Fogarty International Center

Global mHealth Research Training Institute

June 6- 9, 2016

Center for Global Health Studies
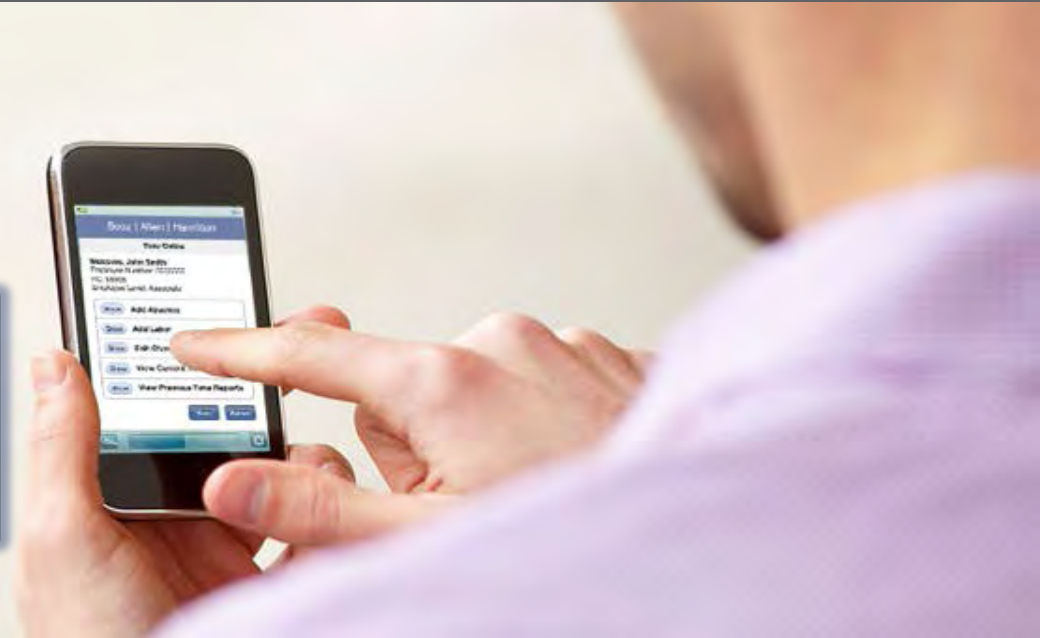
Experimental Designs for Optimizing Interventions

