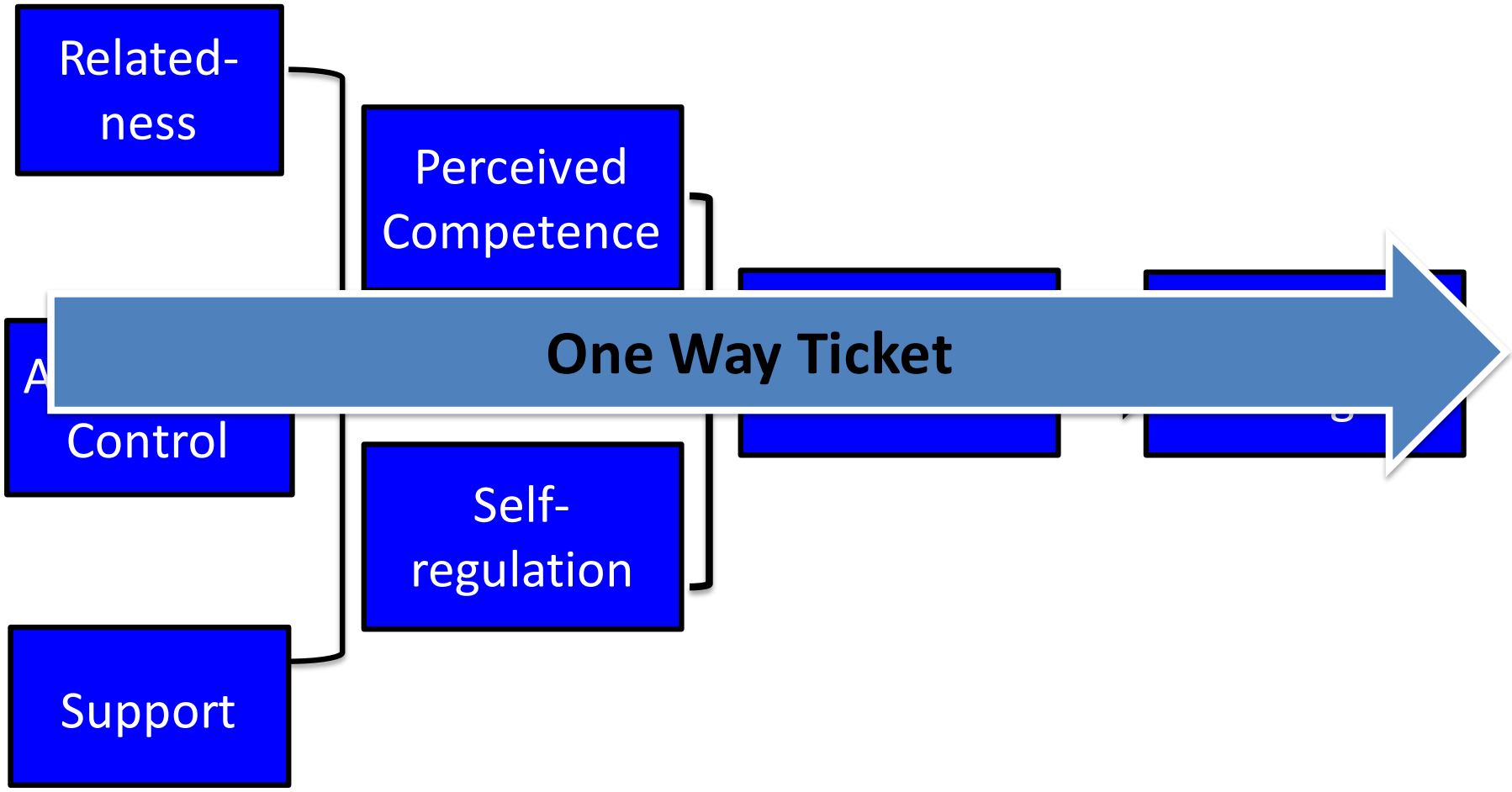
Theory: Self-Determination Theory



Our Current Theories are Static



Our Current Theories are Static



Guiding Principles

- **New means for** continuous behavioral & physiological monitoring & momentary self-report
  - Wearables
  - Deployables
  - Invisibles
  - Chemical sensing
  - Digital breadcrumbs
  - Cell phones
  - Smart phones (sensor-rich + Ecological Momentary Assessment)
- Are now allowing us to think about behavior **dynamically**, in **real time** and in **context**.

