Presented by

Inbal Billie Nahum-Shani, PhD

Multi-modality Adaptive Interventions

MADIs

Overview

Components	Time Scale for Adaptation	Intervention Design	Experimental Design
Human-delivered	*Slow*	Adaptive Interventions	**SMART**
Digital	*Fast*	Just-in-Time Adaptive Interventions	**MRT**
Human-delivered & Digital	*Multiple Time Scales*	Multimodality Adaptive Interventions	**HED**

All examples are based on R01 AA026574 · PI: Walton.
Examples are modified for illustrative purposes.

Overview

Approach guiding intervention delivery in practice

Approach guiding manipulation of independent variables

Components	Time Scale for Adaptation	Intervention Design	Experimental Design
Human-delivered	*Slow*	Adaptive Interventions	**SMART**
Digital	*Fast*	Just-in-Time Adaptive Interventions	**MRT**
Human-delivered & Digital	*Multiple Time Scales*	Multimodality Adaptive Interventions	**HED**

Overview

Optimization RCTs

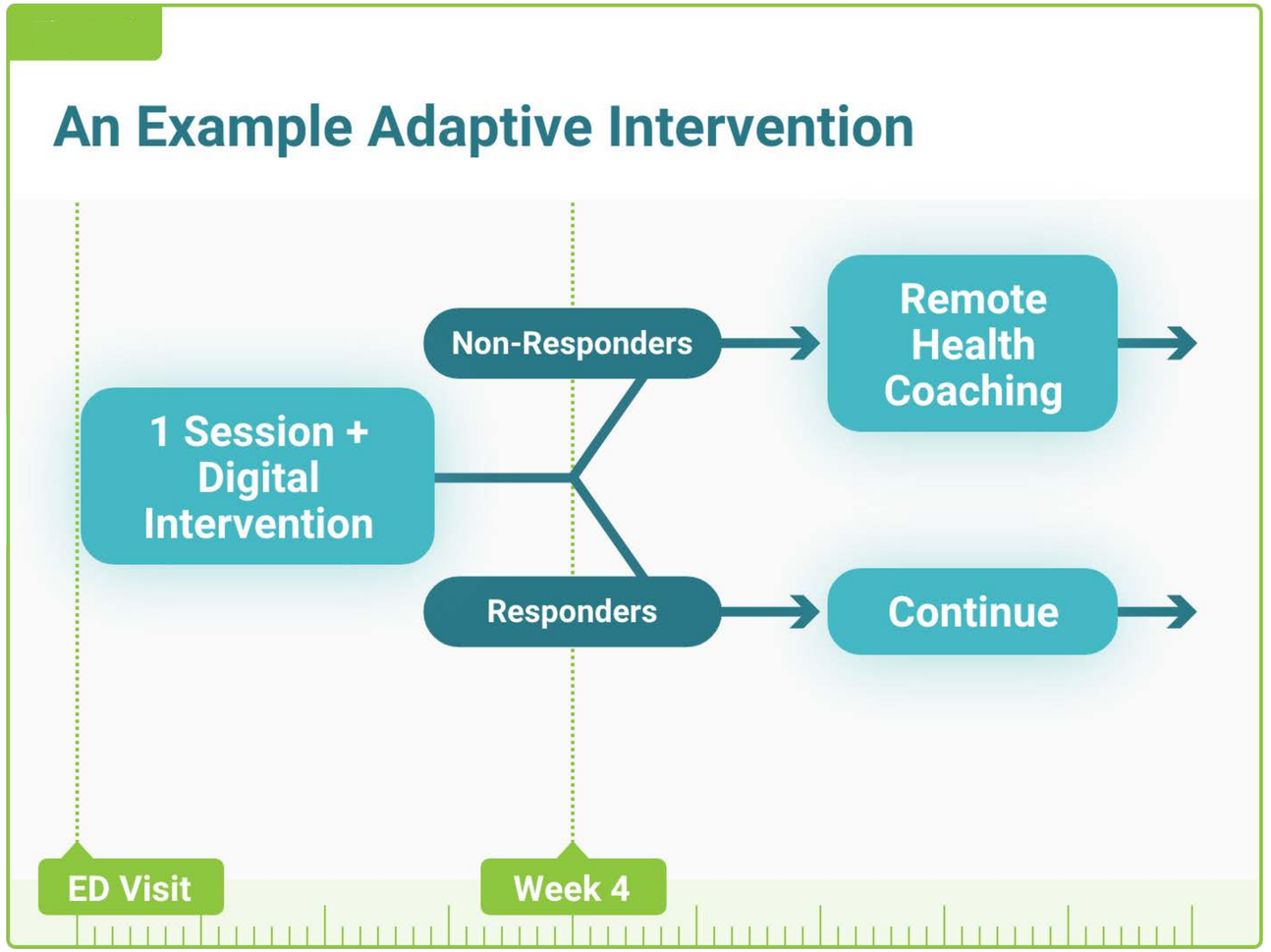
Components	Time Scale for Adaptation	Intervention Framework	Experimental Design
Human-delivered	*Slow*	Adaptive Interventions	**SMART**
Digital	*Fast*	Just-in-Time Adaptive Interventions	**MRT**
Human-delivered & Digital	*Multiple Time Scales*	Multimodal Adaptive Interventions	**HED**

Overview

Components	Time Scale for Adaptation	Intervention Design	Experimental Design
Human-delivered	*Slow*	Adaptive Interventions	**SMART**
Digital	*Fast*	Just-in-Time Adaptive Interventions	**MRT**
Human-delivered & Digital	*Multiple Time Scales*	Multimodal Adaptive Interventions	**HED**

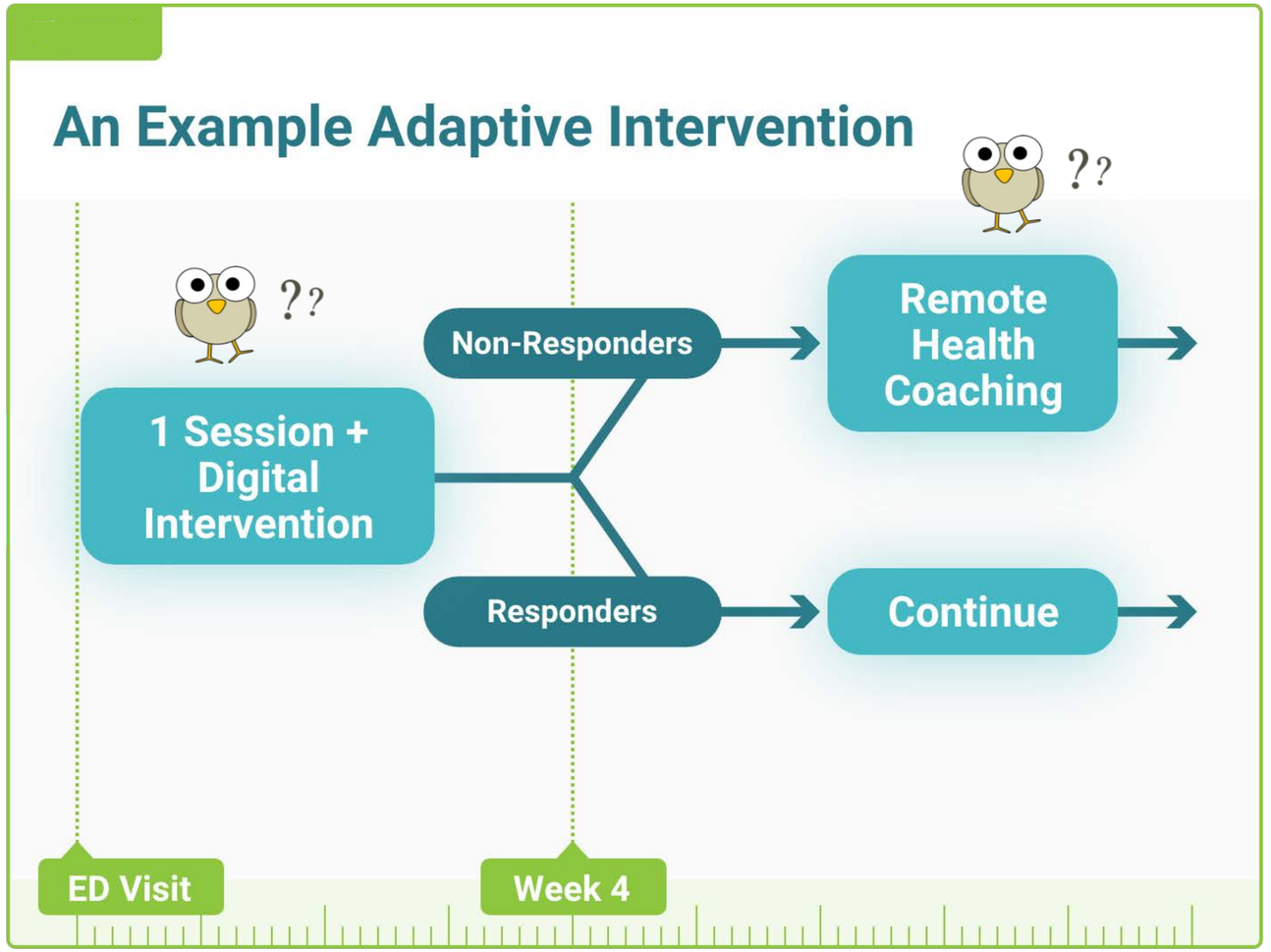
Adaptive Interventions

- Intervention delivery framework
- Use ongoing information about the person to decide whether and how to intervene
- Address conditions that change relatively slowly
- Guide the adaptation of human-delivered components



Adaptive Interventions

- At ED visit—is it beneficial to start with or without RHC?
- At Week 4—is it beneficial to step up the intensity or continue for non-responders?



Beneficial = reducing number of substance use days by week 16

Sequential Multiple Assignment Randomized Trial (SMART)

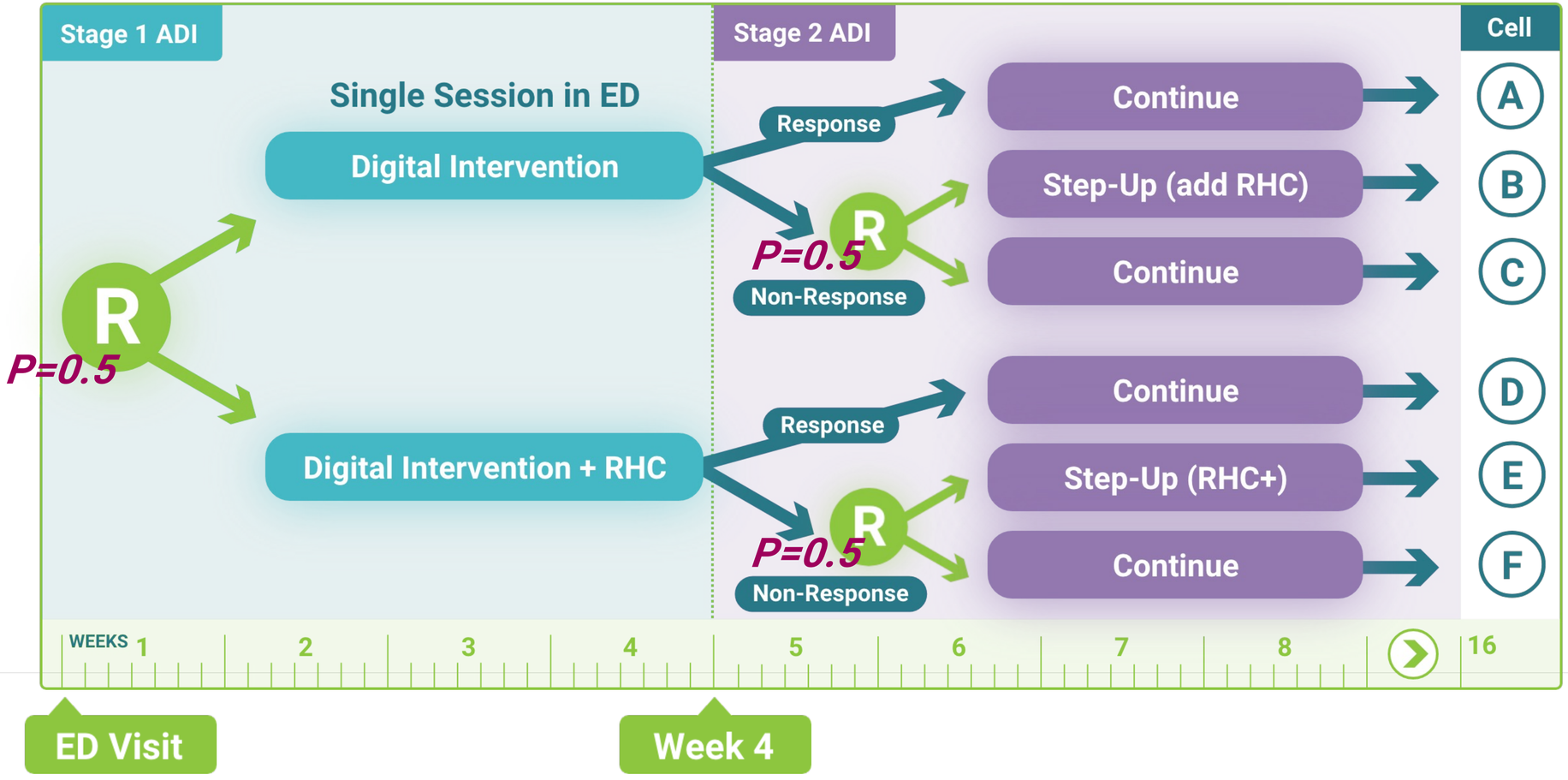
- **Randomized Trial**
  - Multiple stages of randomization
  - Each stage corresponds to a point in time
  - —at which we have scientific questions about the selection and adaptation of components

Lavori PW, Dawson R. A design for testing clinical strategies: biased adaptive within-subject randomization. Journal of the Royal Statistical Society: Series A (Statistics in Society). 2000;163(1):29-38.