Inbal (Billie) Nahum-Shani

How do you evaluate?
Global mHealth Research Training
May 2016

UNIVERSITY OF MICHIGAN

INSTITUTE FOR SOCIAL RESEARCH
UNIVERSITY OF MICHIGAN

Key Definition

- **Multi-Component Interventions**

  - Component:
    - ► The content of the intervention (e.g., topics in prevention program)
    - ► The intervention modality (e.g., phone calls/emails)
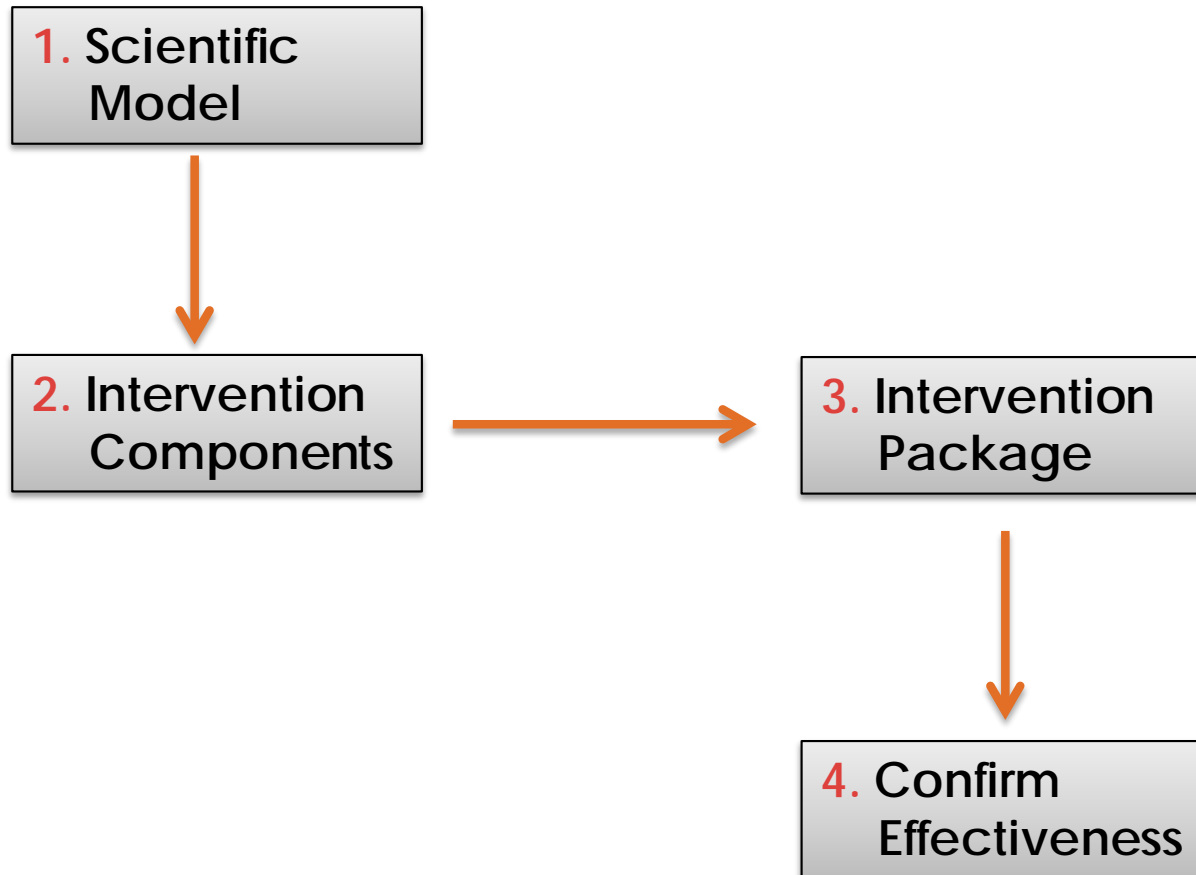   - ► Features to promote compliance or adherence (e.g., reminder emails)

- **Example**:

  - Optimizing a technology supported intervention for weight loss:

    Bonnie Spring, PI. DK097364

    - ► Telephone Caching
    - ► Report to Primary Care Provider
    - ► Text Messages
    - ► Meal Replacements
    - ► Buddy Training

How do We Typically Develop Interventions?

1. Scientific Model

2. Intervention Components

3. Intervention Package

4. Confirm Effectiveness

How do We Typically Develop Interventions?

Open Questions

- Efficacy of Individual components

  – Which components are effective?

  – Which level is more appropriate?

  – Which components work well together?

- Sequencing of components

  – Which component to offer first?

  – Which to offer subsequently?

  – How should I tailor components over time?

Open Questions

- Efficacy of Individual components

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  Factorial Designs

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  SMART

Factorial Designs

Factorial Designs

- Factorials: More than 1 factor; levels of each factor crossed with levels of other factors.

▶ Should I include *Text Messages*?
- Factor 1: Text (**On/Off**)

▶ Should I include *Meal Replacement*?
- Factor 2: Meal (**On/Off**)

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Experimental conditions 2X2 factorial N=400		
Experiment Condition	Factor	
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1 (N=100)	**On**	**On**
2 (N=100)	**On**	**Off**
3 (N=100)	**Off**	**On**
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- Main effect: **On** (N=200) vs. **Off** (N=200)

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4 (N=50)	**On**	**Off**	**Off**
5 (N=50)	**Off**	**On**	**On**
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Factorial Designs

- Power for comparing package vs. control?

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SMART Designs

SMART Designs

- Adaptive Intervention:

  – Intervention design that uses ongoing/dynamic information about the individual to decide which component to offer, when and how.

- Hypothetical Example: (NIH/NIDDK R01DK108678; Spring & Nahum-Shani)

Stage 1 = {Text},

Then

IF *response = {NO}*
    THEN *stage 2 = {Add Buddy}*
ELSE IF *response = {YES}*
    THEN *stage 2 = {Step-Down}*