Guiding Principles

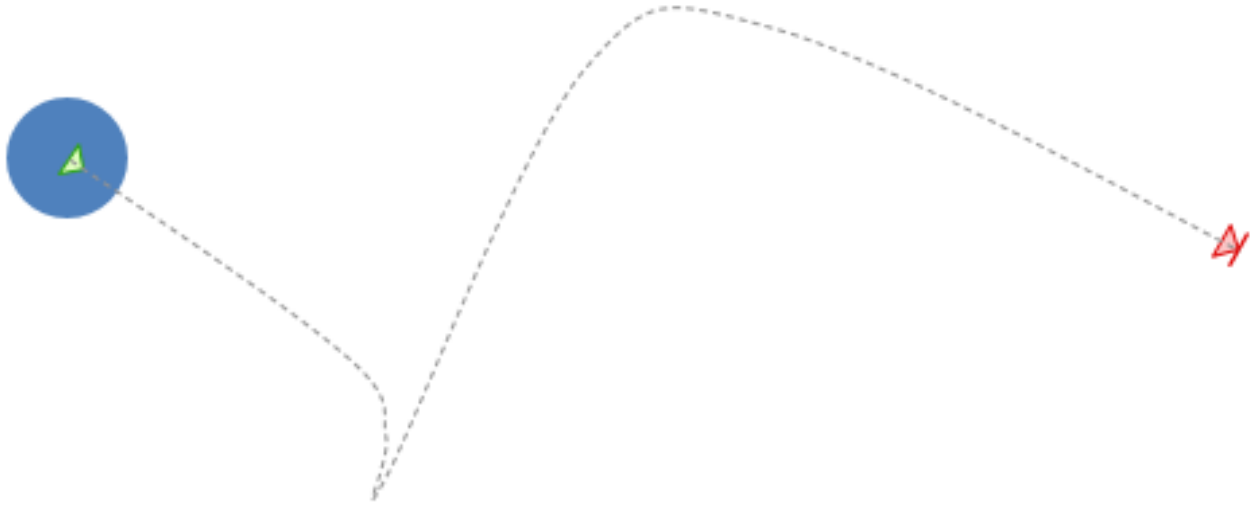
- **New me** ysiological monitori
  - Wearal
  - Deploy
  - Invisibl
  - Chemi
  - Digital
  - Cell ph
  - Smart Assess tary
- Are now r **dynamic**


Context

Target variable:

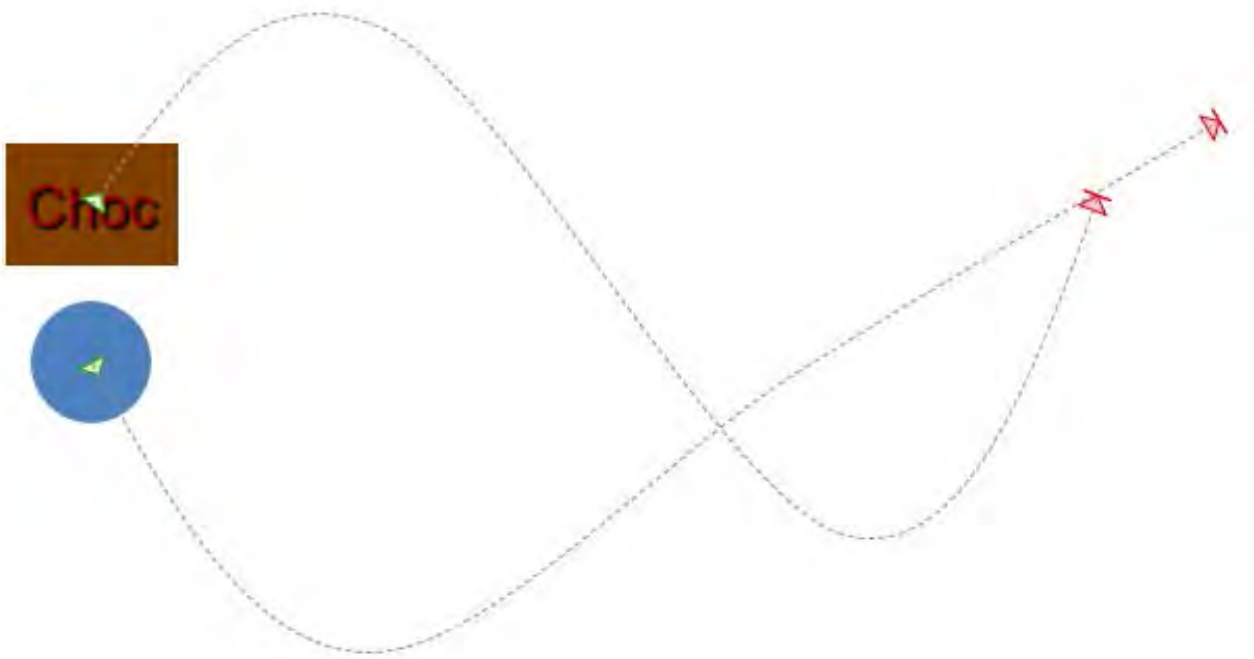
Chocolate Consumption

Desire to eat chocolate changes over time of day



morning midday afternoon evening

Target variable depends on proximity to chocolate



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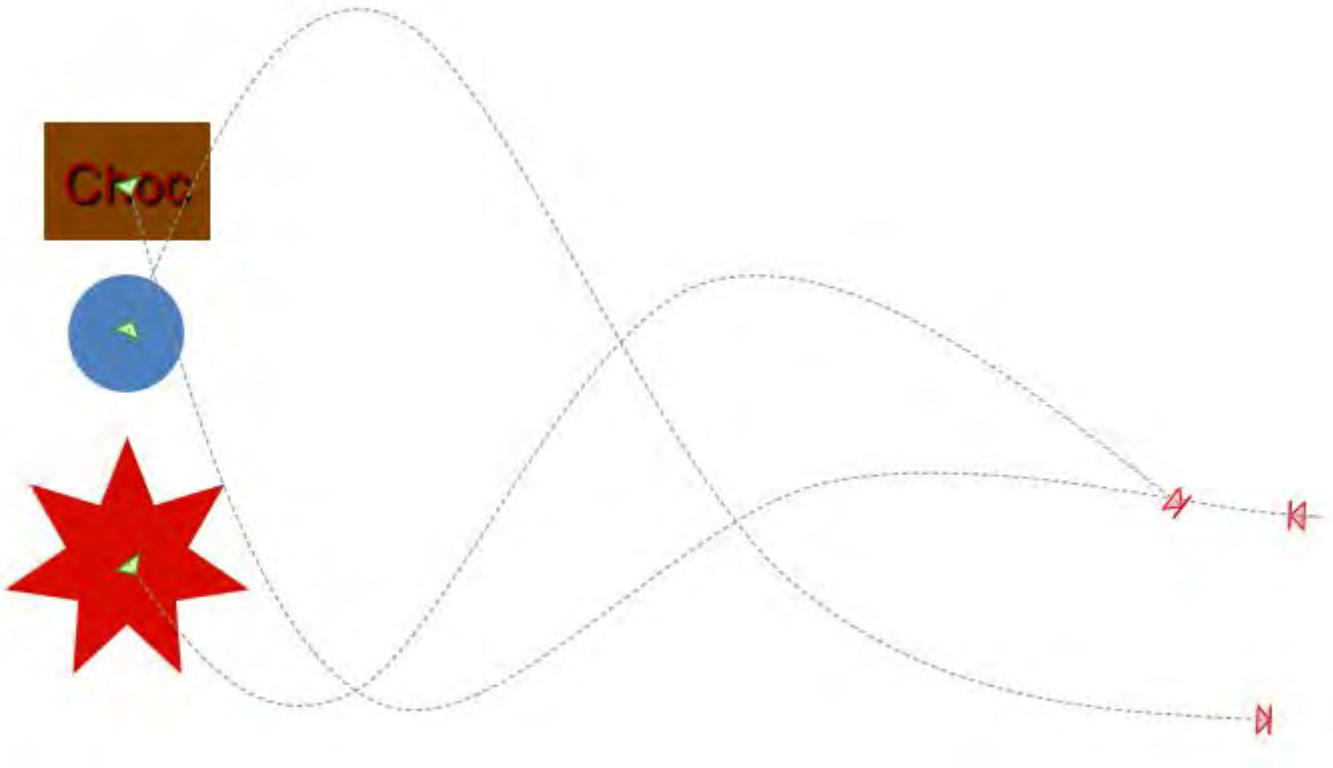
Target variable is also influenced by stress levels