Murphy SA. An experimental design for the development of adaptive treatment strategies. Statistics in Medicine. 2005;24(10):1455-1481.

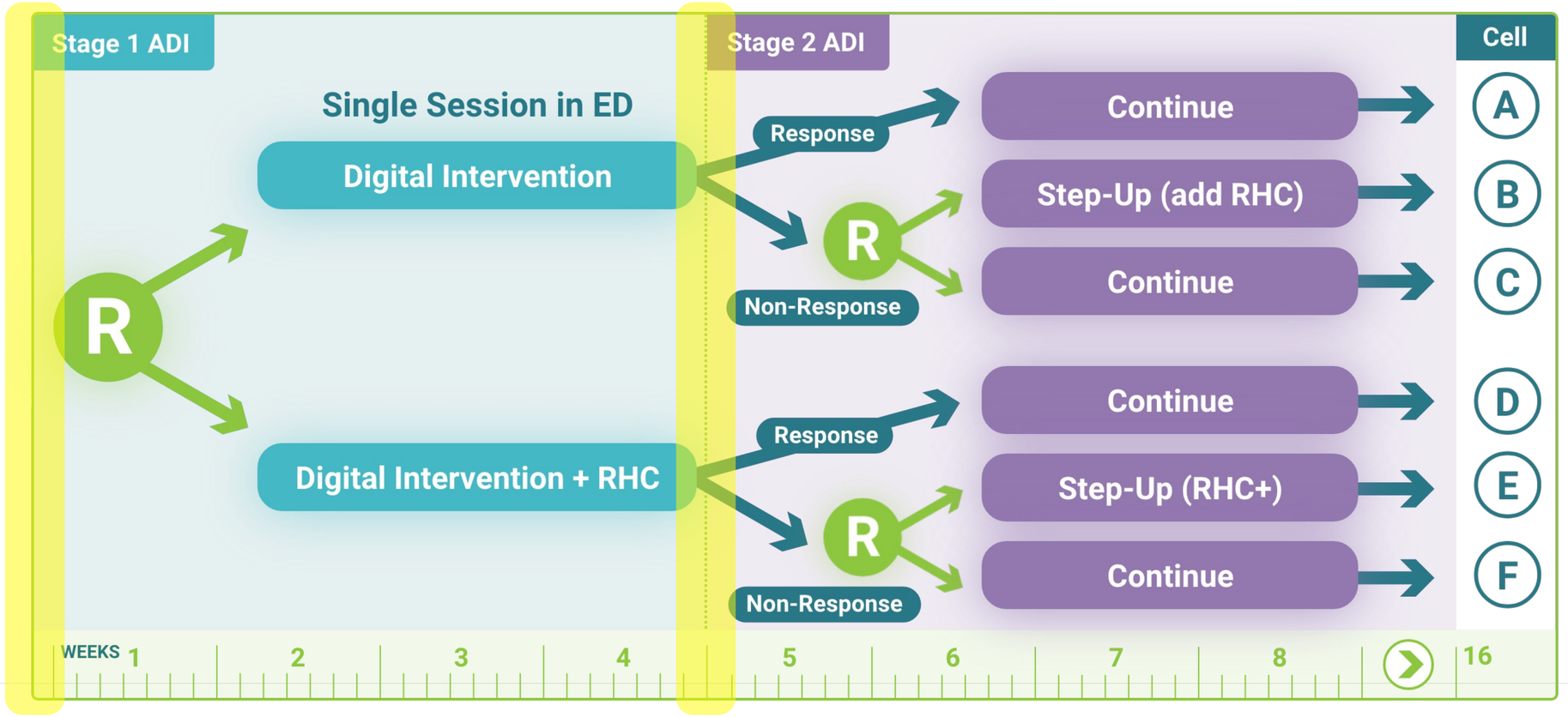
The SMART

- At ED visit—is it beneficial to start with or without RHC?
- At Week 4—is it beneficial to step up the intensity or continue for non-responders?



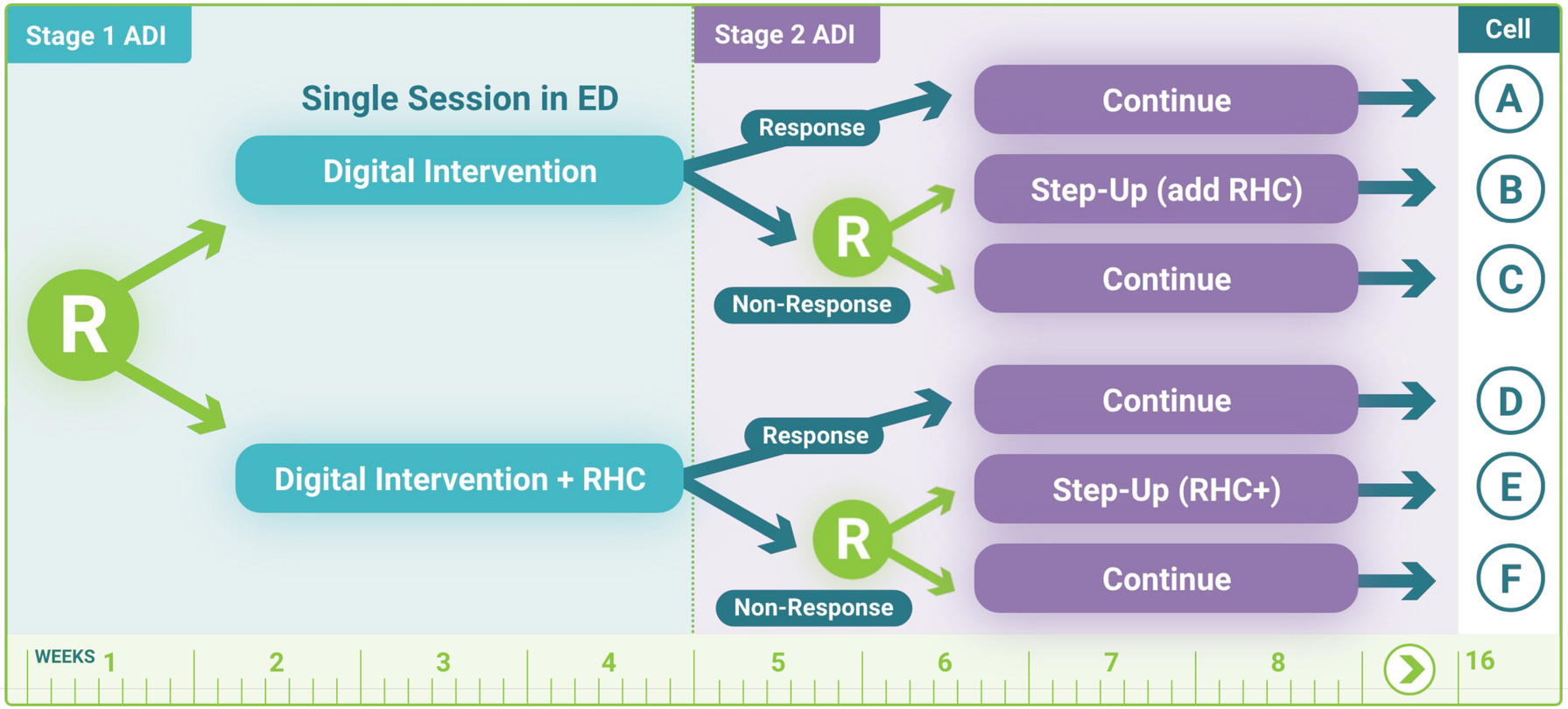
The SMART

- Time scale for randomization: slow
- Questions: sequencing and adaptation at slow time scales



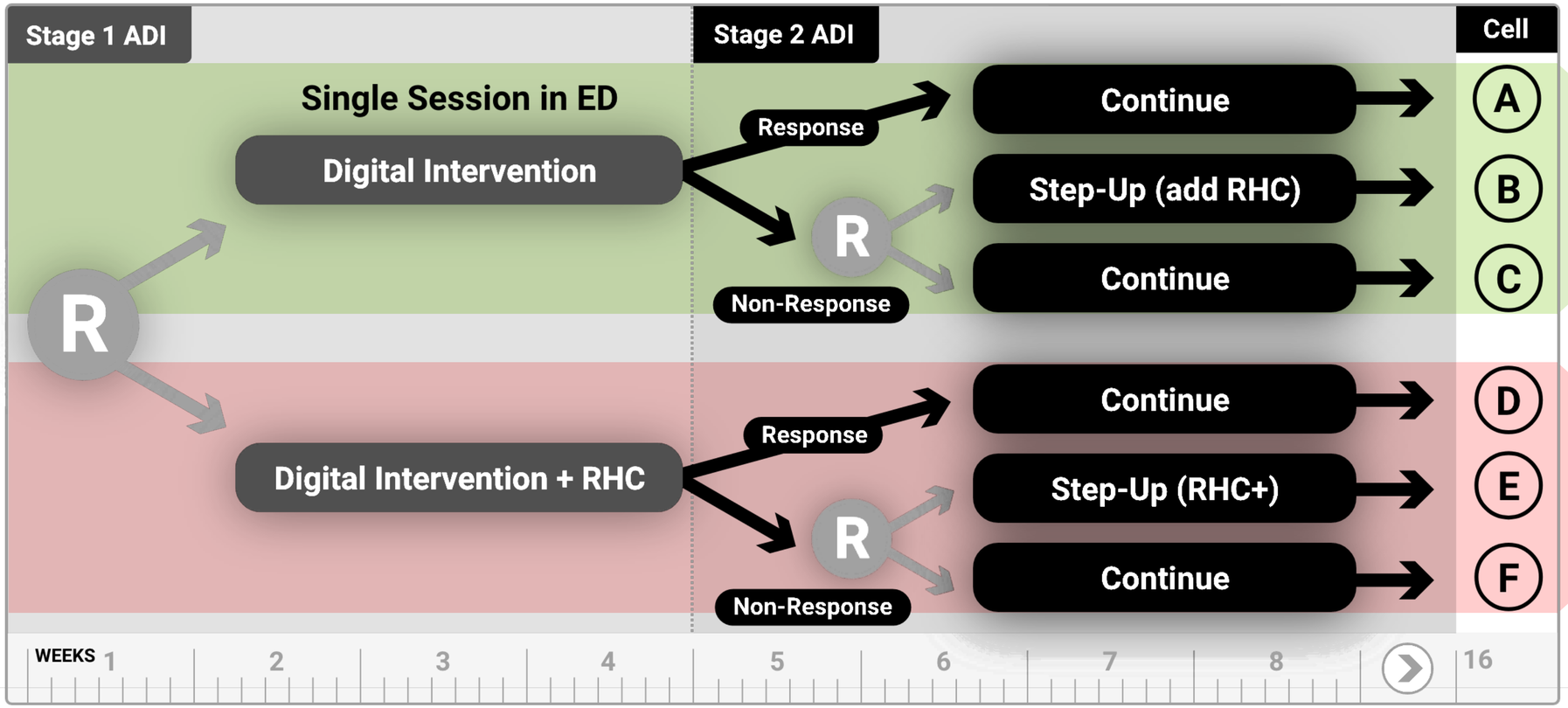
The SMART

- How to answer scientific questions about adaptive intervention development?



The SMART

- At ED visit—is it beneficial to start with or without RHC?
- At Week 4—is it beneficial to step up the intensity or continue for non-responders?

