

Experimental Designs for Optimizing Interventions

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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:

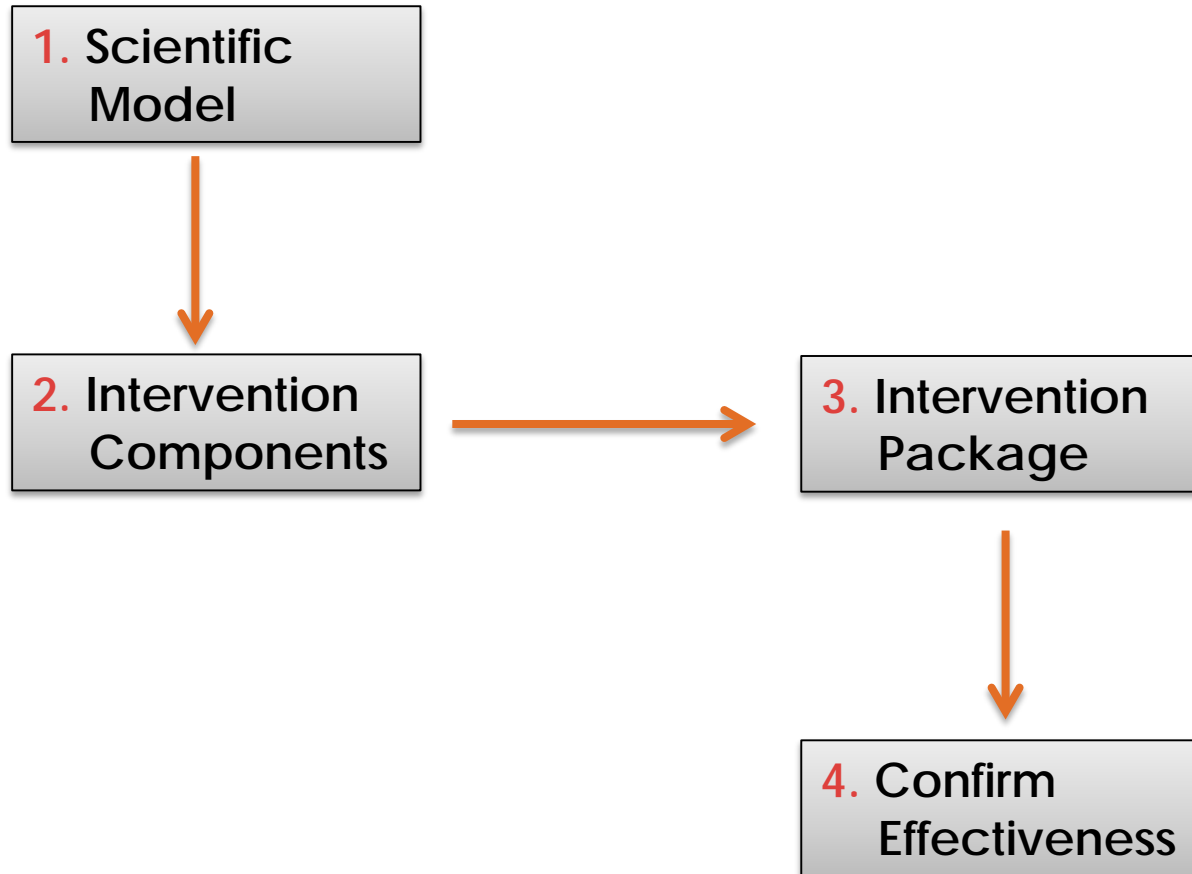
- Optimizing a technology supported intervention for weight loss:

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

Bonnie Spring, PI. DK097364



How do We Typically Develop Interventions?