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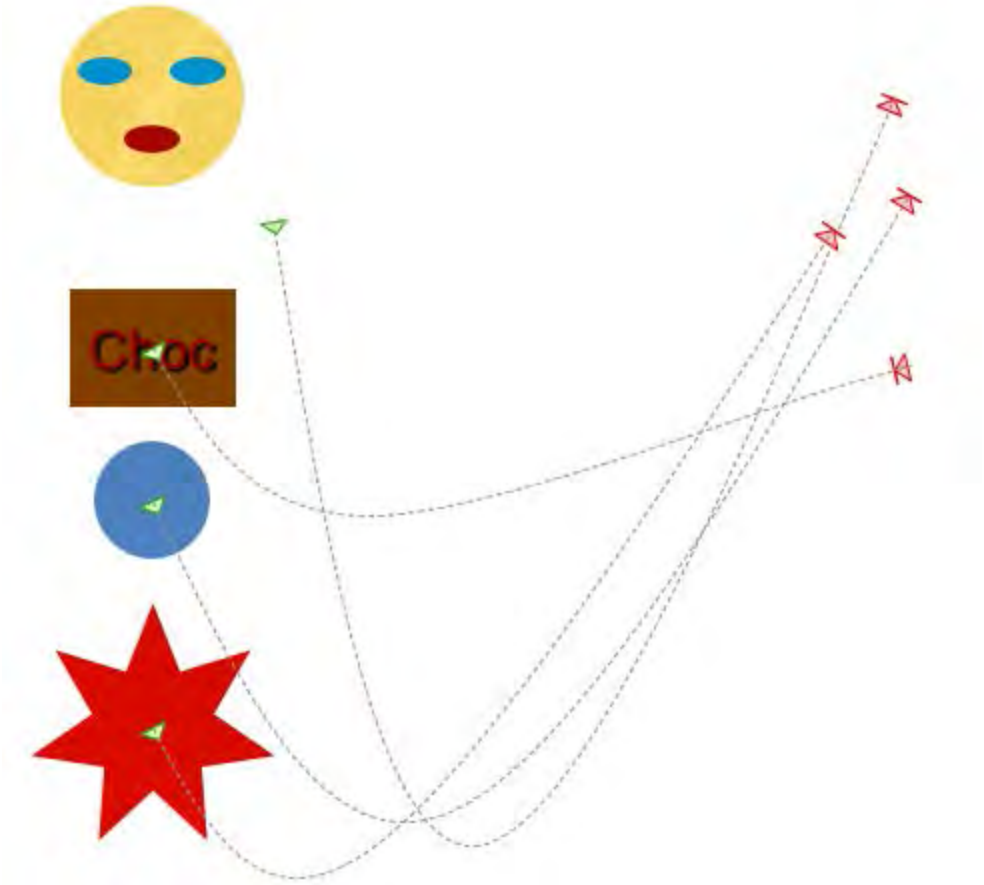
And by the proximity of certain people