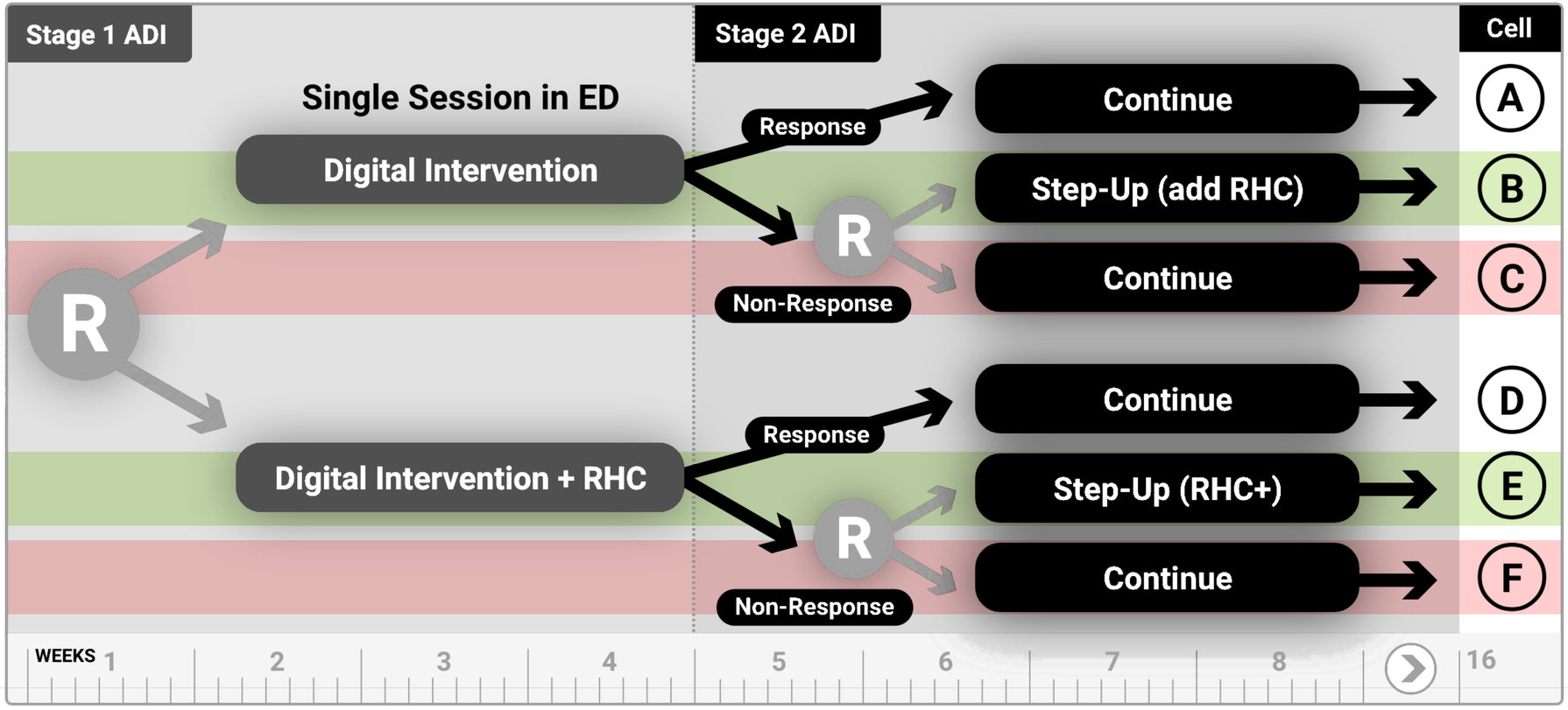


Week 16 Substance Use Across A-C

Week 16 Substance Use Across D-F

The SMART

- At ED visit—is it beneficial to start with or without RHC?
- At Week 4—is it beneficial to step up the intensity or continue for non-responders?



Week 16 Substance Use Across B+E

Week 16 Substance Use Across C+F

The SMART

Contents lists available at ScienceDirect

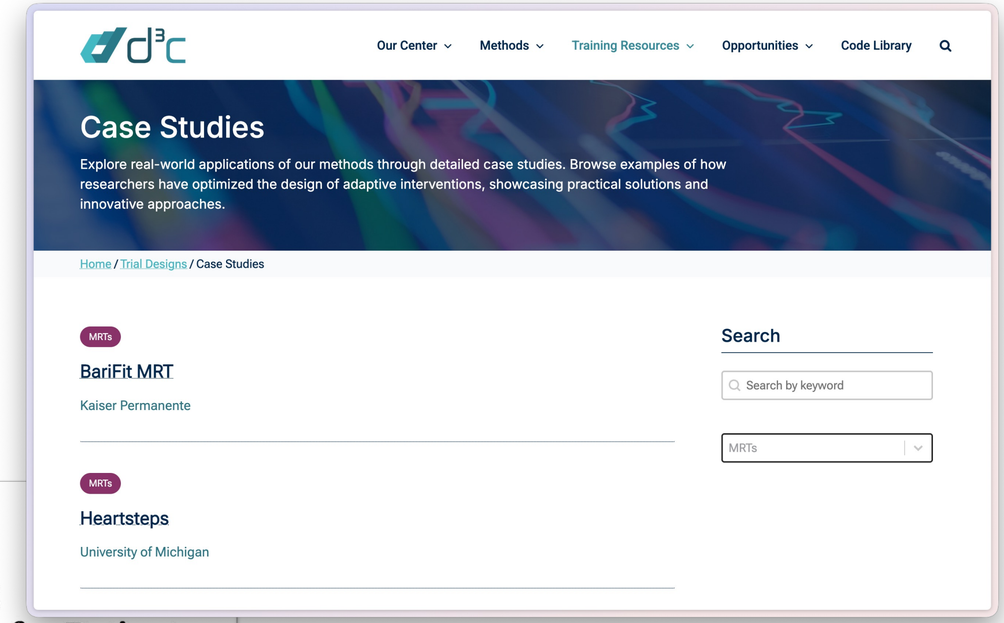
Contemporary Clinical Trials

journal homepage: www.elsevier.com/locate/conclintrial

Program for lung cancer screening and tobacco cessation: Study protocol of a sequential, multiple assignment, randomized trial

Steven S. Fu[a,b,*], Alexander J. Rothman[c], David M. Vock[d], Bruce Lindgren[e], Daniel Almirall[f], Abbie Begnaud[b], Anne Melzer[a,b], Kelsey Schertz[b], Susan Glaeser[b], Patrick Hammett[a,b,g], Anne M. Joseph[b]

[a] VA HSR&D Center for Chronic Disease Outcomes Research, Minneapolis VA Health Care System, Minneapolis, MN,
[b] Department of Medicine, University of Minnesota, Minneapolis, MN, United States
[c] Department of Psychology, University of Minnesota, Minneapolis, MN, United States
[d] Division of Biostatistics, University of Minnesota, Minneapolis, MN, United States
[e] Biostatistics and Bioinformatics Core, Masonic Cancer Center, University of Minnesota, Minneapolis, MN, United State
[f] Survey Research Center, Institute for Social Research, University of Michigan, United States
[g] Division of Epidemiology and Community Health, University of Minnesota, Minneapolis, MN, United States



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MRTs

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MRTs

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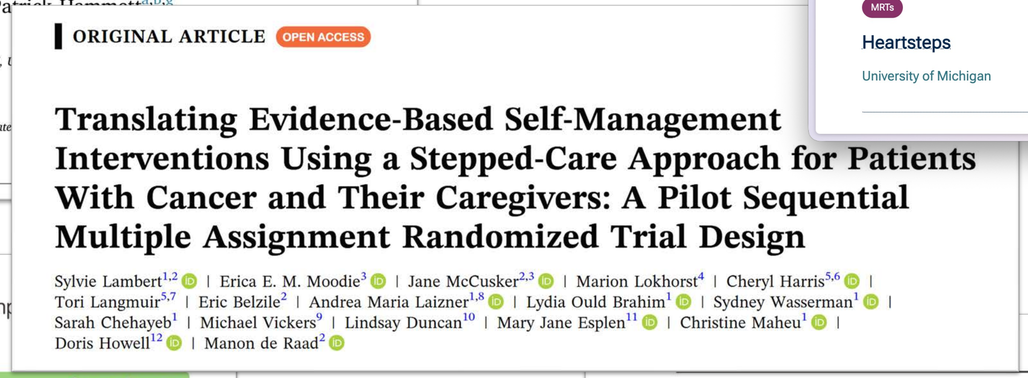
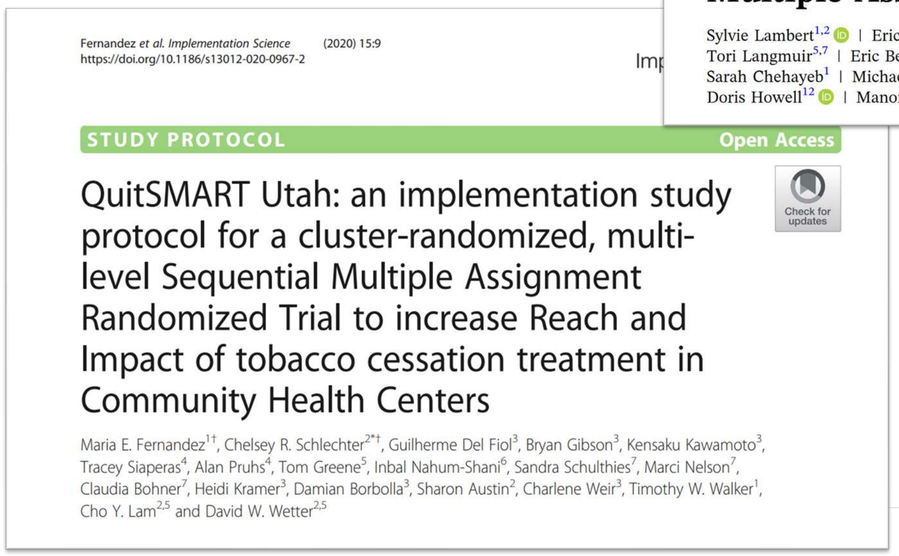
MRTs



ORIGINAL ARTICLE OPEN ACCESS

Translating Evidence-Based Self-Management Interventions Using a Stepped-Care Approach for Patients With Cancer and Their Caregivers: A Pilot Sequential Multiple Assignment Randomized Trial Design

Sylvie Lambert[1,2] | Erica E. M. Moodie[3] | Jane McCusker[2,3] | Marion Lokhorst[4] | Cheryl Harris[5,6] | Tori Langmuir[5,7] | Eric Belzile[2] | Andrea Maria Laizner[1,8] | Lydia Ould Brahim[1] | Sydney Wasserman[1] | Sarah Chehayeb[1] | Michael Vickers[9] | Lindsay Duncan[10] | Mary Jane Esplen[11] | Christine Maheu[1] | Doris Howell[12] | Manon de Raad[2]



Fernandez et al. Implementation Science (2020) 15:9
https://doi.org/10.1186/s13012-020-0967-2

STUDY PROTOCOL Open Access

QuitSMART Utah: an implementation study protocol for a cluster-randomized, multi-level Sequential Multiple Assignment Randomized Trial to increase Reach and Impact of tobacco cessation treatment in Community Health Centers

Maria E. Fernandez[1†], Chelsey R. Schlechter[2*†], Guilherme Del Fiol[3], Bryan Gibson[3], Kensaku Kawamoto[3], Tracey Siaperas[4], Alan Pruhs[4], Tom Greene[5], Inbal Nahum-Shani[6], Sandra Schulthies[7], Marci Nelson[7], Claudia Bohner[7], Heidi Kramer[3], Damian Borbolla[3], Sharon Austin[2], Charlene Weir[3], Timothy W. Walker[1], Cho Y. Lam[2,5] and David W. Wetter[2,5]

PAIN 164 (2023) 1935–1941

PAIN®

Behavioral cancer pain intervention dosing: results of a Sequential Multiple Assignment Randomized Trial

Tamara J. Somers[a,*], Joseph G. Winger[a], Hannah M. Fisher[a], Kelly A. Hyland[a], Marie Davidian[b], Eric B. Laber[c], Shannon N. Miller[a], Sarah A. Kelleher[a], Jennifer C. Plumb Vilardaga[a], Catherine Majestic[a], Rebecca A. Shelby[a], Shelby D. Reed[d,e], Gretchen G. Kimmick[f], Francis J. Keefe[a]

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Overview

Components	Time Scale for Adaptation	Intervention Design	Experimental Design
Human-delivered	*Slow*	Adaptive Interventions	**SMART**
Digital	*Fast*	Just-in-Time Adaptive Interventions	**MRT**
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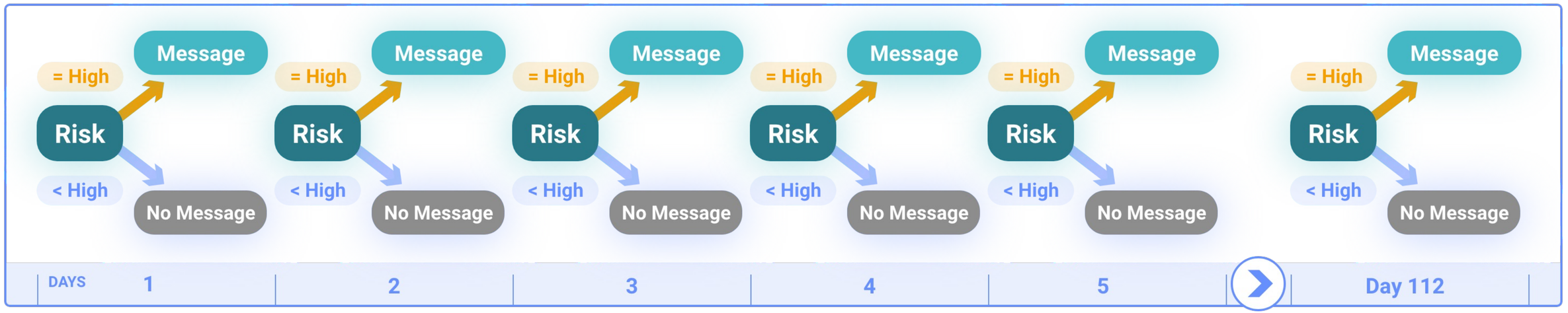
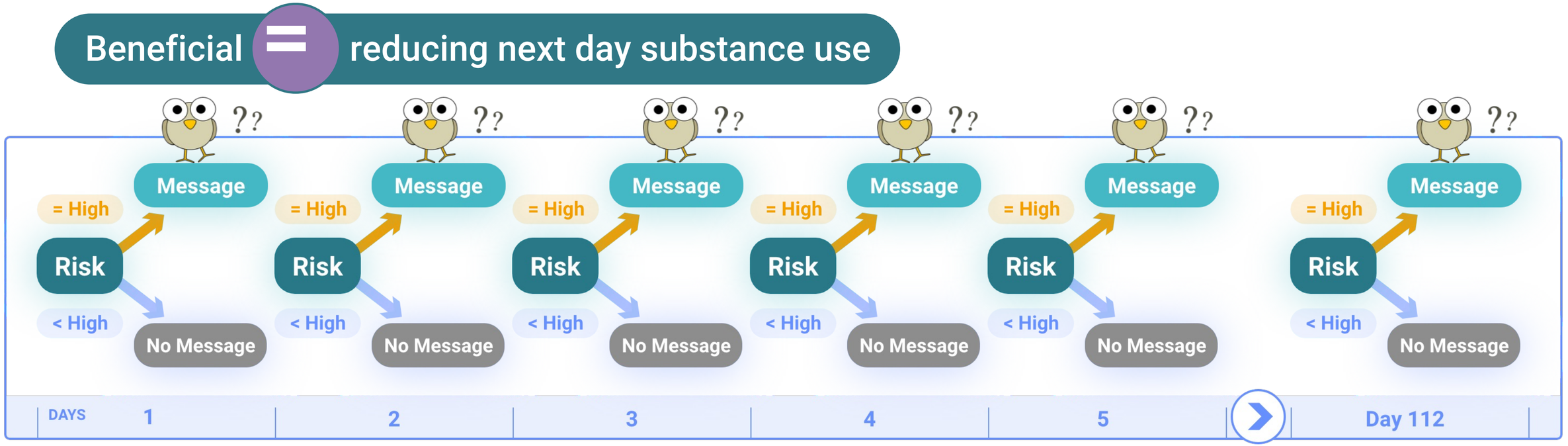
Just-in-Time Adaptive Interventions (JITAI)