Non-Responders

Add Buddy

Text

Responders

Step-down

Week 0

Week 2
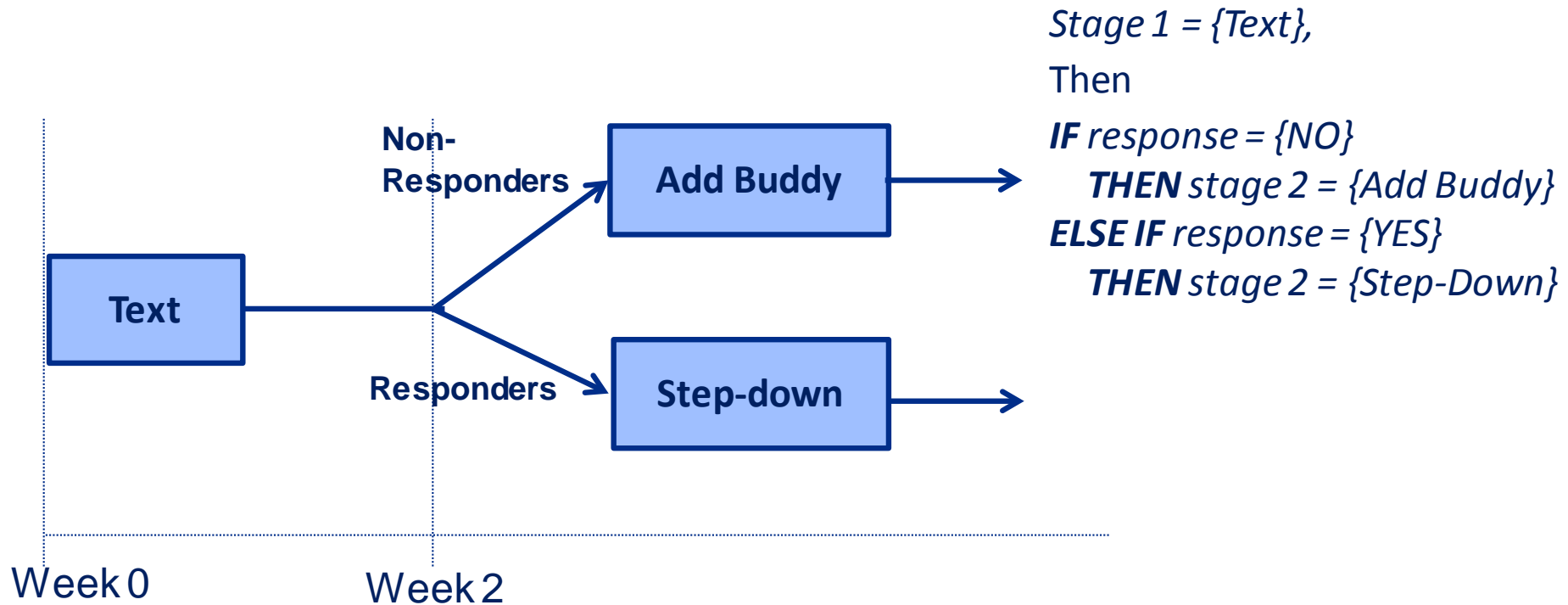
SMART Designs

- Motivation in the context of technology-supported interventions:

— **Cost:** Some mHealth components are costly; resources are often limited

— **Boredom:** Lack of interest in and difficulty concentrating on the task.

— **Burden:** The "workload" required from participants and the impact on their well-being.

SMART Designs

- SMARTs can help us build empirically-based adaptive interventions:

  - Randomized Trials

  - Multiple stages of randomization

  - Each stage corresponds to a critical question concerning the sequencing and adaptation of intervention options over time

SMART Designs

- Hypothetical Example (NIH/NIDDK R01DK108678; Spring & Nahum-Shani)

  – Aim: Develop an **adaptive** technology-supported weight loss intervention

  – Open scientific questions

  Q1. Which component to offer first: Text or Phone?