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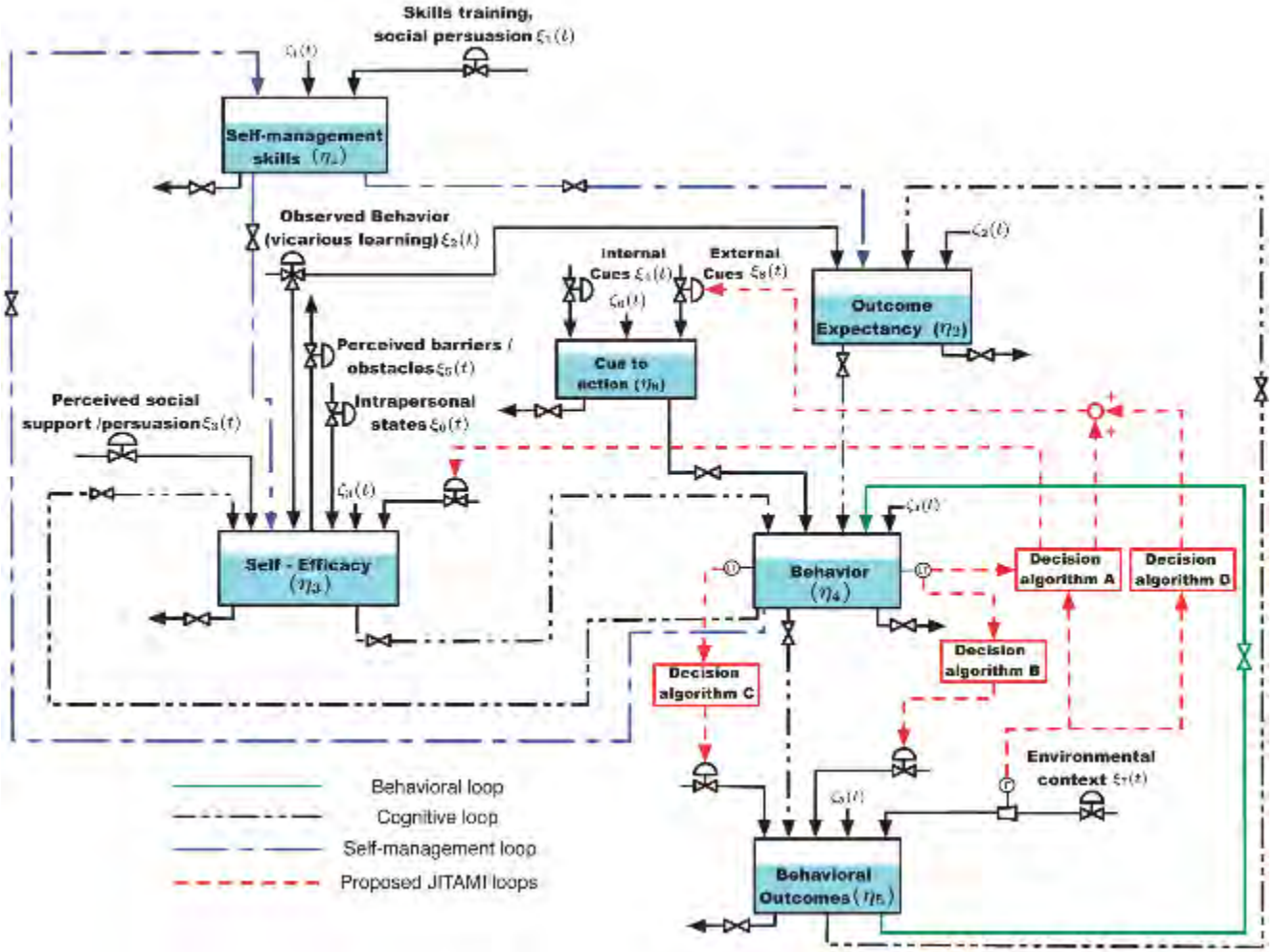
Key Terms

- **Dynamic model**: takes into account momentary & longitudinal changes in:
  - relationships between constructs,
  - within-person fluctuations,
  - the influence of shifting contexts on these.

Dynamic Behavioral Model based on Social Cognitive Theory



Spruijt-Metz, Hekler, Saranummi, Intille, Korhonen, Nilsen, Rivera, Spring, Michie et al. Translational Behavioral Medicine, 2015

Key Questions: What and Who?

- Specific health outcome of interest?
  - Example: Obesity
- Which population to study?
- Behaviors & determinants differ across populations
  - Culture & Country
  - Socioeconomic status
  - Urban versus rural
  - Age
  - Cognitive development,
  - Health status (i.e. diabetic?)