- Use ongoing information about the person to decide whether and how to intervene
- Address conditions that change relatively rapidly
- Guide the adaptation of digital interventions



Just-in-Time Adaptive Interventions (JITAI)

- On average, is it beneficial to deliver (vs. not deliver) a message?
- Under what conditions would delivering a message be beneficial?



Micro-Randomized Trial

(MRT)

- **Randomized Trial**
  - Sequential randomizations: each participant randomized between intervention options at each decision point
  - Each person may be randomized 100s or 1000s of times, multiple times per day

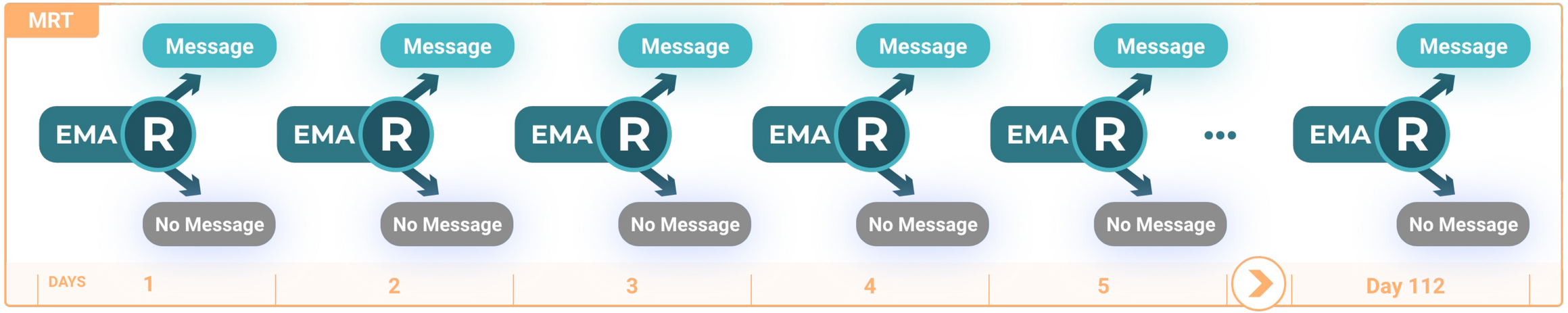
Liao P, Klasnja P, Tewari A, Murphy SA. Sample size calculations for micro-randomized trials in mHealth. Statistics in Medicine. 2016;35(12):1944–1971.

Qian T, Walton AE, Collins LM, ... , Murphy SA. The Micro-Randomized Trial for Developing Digital Interventions: Experimental Design and Data Analysis Considerations. Psychological Methods.

Micro-Randomized Trial

(MRT)

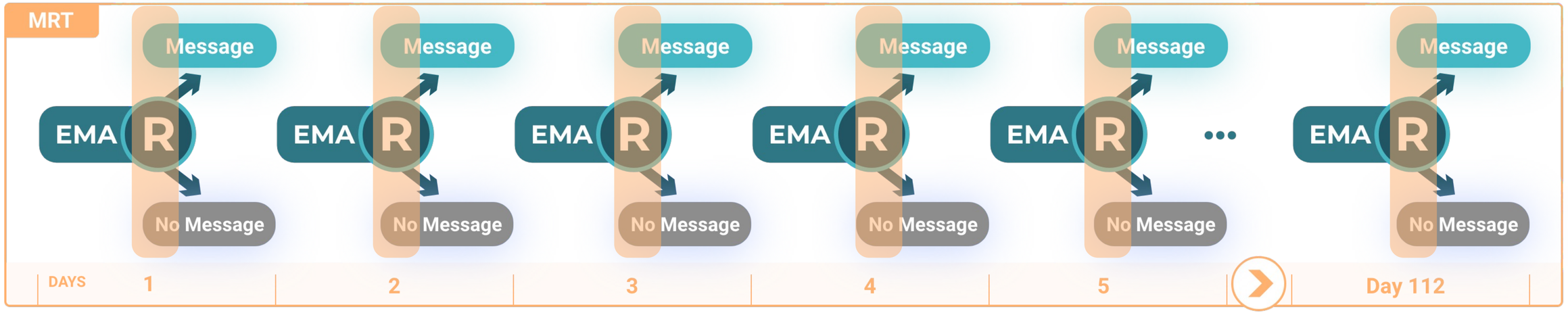
- Is it beneficial to deliver a message in terms of reducing next-day substance use?
- Under what conditions would delivering a message be beneficial?



Micro-Randomized Trial

(MRT)

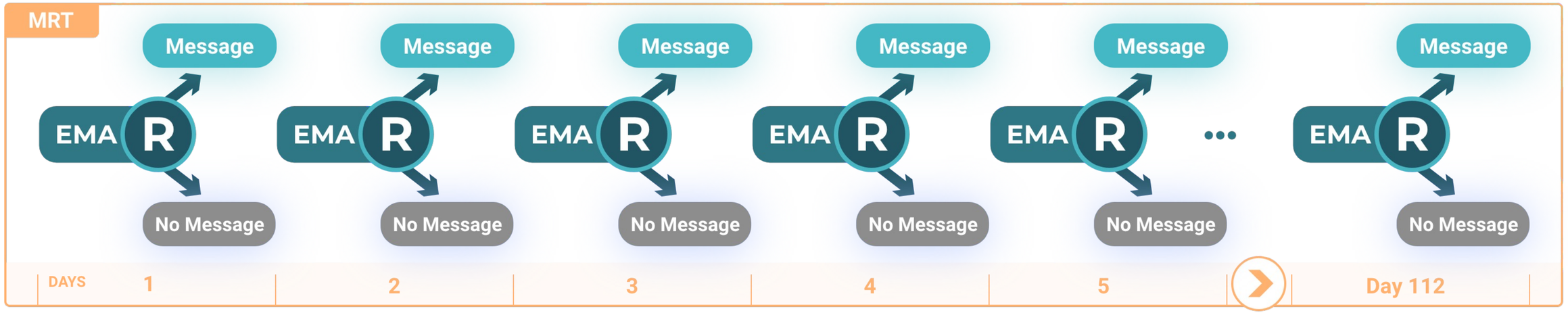
- Time scale for randomization: fast
- Questions: sequencing and adaptation at fast time scales



Micro-Randomized Trial

(MRT)

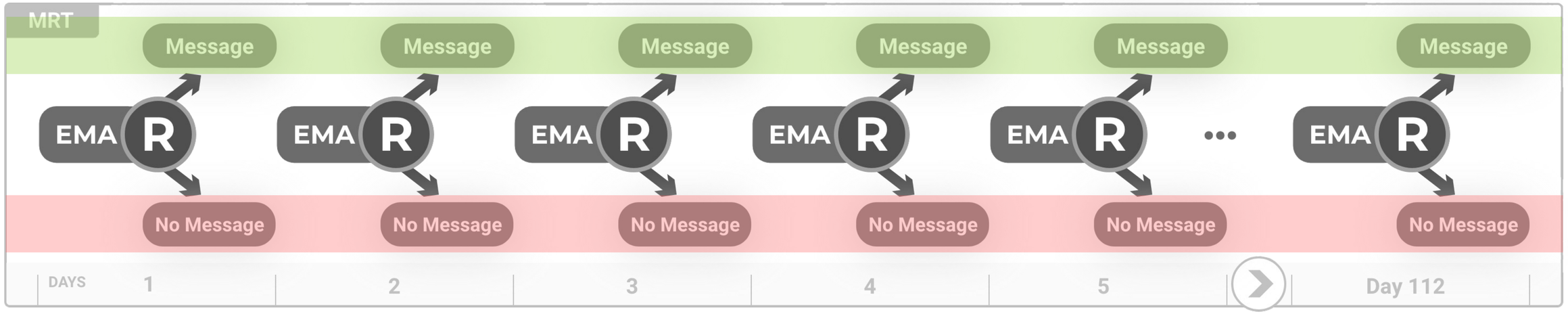
- How to answer scientific questions about JITAI development?



Micro-Randomized Trial

(MRT)

- Is it beneficial to deliver a message in terms of reducing next-day substance use?
- Under what conditions would delivering a message be beneficial?



Next day substance use across all days in which a message was delivered.

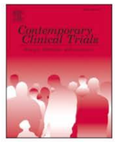
Next day substance use across all days in which a message was not delivered.

Micro-Randomized Trial

Contents lists available at ScienceDirect

Contemporary Clinical Trials

journal homepage: www.elsevier.com/locate/conclintrial



The mobile assistance for regulating smoking (MARS) micro-randomized trial design protocol

Inbal Nahum-Shani [a,*], Lindsey N. Potter [b], Cho Y. Lam [b], Jamie Yap [a], Alexander Moreno [c], Rebecca Stoffel [b], Zhenke Wu [d], Neng Wan [e], Walter Dempsey [d], Santosh Kumar [f], Emre Ertin [g], Susan A. Murphy [h], James M. Rehg [c], David W. Wetter [b]

JMIR FORMATIVE RESEARCH Wang et al

Original Paper

The Dosing of Mobile-Based Just-in-Time Adaptive Self-Management Prompts for Caregivers: Preliminary Findings From a Pilot Microrandomized Study

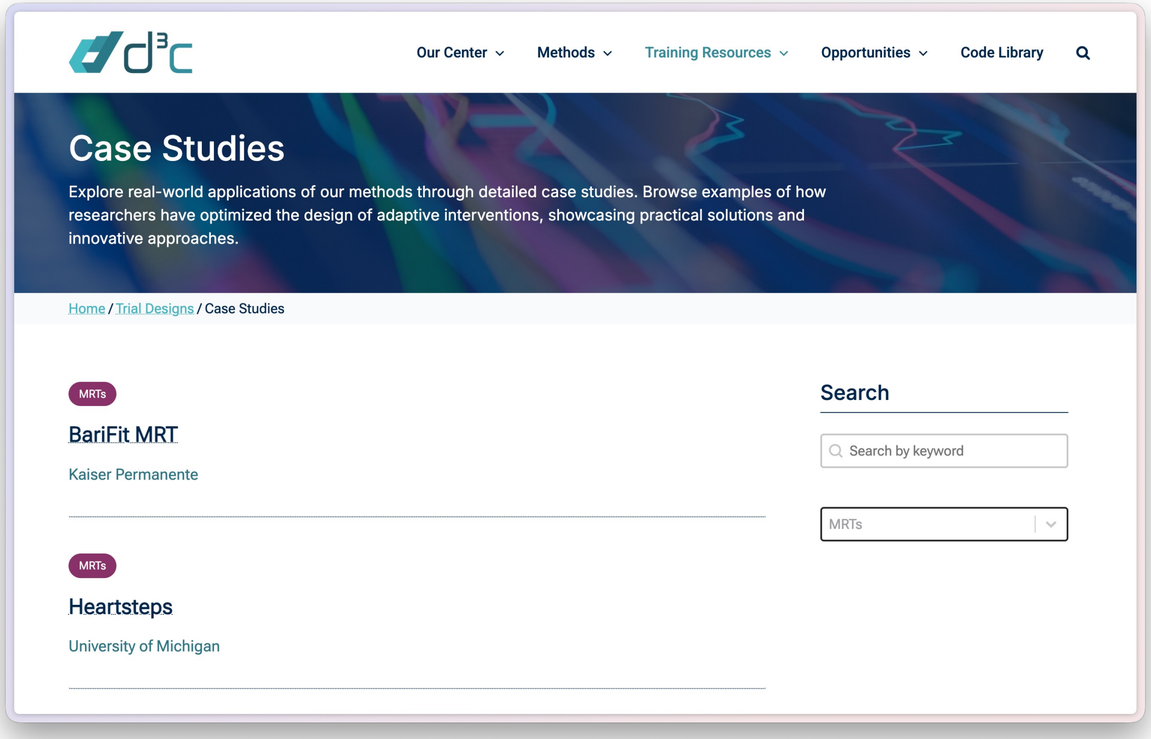
Jitao Wang[1], MS; Zhenke Wu[1,2], PhD; Sung Won Choi[3], MD; Srijan Sen[4], MD; Xinghui Yan[5], MS; Jennifer A Miner[6], MBA; Angelle M Sander[7], PhD; Angela K Lyden[8], MS; Jonathan P Troost[2], PhD; Noelle E Carlozzi[6], PhD