  Q2. Which component to add for non-responders: Buddy or Phone?
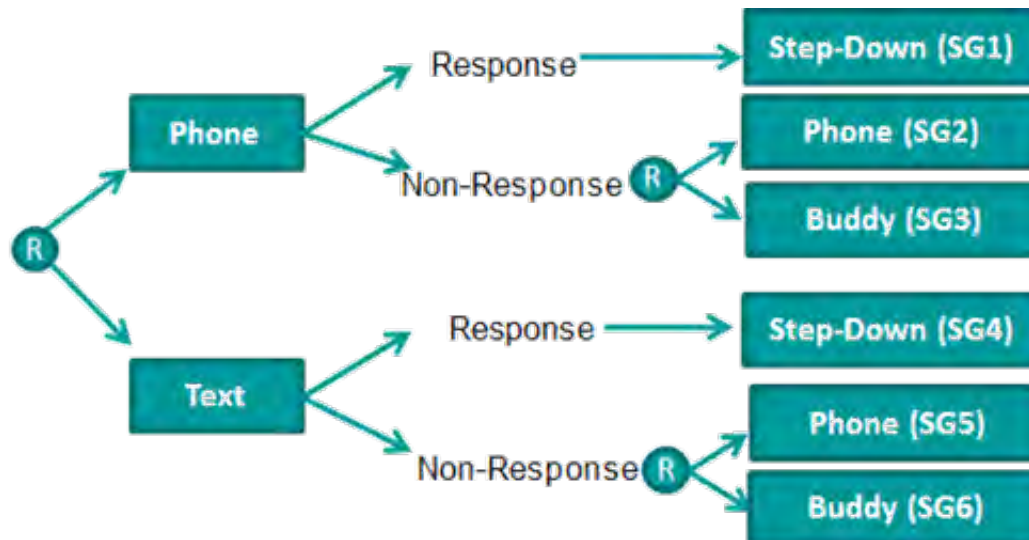
Questions We Can Address with SMART

- **First-stage intervention component:**

  – **Is it better to start with Phone Coaching or Text Messages?**

  – **(SG1+SG2+SG3)** vs. **(SG4+SG5+SG6)**

  – **Phone Coaching** vs. **Text Messages**

    • Controlling for subsequent intervention component
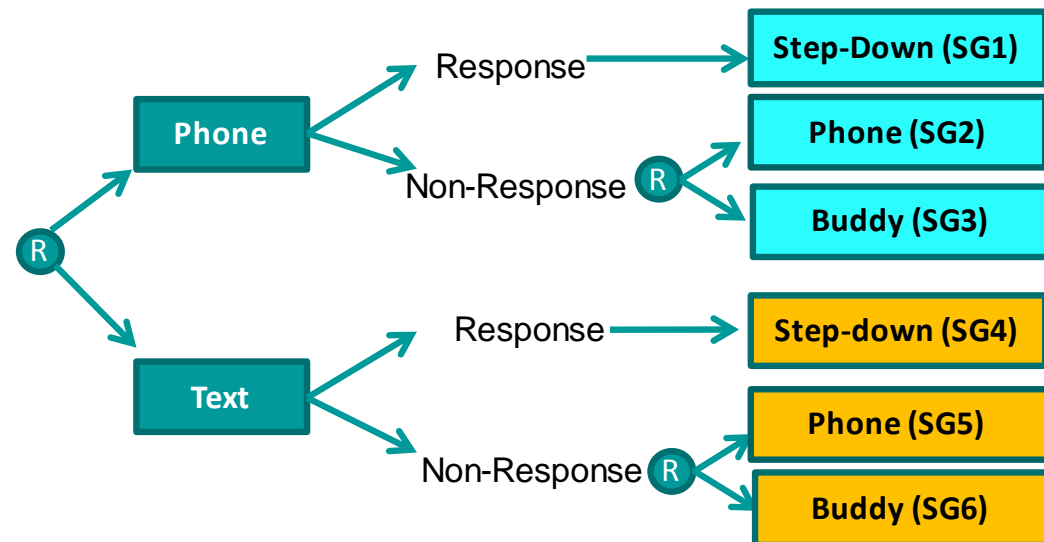
Questions We Can Address with SMART

- **Second-stage intervention component:**

  - **For non-responders: Is it better to add Phone or Buddy?**
  - **(SG2+SG5) vs. (SG3+SG6)**
  - **Phone Coaching vs. Buddy Training**