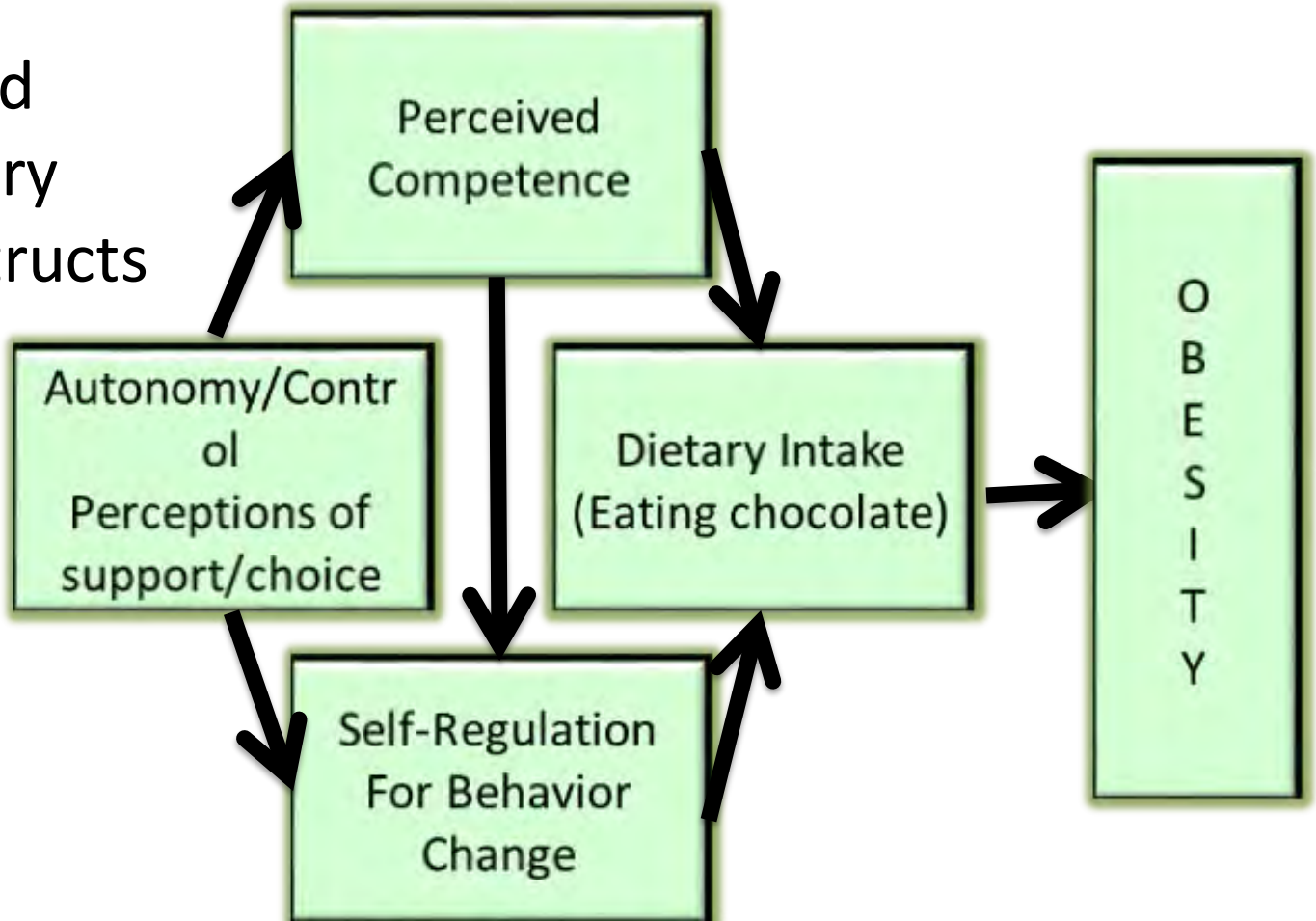
Key Questions: What?

- Which behaviors are related to the chosen outcome?
  - Choose your battles
  - Where possible make this evidence based

Key Questions: The 'deeper what'?

- Which determinants are related to these behaviors?

  Evidence based choice of theory or set of constructs



Key Questions: Which? When? How?

- Paring it down: which constructs, behavior, outcomes to intervene on (and thus measure?)
- How to measure them? (Transdisciplinary collaboration)
  - Timing, frequency, context of measurement
  - Which technologies to use?
  - Where can you measure ubiquitously?
  - What do you want 'on demand' (Ecological Momentary Assessment)? When and where?
  - Which validated measures? & the problem with valid measures and new technologies, & "good enough"?
  - Role of more 'traditional' measures (trait versus state?)

Why should researchers work with experts like me *from the start*?

- Benefits: Enhancing & Strengthening mHealth efforts with knowledge from behavioral science
  - New technologies are not 'magic' – Best practices in development/design/deployment
  - Technology can add to fundamental knowledge on behavior AND visa versa. Otherwise we just have toys.
  - Theory/models drive which behaviors to measure
  - Help with 'best' measures,
  - Understand mechanisms of change
  - Expertise in specific populations, targeting, tailoring, participatory design.
  - Motivate people to give you their data

Case Study

- KNOWME NETWORKS
- A suite of mobile, Bluetooth-enabled, wireless, wearable sensors
- That interface with a mobile phone and secure server
- To process data in real time,
- Designed specifically for use in overweight minority youth

Your Activity Meter

Active Time in the Last 60 Minutes

Each bar = 30 seconds
20 bars = 10 minutes

Sedentary Time (since the last reset)

Total Active Time

Elapsed Time : 58

Total Elapsed Time

Battery Indicator for Each Device

Sedentary = lying down, sitting, sitting & fidgeting, standing, standing & fidgeting
Active = standing playing Wii, slow walking, brisk walking, running