JMIR RESEARCH PROTOCOLS Psihogios et al

Protocol

Understanding Adolescent and Young Adult 6-Mercaptopurine Adherence and mHealth Engagement During Cancer Treatment: Protocol for Ecological Momentary Assessment

Alexandra M Psihogios[1], PhD; Mashfiqui Rabbi[2], PhD; Annisa Ahmed[3], BA; Elise R McKelvey[4], MA; Yimei Li[1], PhD; Jean-Philippe Laurenceau[5], PhD; Stephen P Hunger[1], MD; Linda Fleisher[6], PhD; Ahna LH Pai[7], PhD; Lisa A Schwartz[1], PhD; Susan A Murphy[2], PhD; Lamia P Barakat[1], PhD



d3c.isr.umich.edu/casestudies

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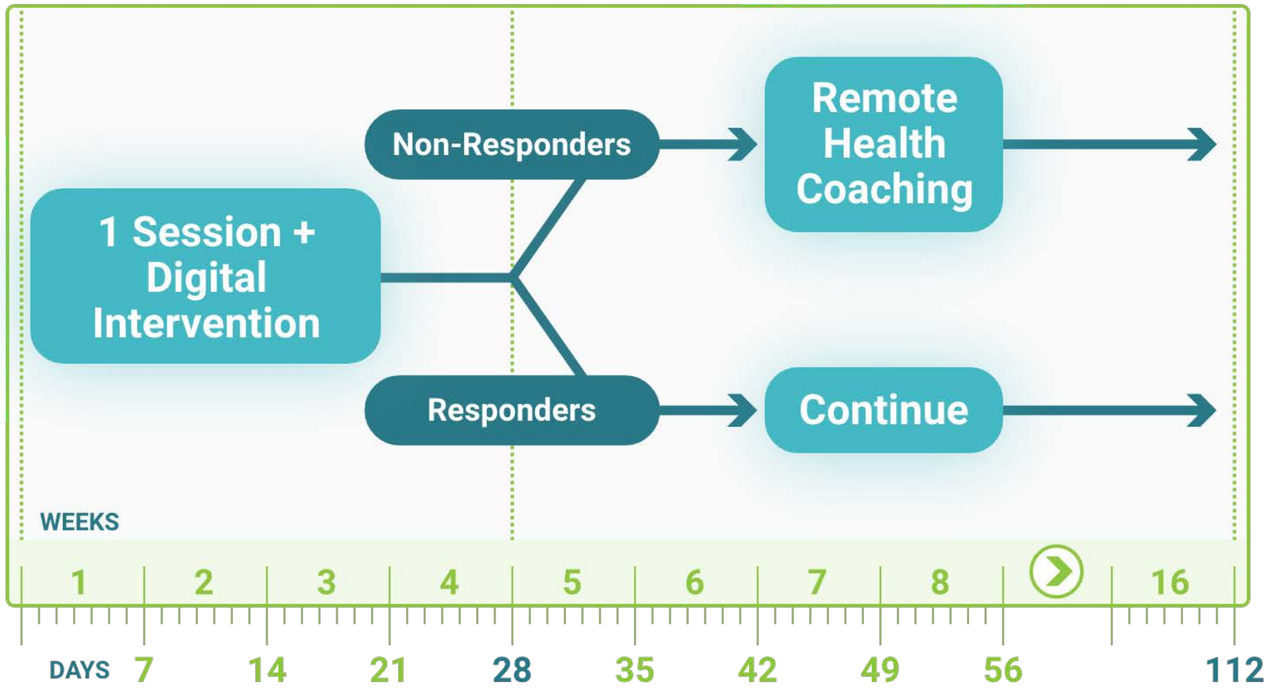
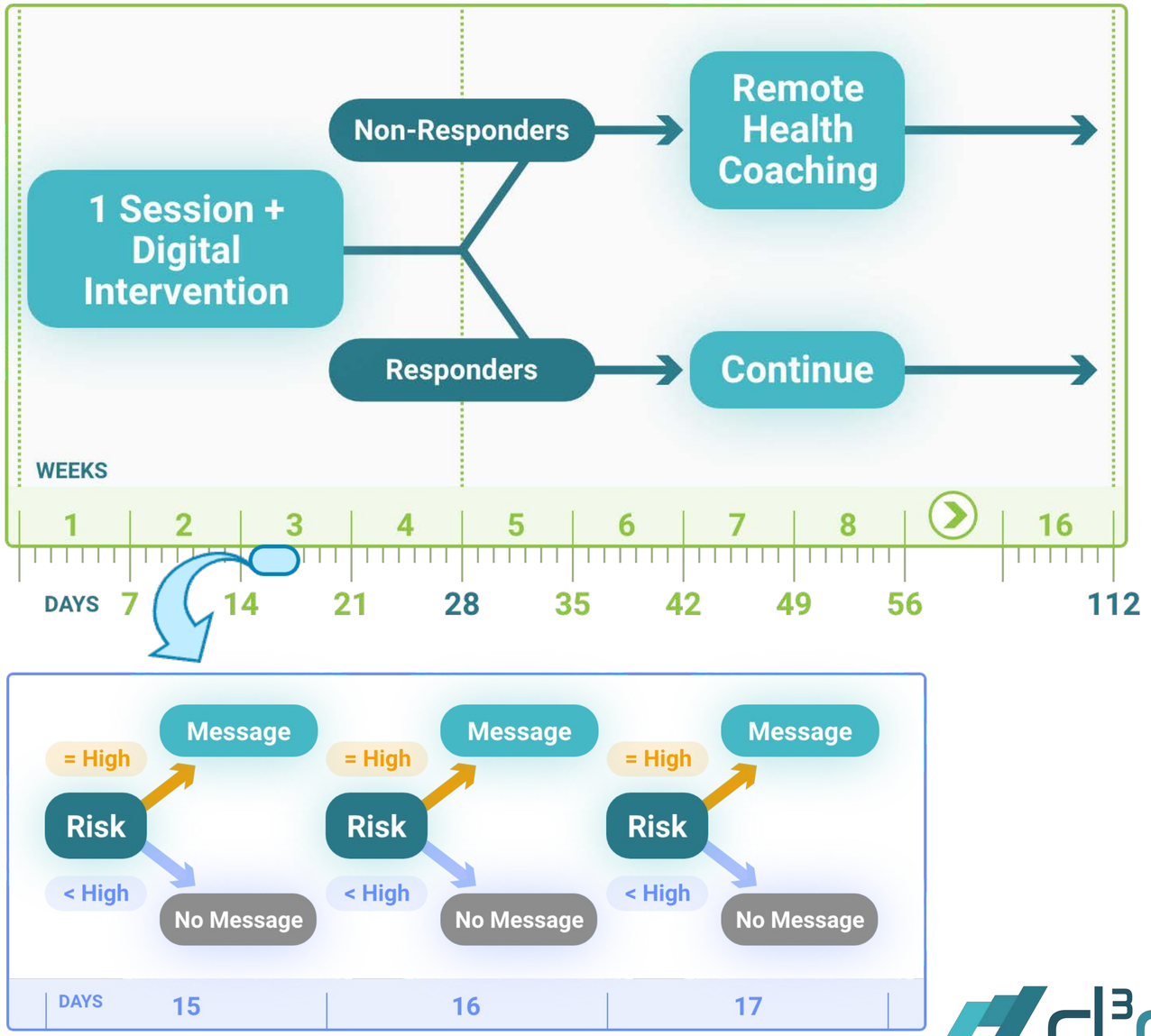
Multimodality Adaptive Intervention

(MADI)



Multimodality Adaptive Intervention

(MADI)



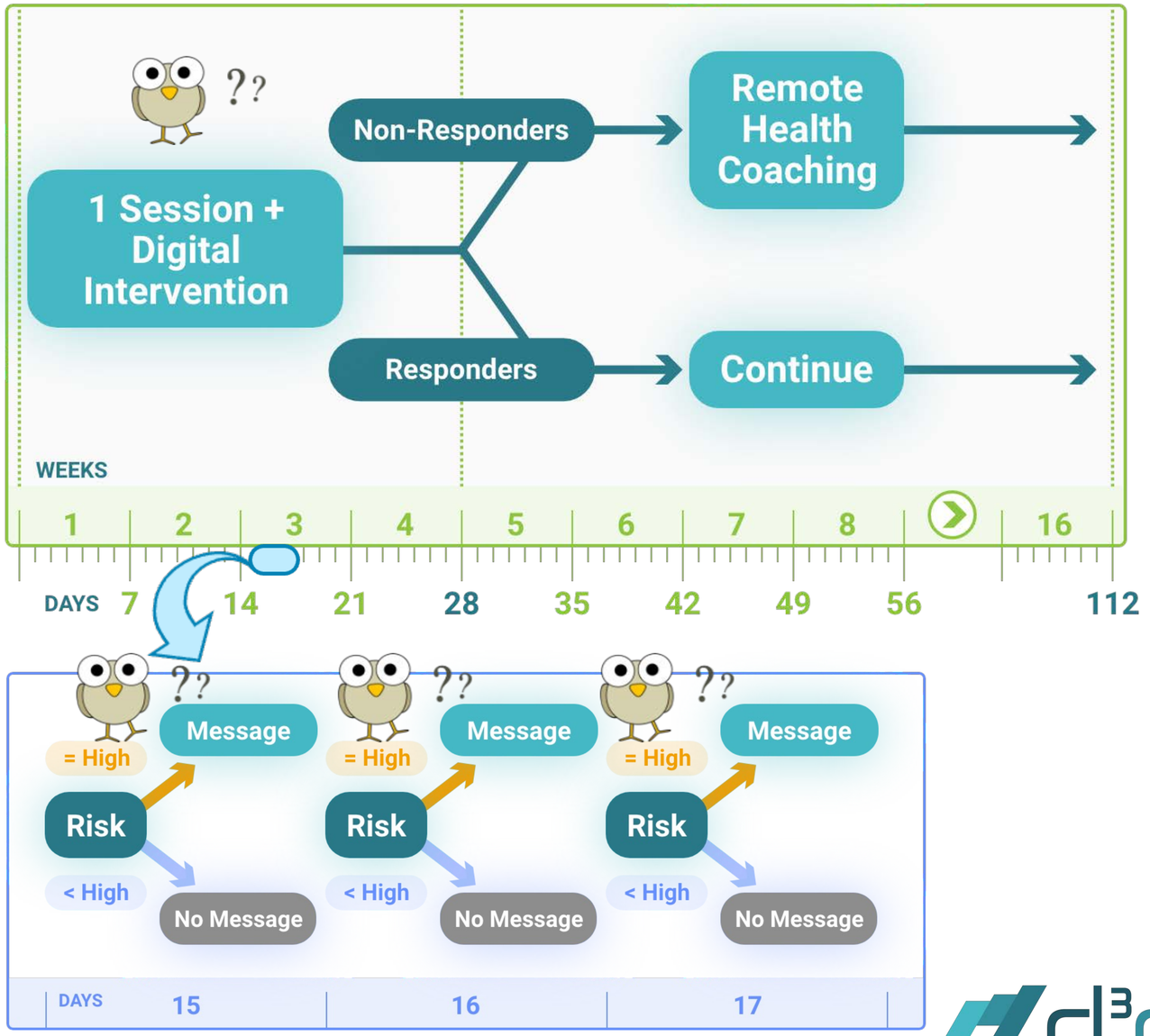
Multimodality Adaptive Intervention

(MADI)

- Intervention delivery framework
- Both human-delivered and digital components are sequenced and adapted over time, at different time scales
- Can be operationalized as the integration between an adaptive intervention and a JITAI

Multimodality Adaptive Intervention

(MADI)



Hybrid Experimental Design

(HED)