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1. Theoretical Model



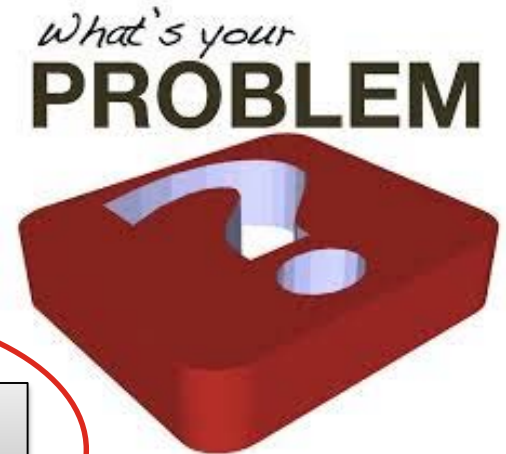
2. Intervention Components



3. Intervention Package



4. Confirm Effectiveness



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?



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- Efficacy of Individual components

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Factorial Designs

- Sequencing of components

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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	
	Text	Meal
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Factorial Designs

- Power for comparing package vs. control?

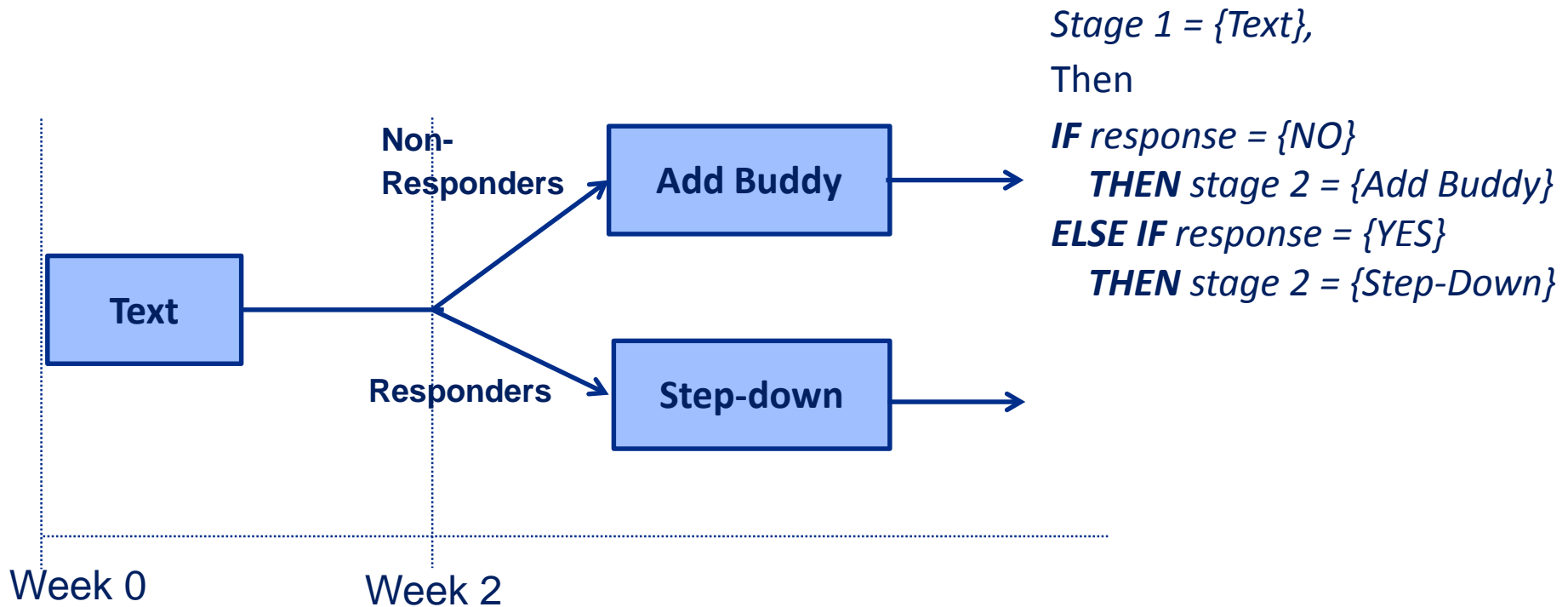
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SMART Designs

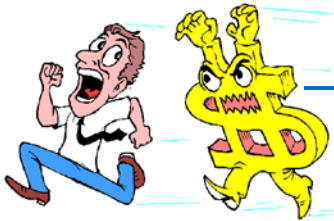
SMART Designs

- 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)



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.



