Defining the Problem: Understanding & Changing Behavior

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The Road to Outcomes

Is through precise specification of behavior & determinants
Causes of Obesity

- Stress
- Sleep
- Diet
- Exercise
### Guiding Principles

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

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

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

- Sensory Processes
  - Mental State
    - Cognitive Attention Control
      - Conscious “Rational”
        - Automatic “Unconscious”
          - Behavior Planning
            - Behavior (Motor)
Theory: Self-Determination Theory

- Perceived Competence
- Maintained Behavior Change
- Self-Regulation For Behavior Change
- Autonomy/Control Perceptions of support/choice
Our Current Theories are Static

- Relatedness
- Autonomy/Control
- Support
- Perceived Competence
- Self-regulation
- Motivation
- Behavior change
Our Current Theories are Static

- Relatedness
- Perceived Competence
- Control
- Self-regulation
- Support

One Way Ticket
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 means for continuous behavioral and physiological monitoring:
  - 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.
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

morning midday afternoon evening
Target variable is also influenced by stress levels

morning  midday  afternoon  evening
And by the proximity of certain people

morning  midday  afternoon  evening
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

**Battery Indicator for Each Device**

**Sedentary Time (since the last reset)**

**Total Active Time**

**Total Elapsed Time: 58 minutes**

**Sedentary** = lying down, sitting, sitting & fidgeting, standing, standing & fidgeting

**Active** = standing playing Wii, slow walking, brisk walking, running
## Theory & Evidence Guided Choices

<table>
<thead>
<tr>
<th>Needs</th>
<th>Choice</th>
<th>Basis</th>
<th>Measurement modality</th>
</tr>
</thead>
</table>
| 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  
• “Watcher” utterances |
| 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?

<table>
<thead>
<tr>
<th>Activity Level</th>
<th>Mean Minutes Baseline (±SD)</th>
<th>Mean Minutes Intervention (±SD)</th>
<th>t-value</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary</td>
<td>1765.5 (357.7)</td>
<td>1594.7 (208.3)</td>
<td>1.28</td>
<td>0.1</td>
</tr>
<tr>
<td>Light</td>
<td>436.6 (222.3)</td>
<td>413.4 (163.4)</td>
<td>0.75</td>
<td>0.2</td>
</tr>
<tr>
<td>MVPA</td>
<td>0.3 (0.6)</td>
<td>1.8 (3.2)</td>
<td>-1.45</td>
<td>0.09</td>
</tr>
</tbody>
</table>

*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

- **26.2** (68%)
- **N.S.**
- **p < 0.01**

- Affirmation Message
- Neutral Message
- Prompting Question
- Suggestion Message
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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