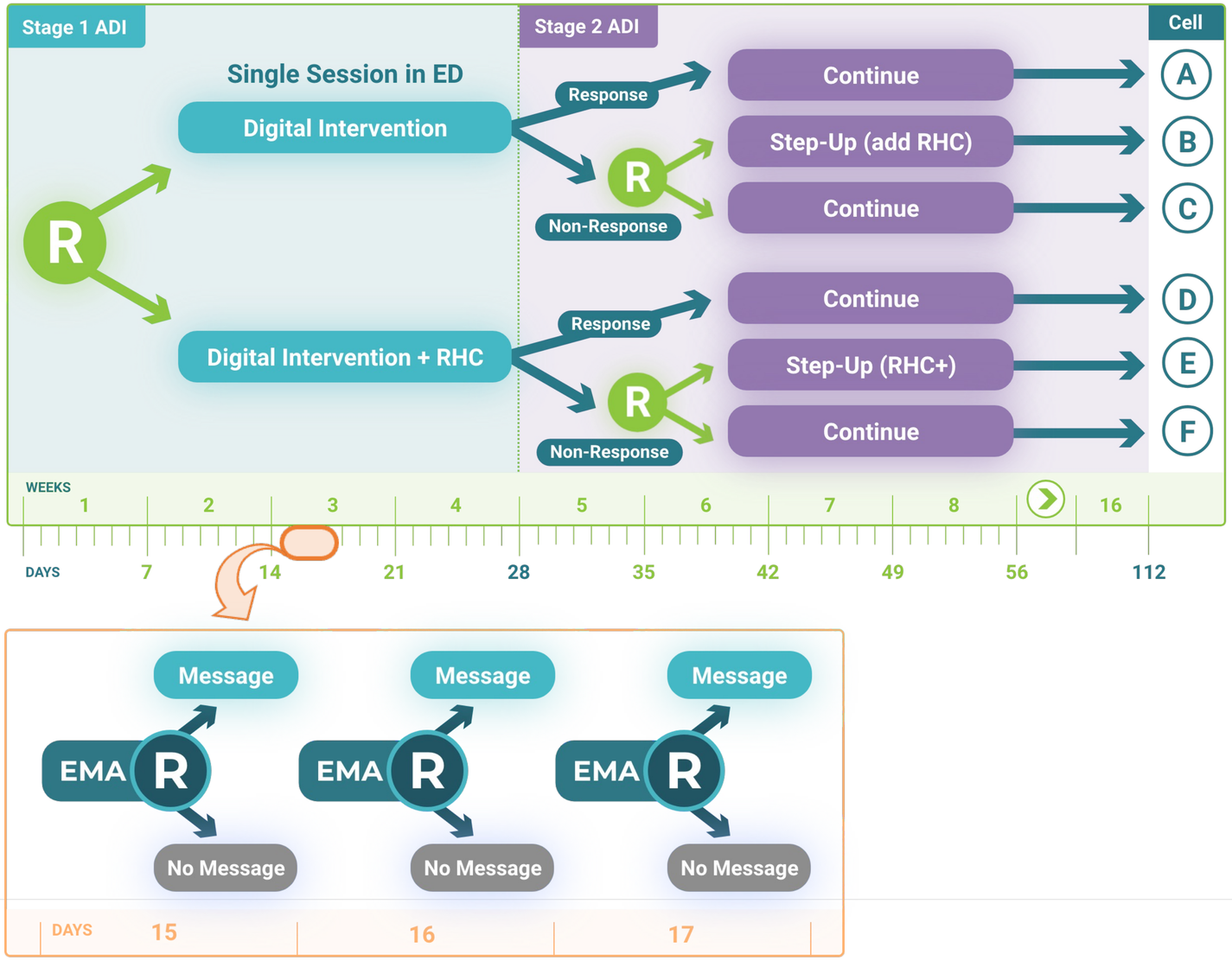
- **Randomized Trial**
  - **Sequential randomizations**
  - **On multiple time scales**

Nahum-Shani, I., Dziak, J. J., Walton, M. A., & Dempsey, W. (2022). Hybrid Experimental Designs for Intervention Development: What, Why and How. Advances in Methods and Practices in Psychological Science, 5(3), 1–15.

Nahum-Shani, I., Dziak, J. J., Venera, H., Pfammatter, A. F., Spring, B., & Dempsey, W. (2023). Design of experiments with sequential randomizations on multiple timescales: the hybrid experimental design. Behavior Research Methods, 1-23.

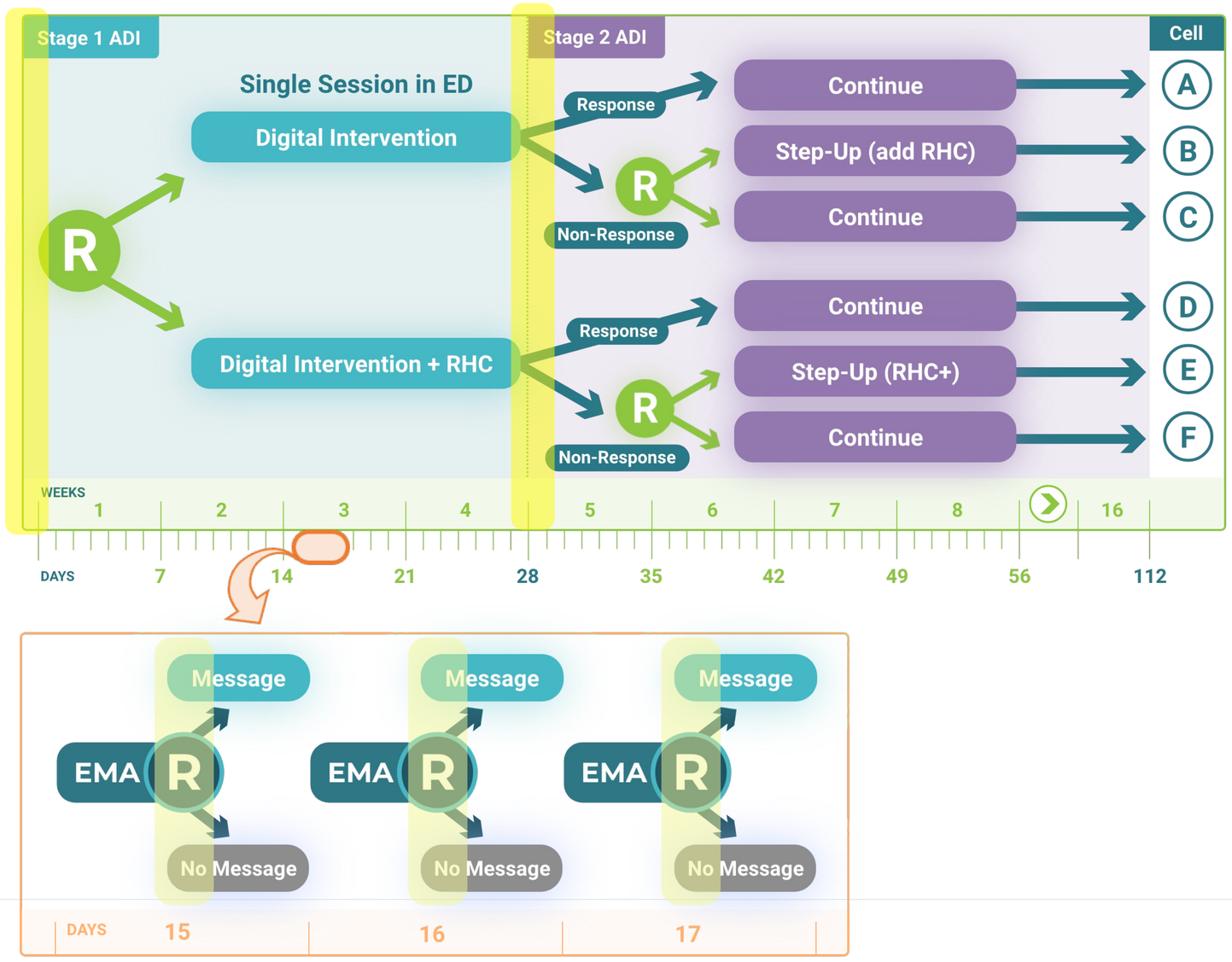
Hybrid Experimental Design

(HED)

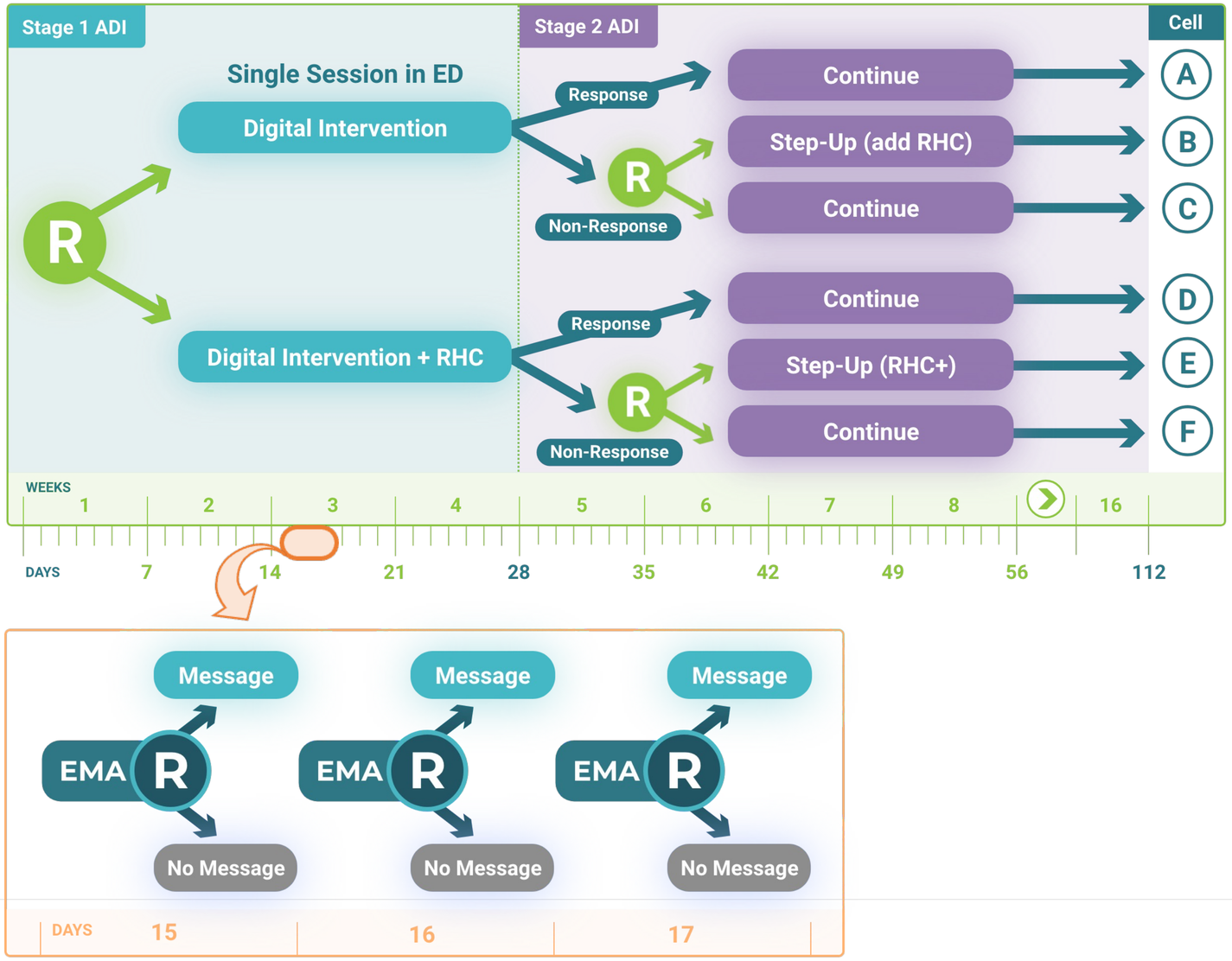


Hybrid Experimental Design

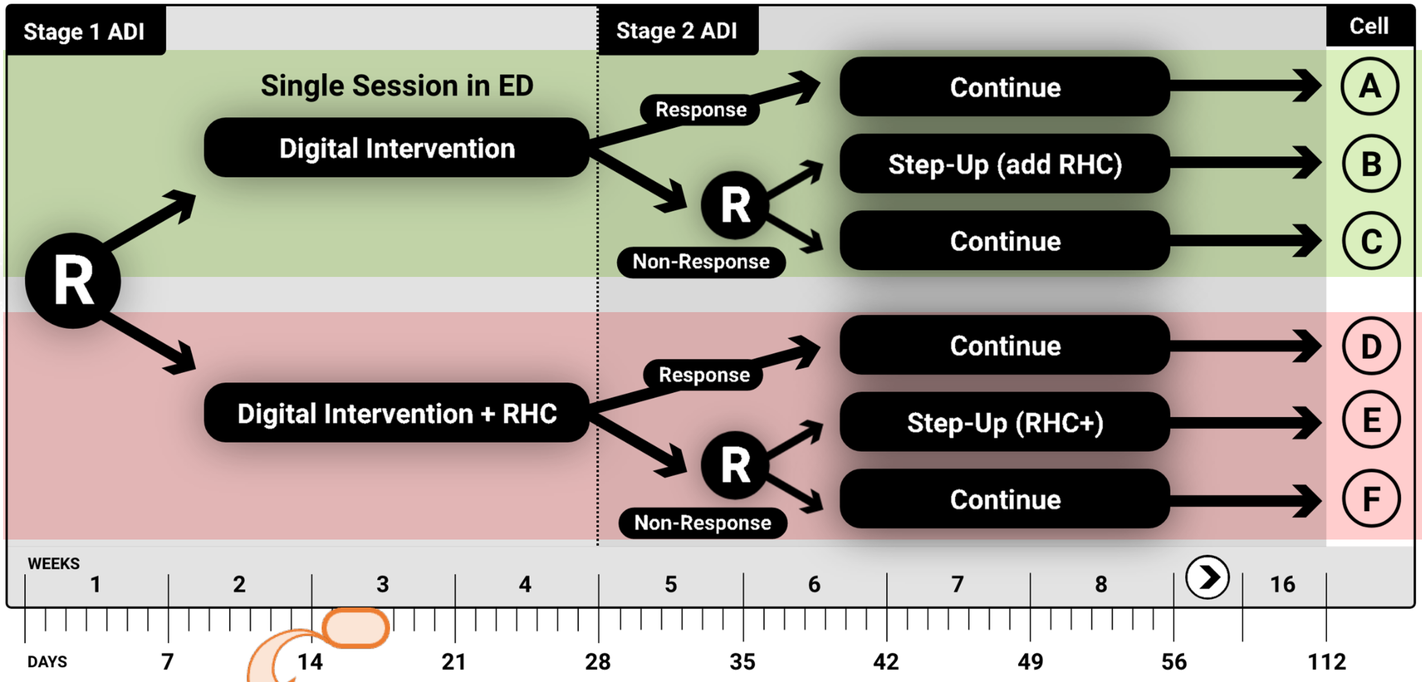
(HED)

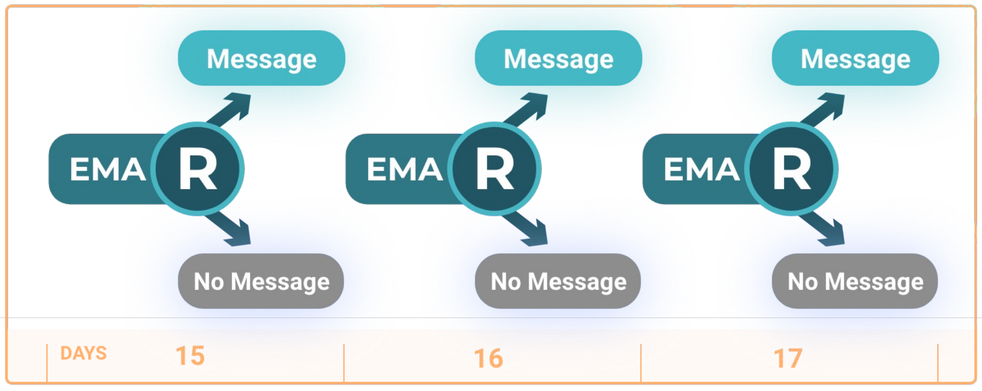


How to use this design to answer scientific questions about MADIs?