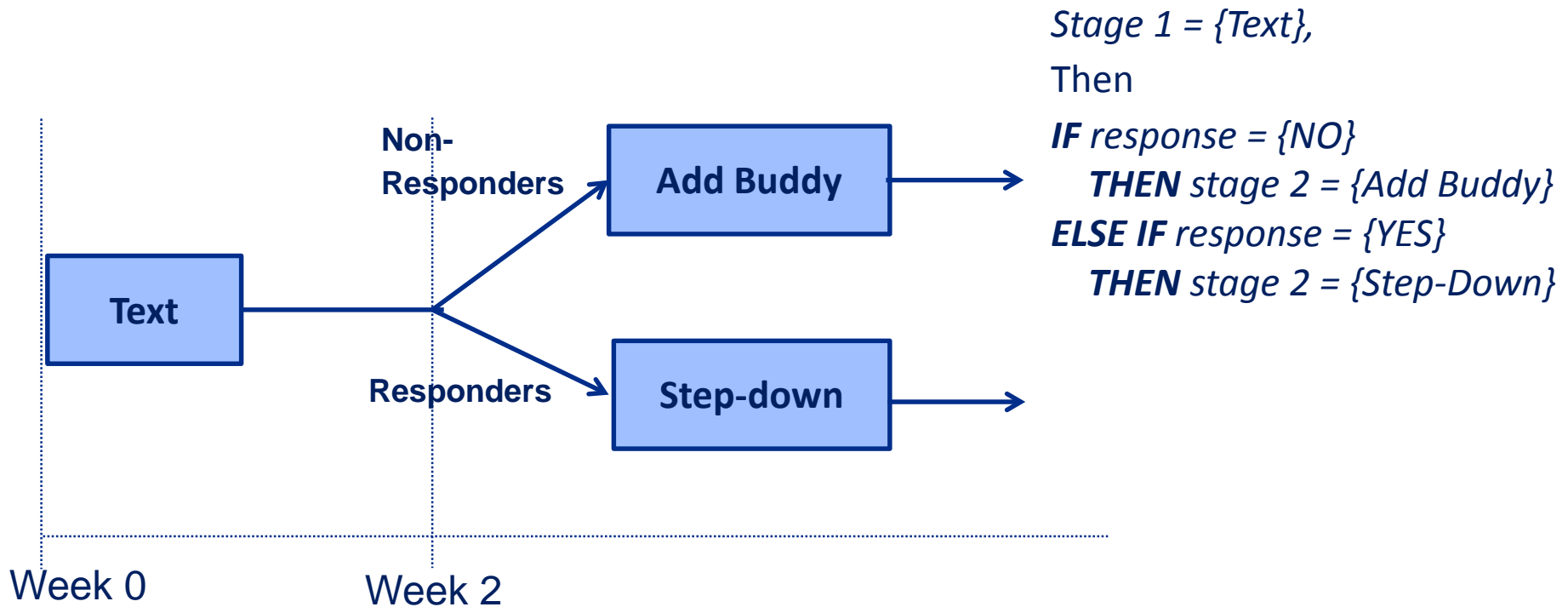
— **Burden:** The “workload” required from participants and the impact on their well-being.