Theory & Evidence Guided Choices

Needs	Choice	Basis	Measurement modality
When to intervene: Decision Points	2 hours sedentary Outside School	Evidence base (at the time)	• Sensors • Algorithms • Time (of course)
Tailoring Variables	Child current location & access	SDT: Competence	• Detailed Intake • Text messages • "Watcher" utterances
Decision Rule	Child availability	Common sense	• Text messages
Intervention Options	Motivational Interviewing	SDT: Competence, connectedness, autonomy	• "Watcher" utterances
Proximal outcome	Reduction in sedentary time	Evidence base	• Sensors • Algorithms

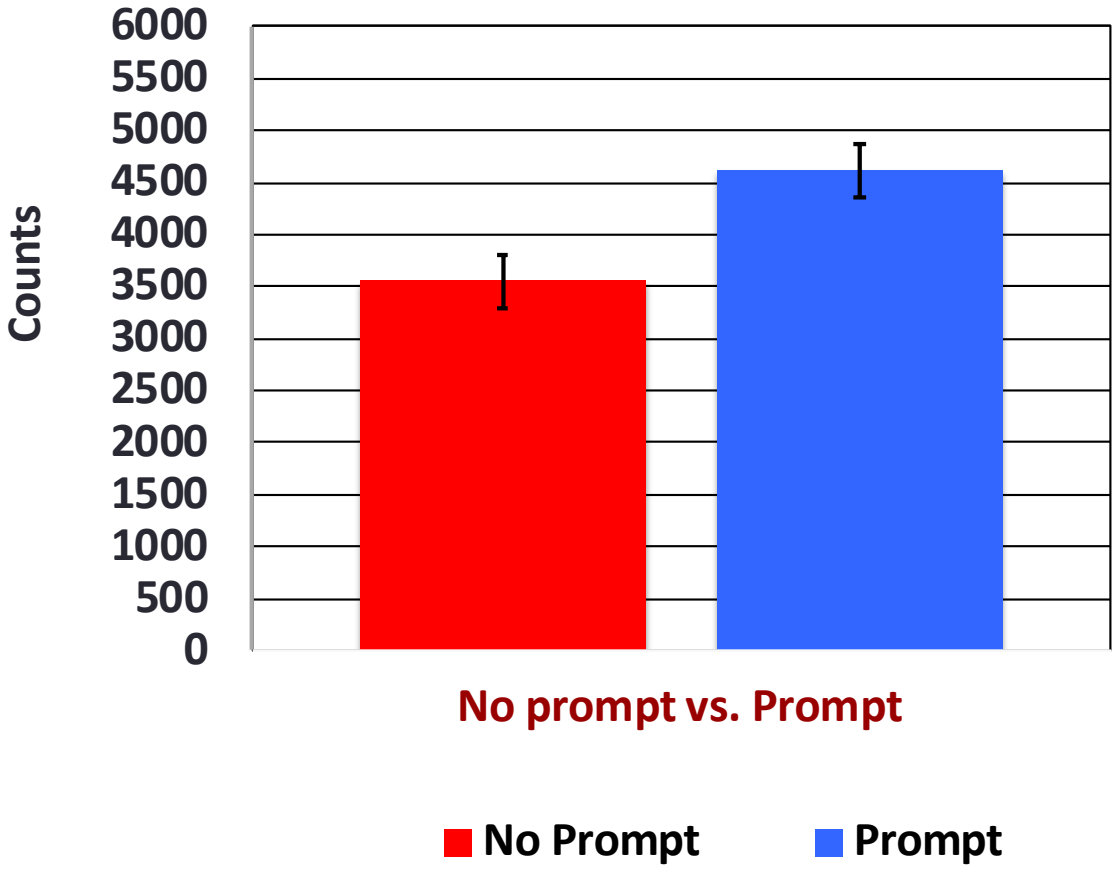
Did we impact sedentary behavior?