Is it better to start with coaching in terms of week 16 substance use, averaging over daily message (vs. no message) delivery?

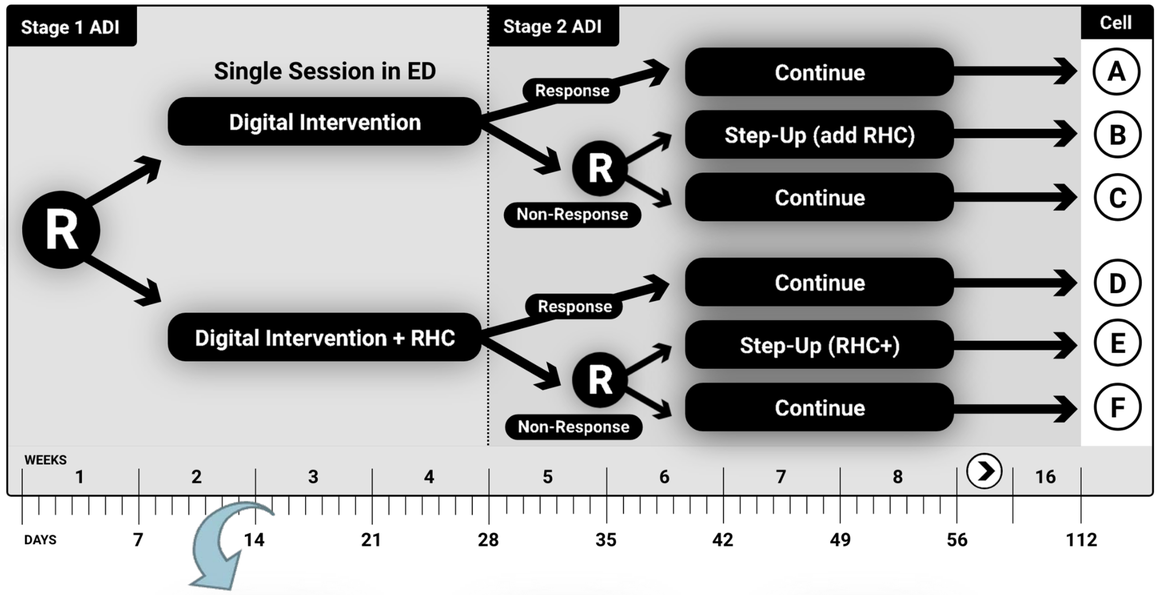


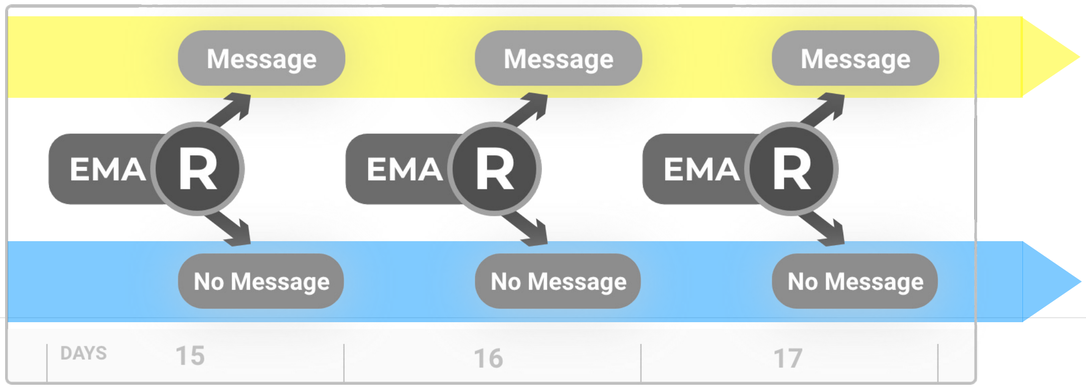


Week 16 Substance Use Across A-C

Week 16 Substance Use Across D-F

Is it better to deliver (vs. not deliver) a daily message in terms of next day substance use, averaging over the delivery (vs. no delivery) of coaching initially and at week 4 for non-responders?

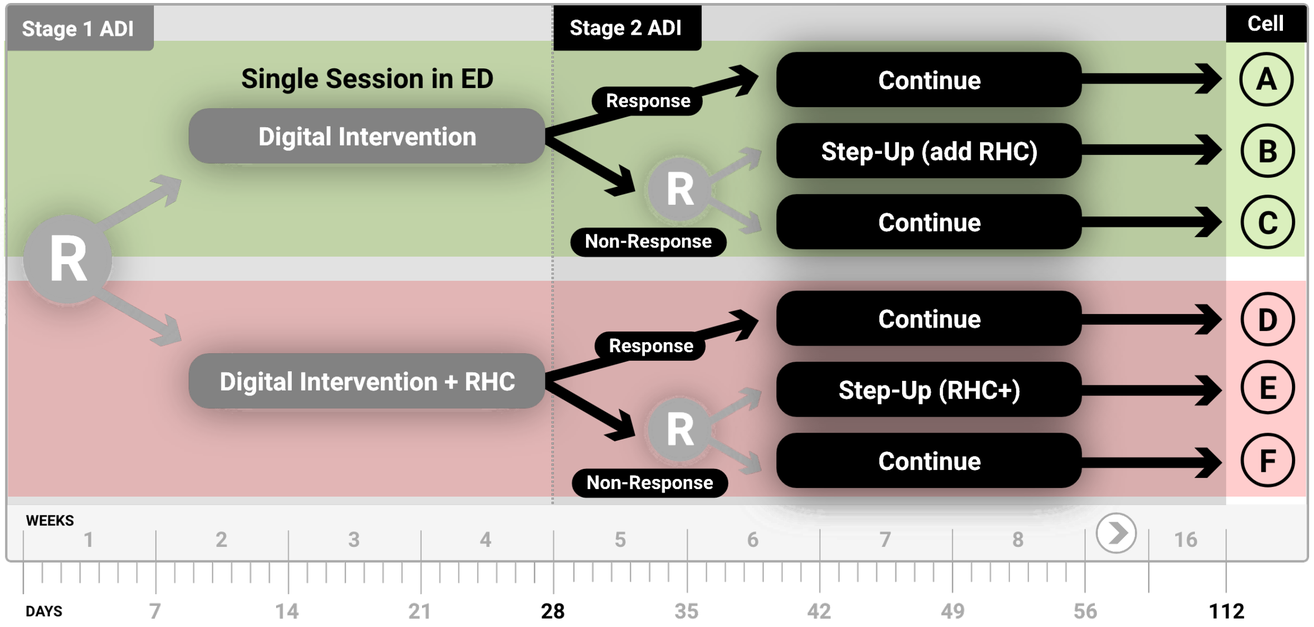




Next day substance use across all days in which a message was delivered.

Next day substance use across all days in which a message was not delivered.

Does the proximal effect of delivering (vs. not delivering) a daily message on next day substance use vary by whether coaching was delivered initially?



Hybrid Experimental Design (HED)

General Article

aps ASSOCIATION FOR PSYCHOLOGICAL SCIENCE

Advances in Methods and Practices in Psychological Science
July-September 2022, Vol. 5, No. 3, pp. 1–15

DOI: 10.1177/25152459221114279
www.psychologicalscience.org/AMPPS
SAGE

Hybrid Experimental Designs for Intervention Development: What, Why, and How

Inbal Nahum-Shani[1], John J. Dziak[2], Maureen A. Walton[3], and Walter Dempsey[4]
[1]Institute for Social Research, University of Michigan, Ann Arbor, Michigan; [2]Prevention Research Center, The Pennsylvania State University, State College, Pennsylvania; [3]Department of Psychiatry and Addiction Center, Injury Prevention Center, University of Michigan, Ann Arbor, Michigan; and [4]School of Public Health and Institute for Social Research, University of Michigan, Ann Arbor, Michigan

Abstract
Advances in mobile and wireless technologies offer tremendous opportunities for extending the reach psychological interventions and for adapting interventions to the unique and changing needs of individ insufficient engagement remains a critical barrier to the effectiveness of digital interventions. Hum interventions (e.g., by clinical staff) can be more engaging but potentially more expensive and burde

Current HIV/AIDS Reports
https://doi.org/10.1007/s11904-023-00671-z

Check for updates

Digital Adaptive Behavioral Interventions to Improve HIV Prevention and Care: Innovations in Intervention Approach and Experimental Design

Inbal Nahum-Shani[1] · Sylvie Naar[2]

Accepted: 6 October 2023

Abstract
Purpose of Review Recent advances in digital technologies can be leveraged to adapt HIV prevention and treatment services to the rapidly changing needs of individuals in everyday life. However, to fully take advantage of these technologies, it is critical to effectively integrate them with human-delivered components. Here, we introduce a new experimental approach for optimizing the integration and adaptation of digital and human-delivered behavioral intervention components for HIV prevention and treatment.

Behavior Research Methods
https://doi.org/10.3758/s13428-023-02119-z

Check for updates

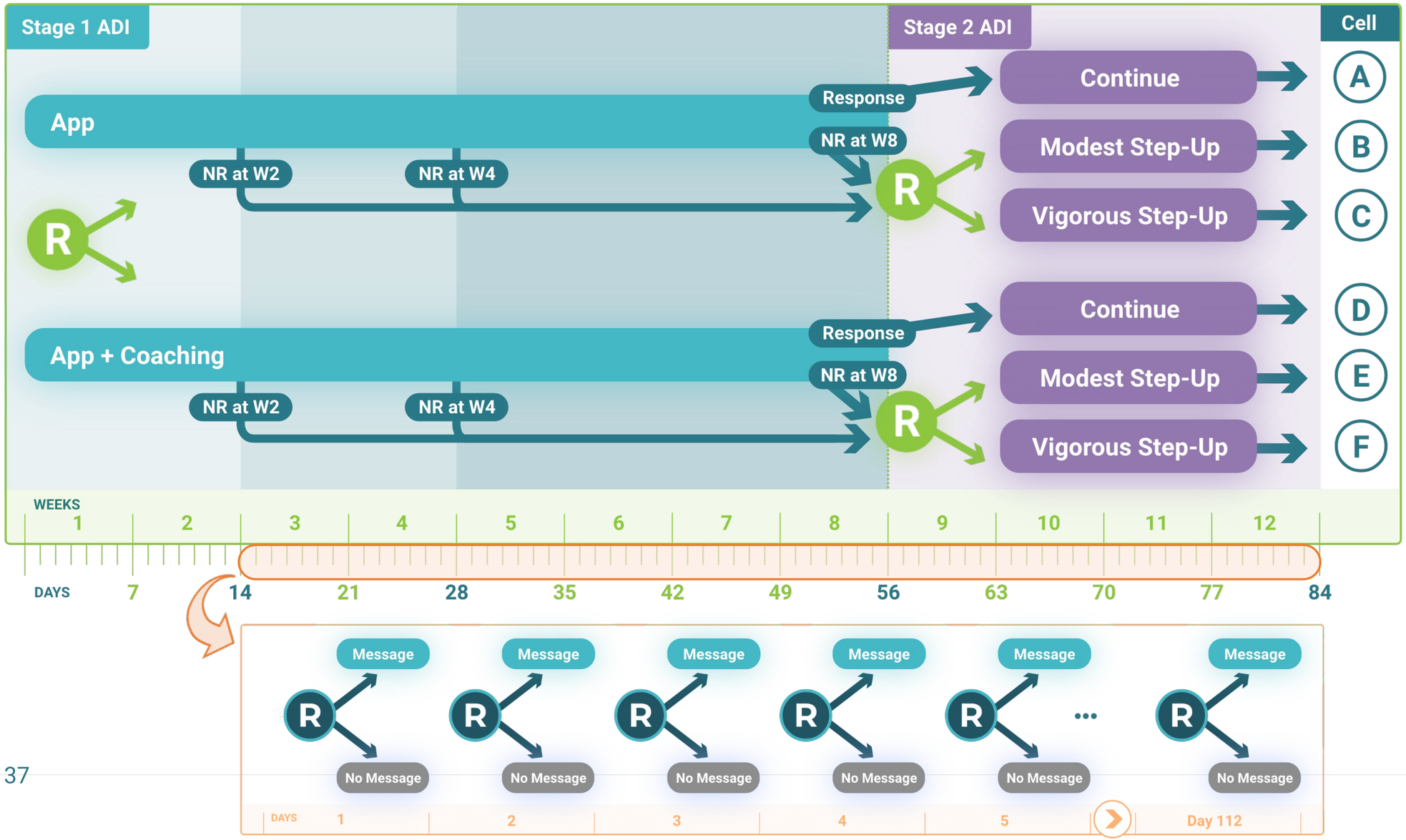
Design of experiments with sequential randomizations on multiple timescales: the hybrid experimental design