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

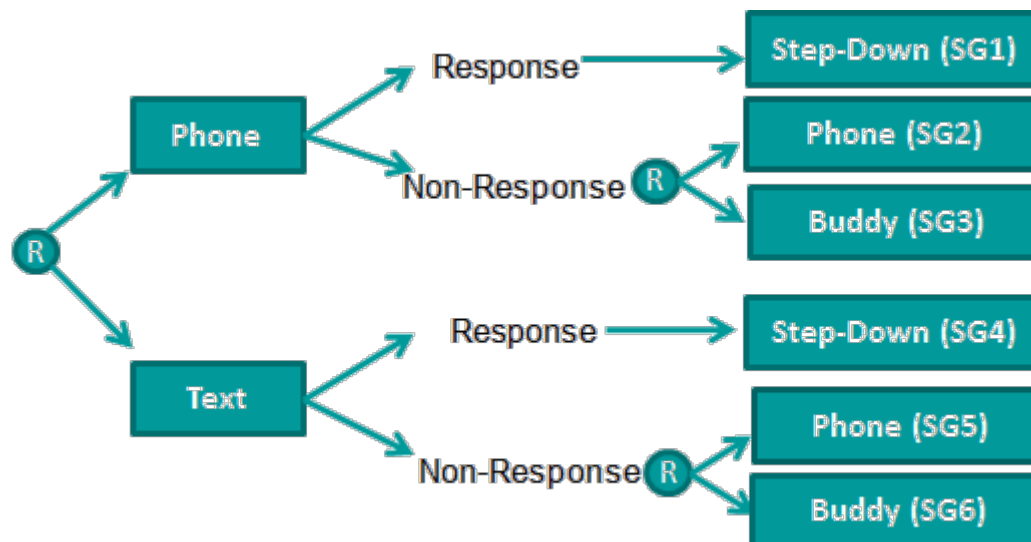
SMART Designs

- Hypothetical Example (NIH/NIDDK R01DK108678; Spring & Nahum-Shani)
 - Remember this Adaptive Intervention?



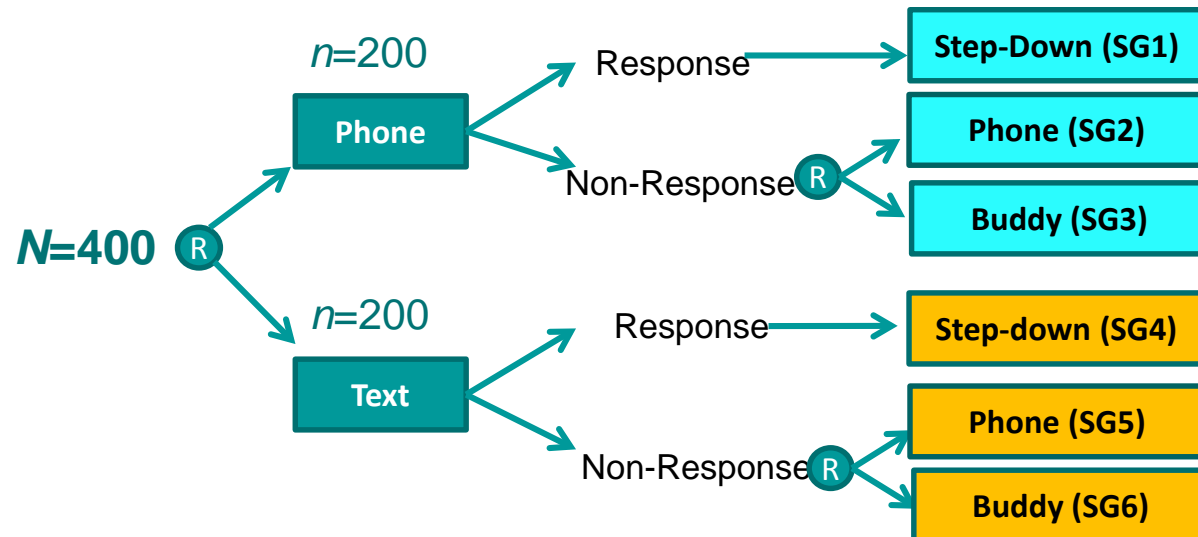
SMART Designs

- 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?