	Mean Minutes Baseline (±SD)	Mean Minutes Intervention (±SD)	t-value	p-value*
Sedentary	1765.5 (357.7)	1594.7 (208.3)	1.28	0.1
Light	436.6 (222.3)	413.4 (163.4)	0.75	0.2
MVPA	0.3 (0.6)	1.8 (3.2)	-1.45	0.09

*1-tailed, significance level set at 0.1

Activity levels measured by Actigraph

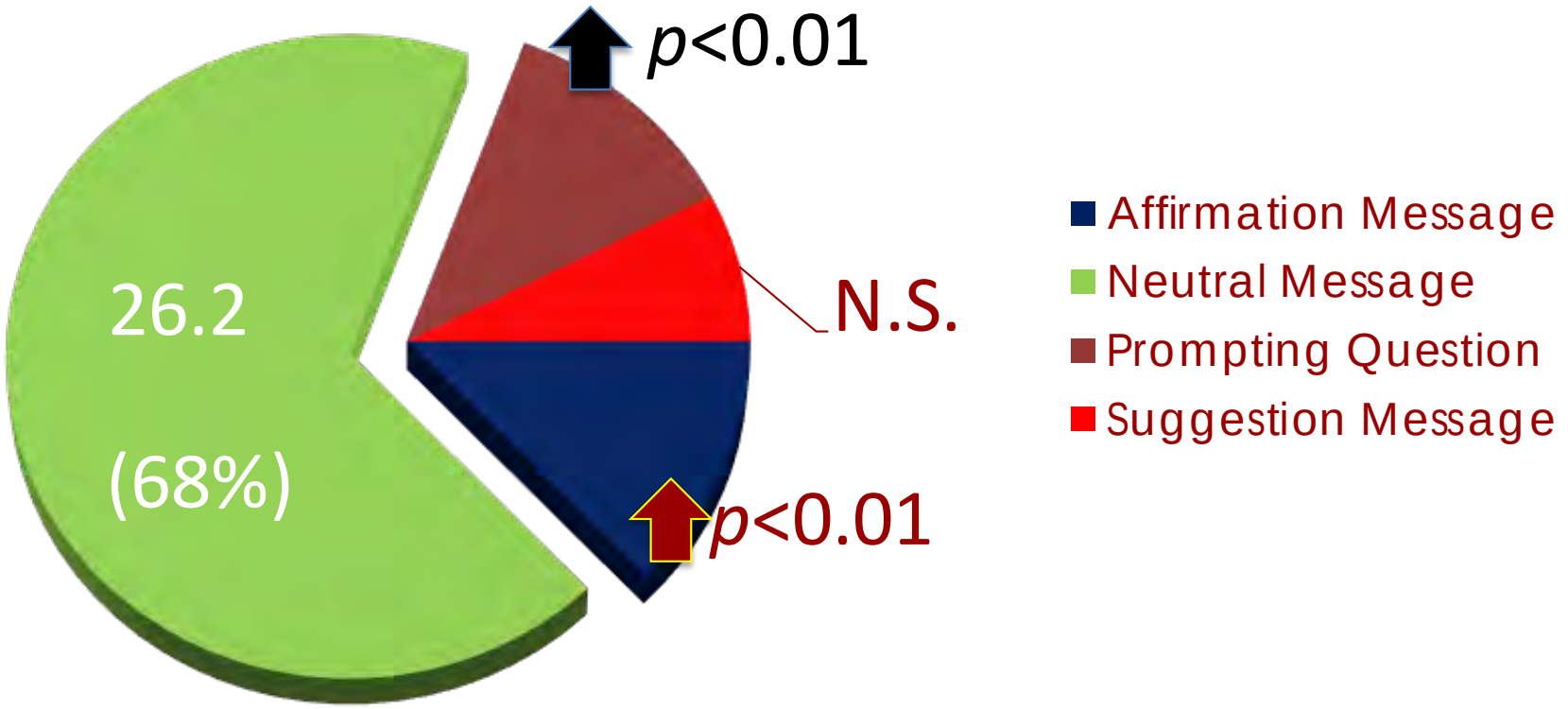
Was it novelty? Or did prompts matter?



- Accelerometer counts were 1,066 counts higher
- in the following 10 minute period
- compared to when SMS prompts were not sent ($p<0.0001$)

Did theory matter??

Changes in PA in next 10 minutes by Messages Type



Take-aways

- Understanding the behaviors you choose to intervene on is ***key***
- Current & emerging technologies provide the data to transform static theories of behavior (conceptual models) into dynamic mathematical models of behavior.
- These can guide development and testing of any intervention.
- Caveat: have to know what, when and how to measure!

What do I mean by 'understanding behavior?

- Which behavior?
- Which determinant?
- Which theories?
- Principles of Behavior Change?
- Which particular intervention?
- Personalization: What might work for whom in which dose?
- CONTEXT: When and where to deliver?

Thank you! Any questions? Please stay connected!

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