Inbal Nahum-Shani[1] · John J. Dziak[2] · Hanna Venera[3] · Angela F. Pfammatter[4,5] · Bonnie Spring[5] · Walter Dempsey[3]

Accepted: 28 March 2023

Abstract
Psychological interventions, especially those leveraging mobile and wireless technologies, often include multiple components that are delivered and adapted on multiple timescales (e.g., coaching sessions adapted monthly based on clinical progress, combined with motivational messages from a mobile device adapted daily based on the person's daily emotional state). The hybrid experimental design (HED) is a new experimental approach that enables researchers to answer scientific questions about the construction of psychological interventions in which components are delivered and adapted on different timescales. These designs involve sequential randomizations of study participants to intervention components, each at an appropriate timescale (e.g., monthly randomization to different intensities of coaching sessions and daily randomization to different forms of motivational messages). The goal of the current manuscript is twofold. The first is to highlight the flexibility of

Hybrid SMART-MRT Weight Loss Study (Spring & Nahum-Shani)



Hybrid SMART-MRT Weight Loss Study (Spring & Nahum-Shani)

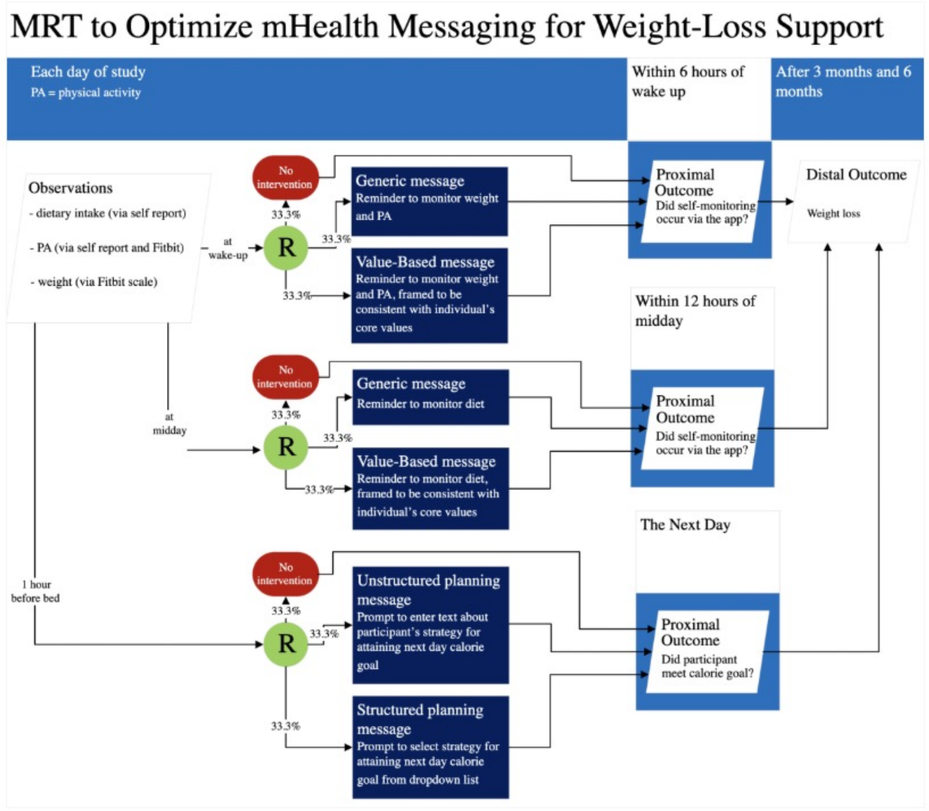
https://d3c.isr.umich.edu/case_study/mrt-to-optimize-mhealth-messaging-for-weight-loss-support/

MRT to Optimize mHealth Messaging for Weight-Loss Support

Home / Case Studies

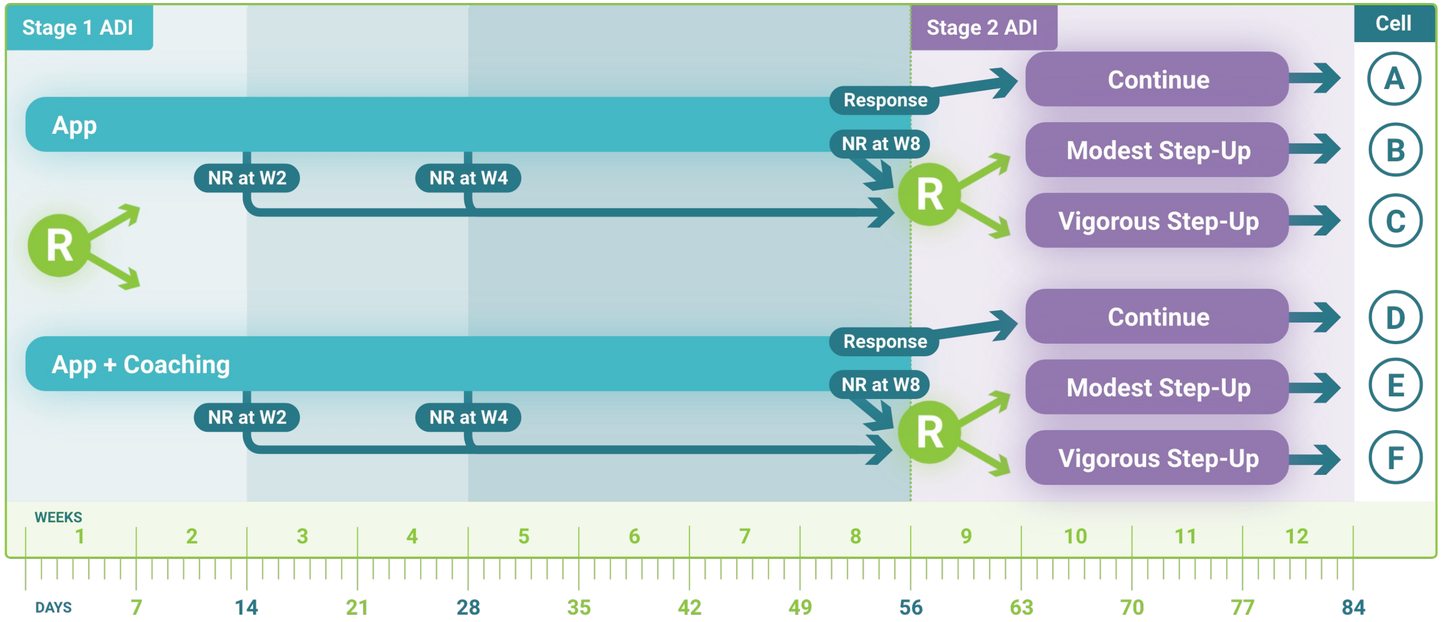
Description:

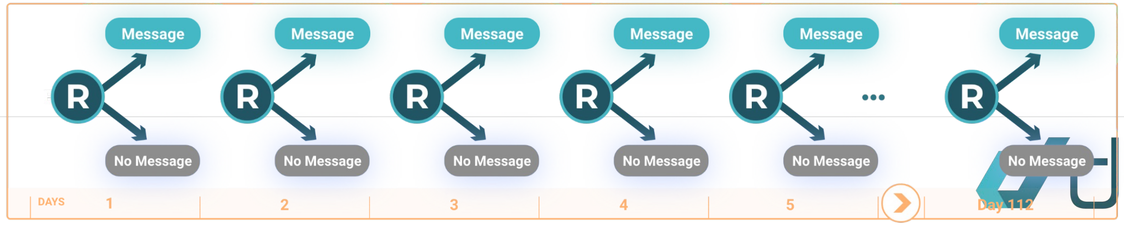
The current study seeks to investigate whether, what type, and under what conditions prompts should be provided in the context of a weight-loss program that uses a mobile app as minimal support for obese/overweight adults.



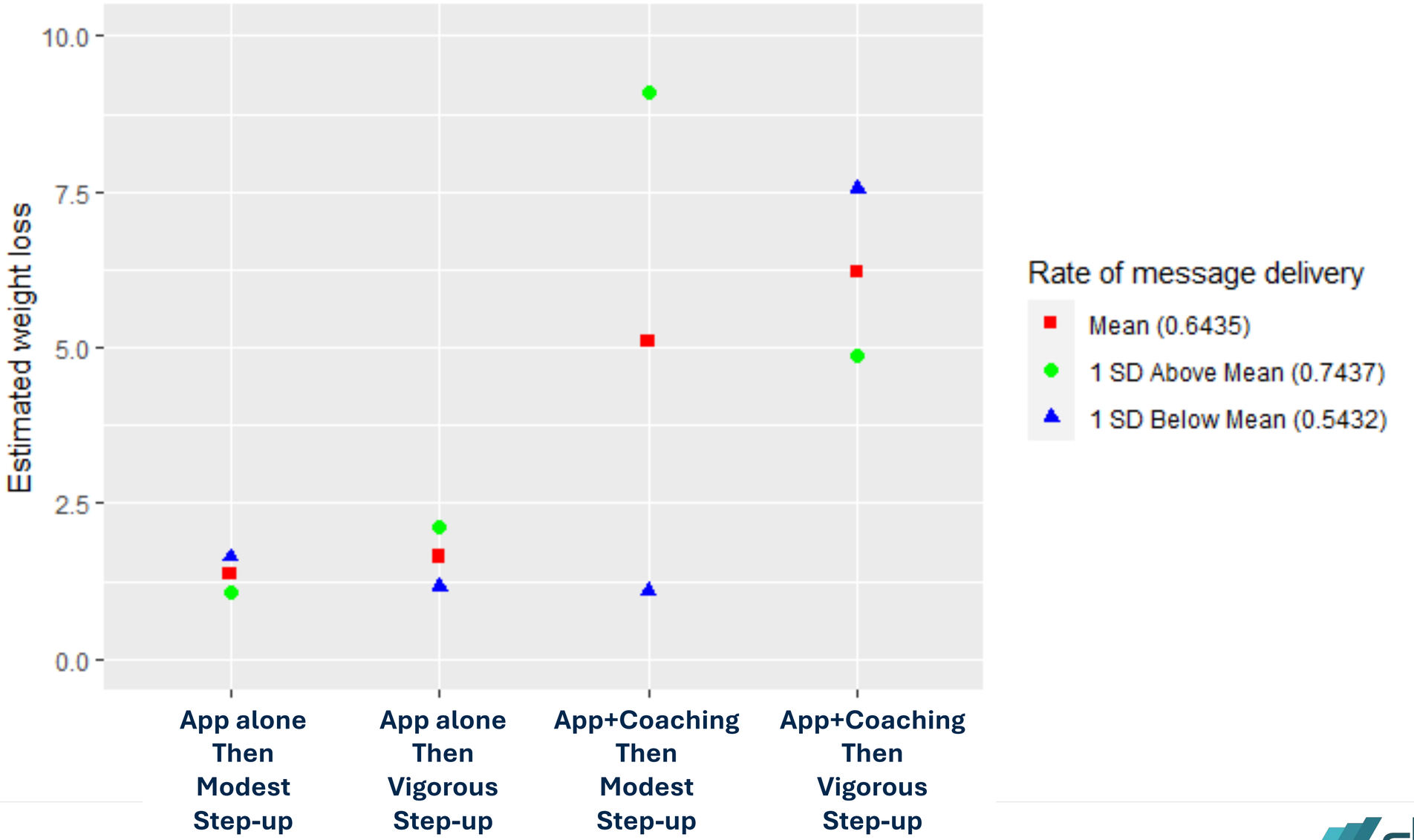
Scientific Question

Does the distal effect of offering coaching initially (vs. App alone) on month 6 weight loss vary depending on whether a vigorous (vs. modest) step-up was offered to non-responders and depending on the rate of prompts delivered to non-responders?





Results


Estimated weight loss
10.0
7.5
5.0
2.5
0.0
App alone Then Modest Step-up
App alone Then Vigorous Step-up
App+Coaching Then Modest Step-up
App+Coaching Then Vigorous Step-up
Rate of message delivery
Mean (0.6435)
1 SD Above Mean (0.7437)
1 SD Below Mean (0.5432)

Thank You!