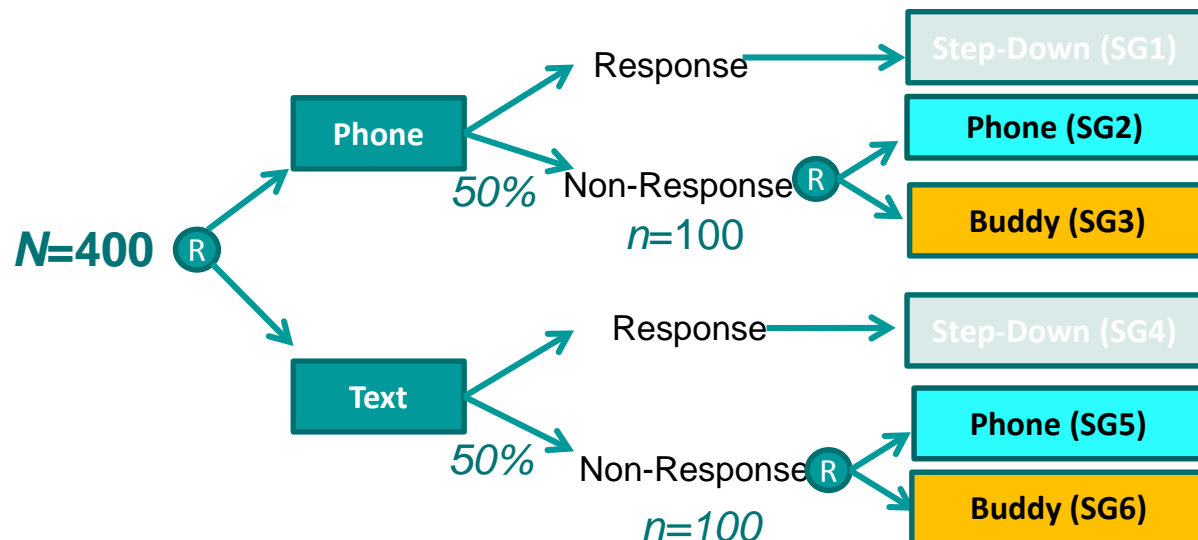
Questions We Can Address with SMART

- 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},

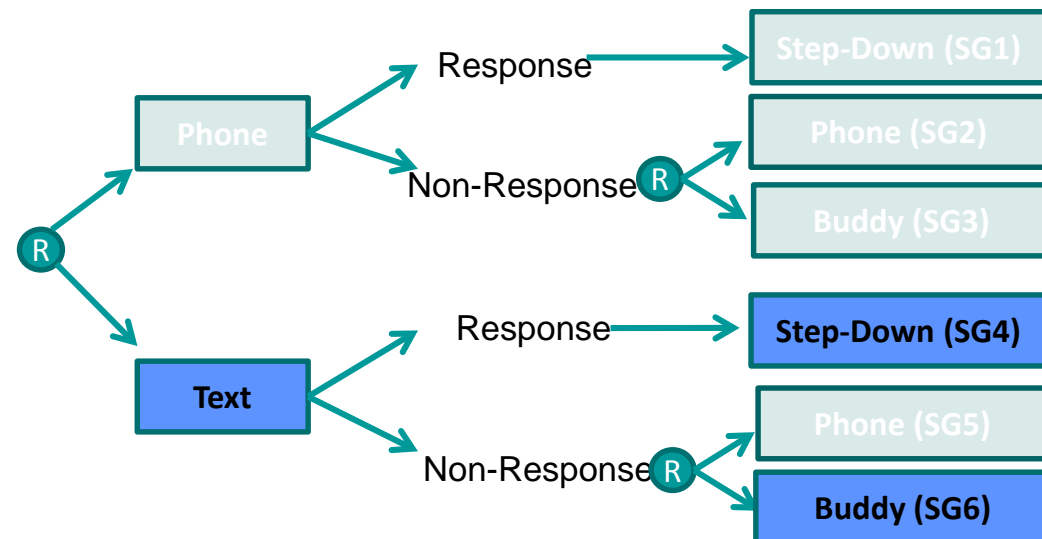
Then

***IF** response = {NO}*

***THEN** stage 2 = {Add Buddy}*

***ELSE IF** response = {YES}*

***THEN** stage 2 = {Step-Down}*



Questions We Can Address with SMART

- Embedded adaptive interventions