Questions We Can Address with SMART

■ **Embedded adaptive interventions**

Stage 1 = {Text},

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IF *response = {NO}*
    THEN *stage 2 = {Add Buddy}*
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Questions We Can Address with SMART
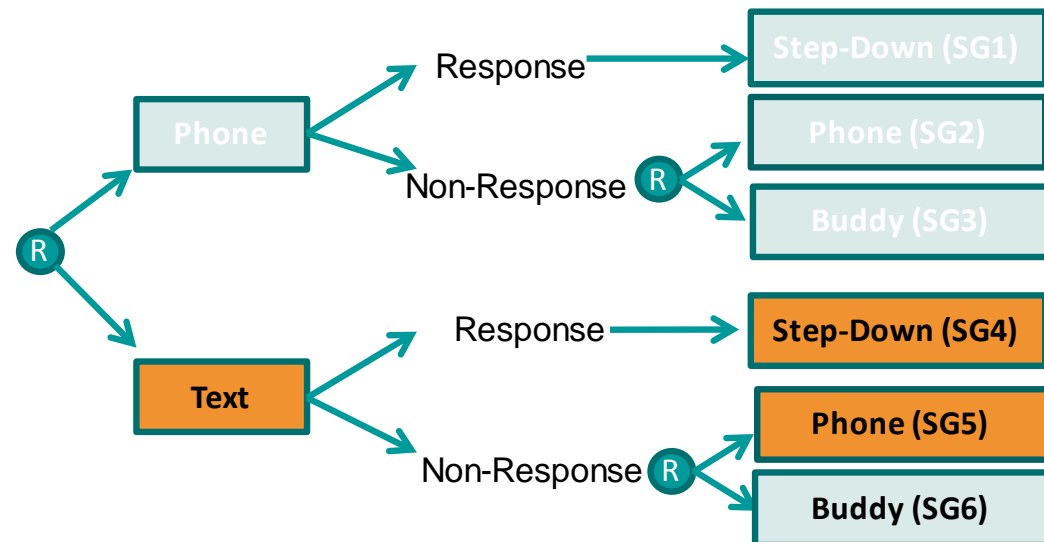
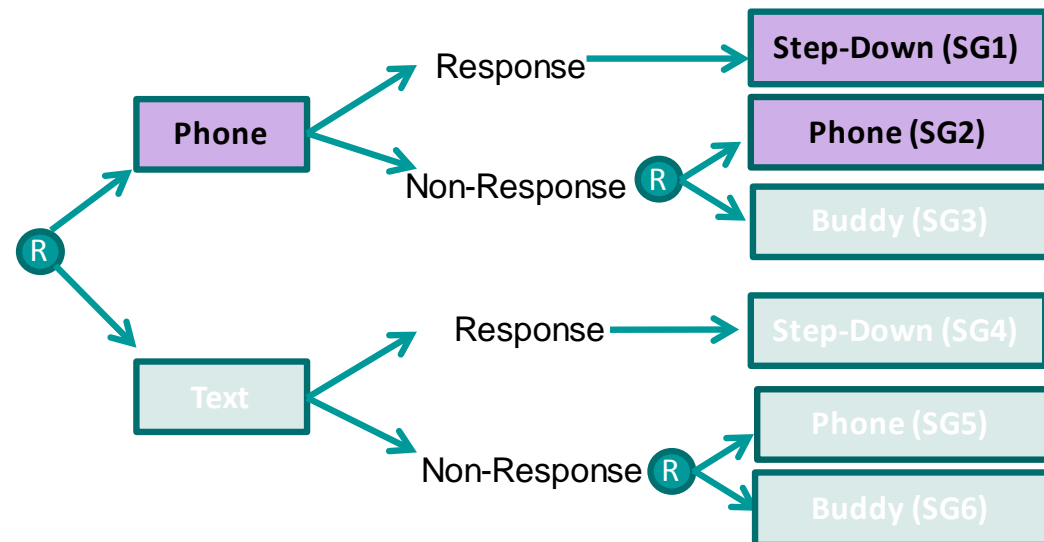- **Embedded adaptive interventions**

Stage 1 = {Text},

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   THEN *stage 2 = {Add Phone}*
ELSE IF *response = {YES}*
   THEN *st*age 2 = {Step-Down}*

Questions We Can Address with SMART

- **Embedded adaptive interventions**

Stage 1 = {Phone},

Then

IF *response = {NO}*

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Questions We Can Address with SMART