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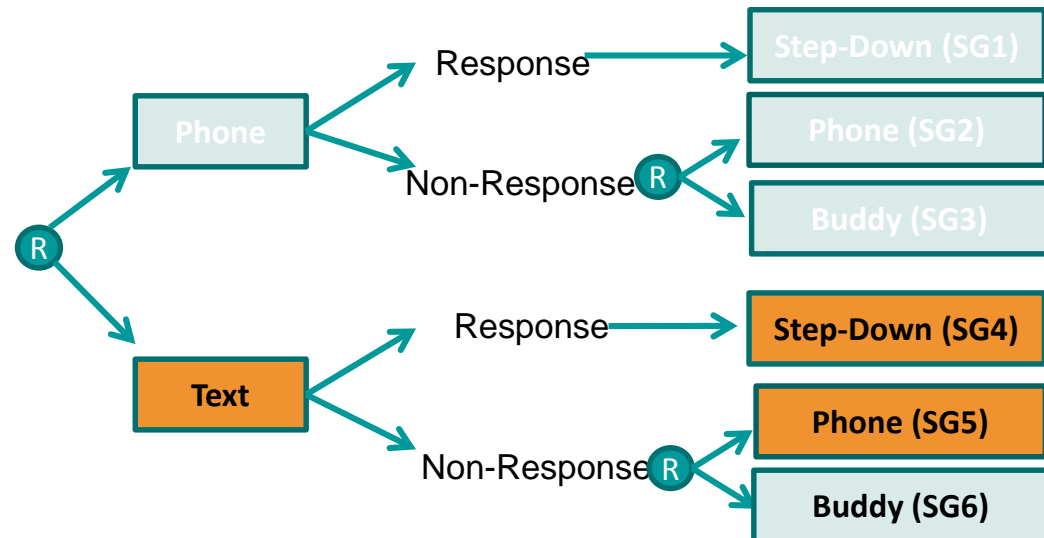
Then

IF response = {NO}

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ELSE IF response = {YES}

THEN stage 2 = {Step-Down}



Questions We Can Address with SMART

- Embedded adaptive interventions

Stage 1 = {Phone},

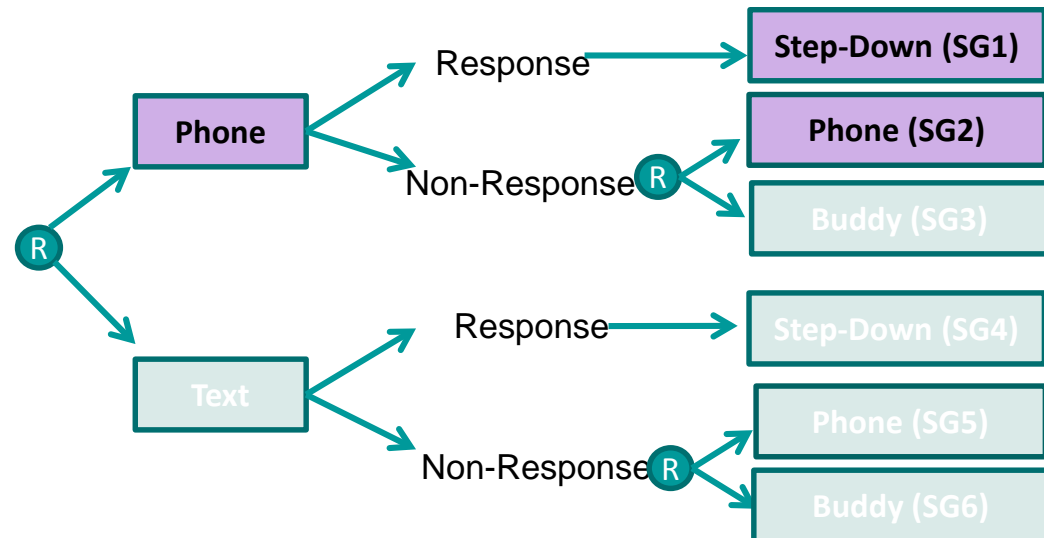
Then

IF response = {NO}

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Questions We Can Address with SMART

- Embedded adaptive interventions

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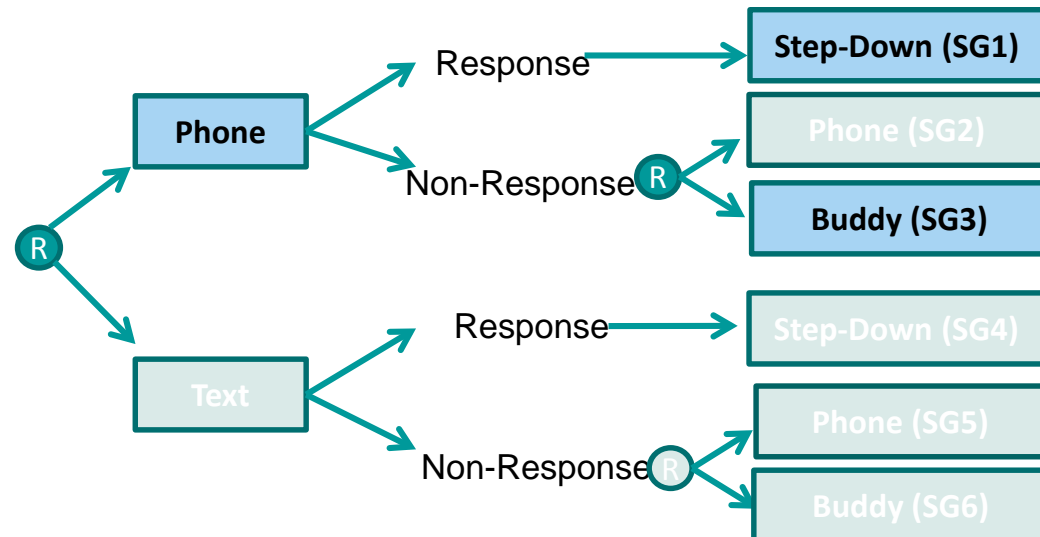
Then,

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Questions We Can Address with SMART

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Stage 1 = {Phone},

Then

IF response = {NO}

THEN stage 2 = {Add Phone}

ELSE IF response = {YES}

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VS.

Stage 1 = {Text},

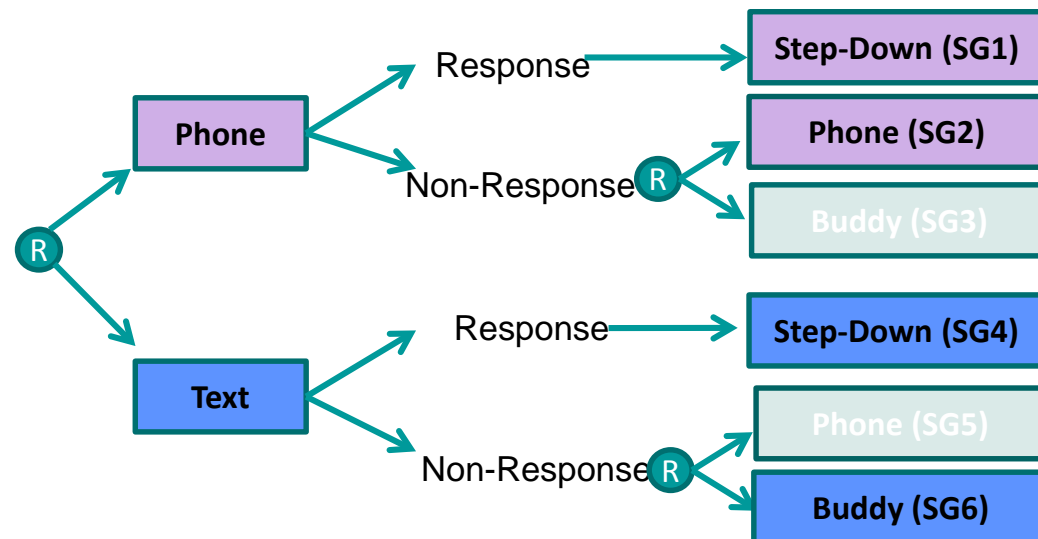
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Summary

- **Factorial Designs:**
 - **Efficacy of Individual components**
 - Which components are effective?
 - Which level is more appropriate?
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- **SMART Designs:**
 - **Sequencing and adaptation of components**
 - Which component to offer first?
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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

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