- **Embedded adaptive interventions**
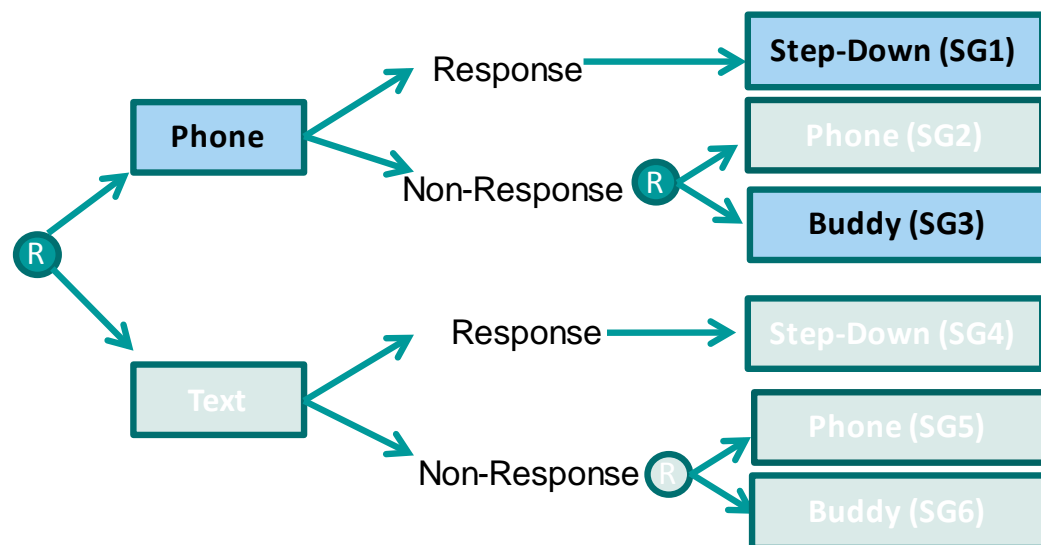
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VS.

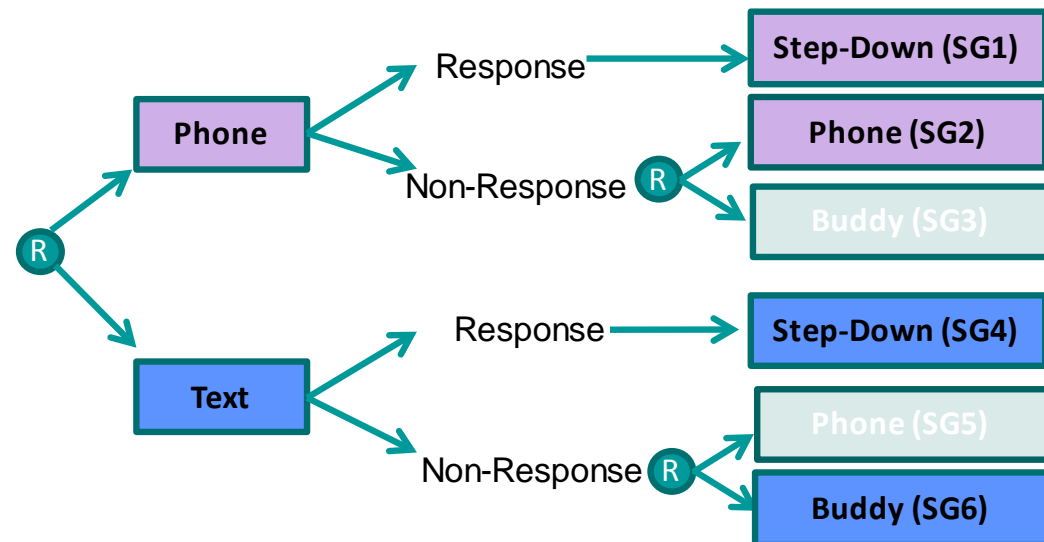*Stage 1 = {Text},*

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Summary

- **Factorial Designs:**

  - **Efficacy of Individual components**

    - Which components are effective?
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- **SMART Designs:**

  - **Sequencing and adaptation of components**

    - Which component to offer first?
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    - How should I tailor components over time?

Experts + Resources

- Collaborators:

  - U of Michigan: Statistical Reinforcement Learning Lab
    - Susan Murphy: http://dept.stat.lsa.umich.edu/~samurphy/
    - Danny Almirall: http://www-personal.umich.edu/~dalmiral/
  - Penn State: Methodology Center
    - Linda Collins: http://methodology.psu.edu/people/lcollins
    - John Dziak: http://methodology.psu.edu/people/jdziak

- Resources:

  - SMART:
    - Projects using SMARTs: https://methodology.psu.edu/ra/adap-inter
    - Lei, H., Nahum-Shani, I., Lynch, K., Oslin, D., & Murphy, S. A. (2012). A "SMART" design for building individualized treatment sequences. *Annual Review of Clinical Psychology*, 8, 14.1 - 14.28
  - Factorials:
    - Q&A: https://methodology.psu.edu/ra/most/fefaq
    - Collins, L. M., Dziak, J. J., & Li, R. (2009). Design of experiments with multiple independent variables: A resource management perspective on complete and reduced factorial designs. *Psychological Methods*, 14, 202-224.

Questions

Inbal (Billie) Nahum-Shani

University of Michigan

inbal@umich.edu