The Multiphase Optimization Strategy: A New Approach to Building Effective and Efficient Behavioral Interventions

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Outline

- > Behavioral intervention example
- > Traditional approach
- MOST approach
- Research considerations
- > Take away messages





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Hypothetical parenting intervention to prevent pediatric obesity



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Behaviors are complex, so interventions often include multiple components

- Intervention component: Any aspect of an intervention that can be separated out for study
 - Parts of intervention content (e.g., prepare healthy meals or reduce screen time)
 - Features that promote compliance/adherence (e.g., weekly text messages or phone counseling sessions)
 - Features aimed at improving fidelity (e.g., training modules for staff)





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Traditional approach



Excellent for evaluating whether the packaged intervention performs better than a control or standard of care





If the RCT shows a *significant* effect, we still do not know

- Which components are making positive contributions to overall effect
- > Whether all the components are really needed
- Whether a component's contribution offsets its cost
- How to make the intervention more effective, efficient, scalable and/or sustainable





Or if the RCT shows a *non-significant* effect, we do not know

- > Whether any components are worth retaining
- Whether one component had a negative effect that offset the positive effect of others
- Specifically what went wrong and what the next steps should be





What's the alternative?

- Start by specifying
 - <u>the ideal</u> we would like to accomplish
 - the <u>constraints</u> that limit what we can accomplish





What's the alternative?

- > Then systematically build
 - <u>The ideal</u>: The most effective intervention possible
 - <u>That:</u>
 - Only includes active components
 - Can be delivered for less than \$200/participant
 - Takes no more than 30 minutes of staff time to deliver
 - Takes the average participant no more than two hours to complete





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The Multiphase Optimization Strategy

 An engineering-inspired framework for development, optimization, and evaluation of behavioral interventions

PENNSTATE

Developed by Linda Collins and colleagues







The MOST approach







Component screening experiment

- Goal: To empirically determine which components, individually and in combination, are active
 - "Active" can be defined by statistical significance, effect size, etc.
- Most often a factorial experiment is most efficient experimental design





Hypothetical factorial experiment

Experimental Conditions for 2 ³ Factorial Experiment						
Condition	Intervention Components					
Number	MEALS	SCREEN	TEXT			
1	x	Х	X			
2	×	Х				
3	X		Х			
4	x					
5		Х	x			
6		Х				
7			Х			
8						

Main effect 23 = 8 Experimental MEALS: Mean (1conditions 4) – Mean (5-8)





Hypothetical factorial experiment

	Experimental Conditions for 2 ³ Factorial Experiment			
	Condition	Intervention Components		
	Number	MEALS	SCREEN	TEXT
	1	Х	(x)	Х
Main effect SCREEN: Mean (1,2,5,6) – Mean (3,4,7,8)	2	Х	X	
	3	Х		Х
	4	Х	\bigcirc	
	5		X	Х
	6		X	
	7		\square	х
	8			





Hypothetical factorial experiment

Experimental Conditions for 2³ Factorial Experiment Intervention Components Condition Number **SCREEN** MEALS TEXT Х 1 Х 2 Х Х 3 Х Х 4 Х 5 Х 6 Х Х 7 8

Main effect TEXT: Mean (1,3,5,7) – Mean (2,4,6,8)





Analyzing a factorial experiment

- Conduct an ANOVA using linear regression models
- Examine main effects and interaction effects
 - E.g., What is the effect of receiving healthy meals component, averaged across the other components?
 - E.g., Does the effect of receiving healthy meals vary if receive text messages, averaged across screen time component?





Assemble the optimized intervention

- Goal: To assemble the best intervention possible with no inactive components
- > Other optimization criteria
 - Cost (e.g., < \$200/participant)
 - Staff time (e.g., < 30 minutes)
 - Participant time (e.g., 2 hours)



Researchers determine which optimization criterion to use





The Multiphase Optimization Strategy







Evaluate optimized intervention

- Conduct RCT comparing optimized intervention to control or standard of care
 - If effective \rightarrow release optimized intervention
 - If not effective → go back and re-evaluate theoretical model, components selected, and conduct another component screening experiment





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Factorial experiment considerations

- Make efficient use of subjects, but require more experimental conditions than other RCTs
 - Variations of factorial experiment can reduce number of experimental conditions
- Can add additional component without increasing sample size
- Designed to detect main effects and interactions, not to examine pair-wise comparisons





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Take-away messages

- MOST is a new approach for building more effective and efficient behavioral interventions
 - Requires an additional step of optimization
 - Factorial experiments are efficient study design for optimization
- MOST can help move science forward faster to provide a greater public health impact
 - As constraints are changed, can ask new questions





Clinic-based Smoking Cessation Intervention

- PIs Baker & Collins
- P50 CA143188

School-based Drug Abuse & HIV Intervention

- PIs Caldwell & Smith
- R01 DA029084

Opt-In: Weight Management Intervention

- PIs Spring & Collins
- R01 DK097364



The Methodology Center









Thank you!

- Questions or comments, please contact me
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- Visit Methodology Center website:
 - http://methodology.psu.edu







Extra slides





Component selection experiment

Choose most efficient study design that permits examination of main effects and interaction effects of components

Study design	Sample size	# Experimental Conditions	Estimate interactions?
Individual experiments	Larger	10	No
Single control group	Smaller	6	No
Factorial experiment	Smallest	32	Yes
Fractional factorial experiment	Smallest	8-16	Yes, but limited





Smoking Cessation Intervention

- > Objective: To build most effective intervention with no inactive components
 - 3 separate experiments for pre-contemplation, contemplation, and maintenance phases of cessation
- Intervention components:
 - Pre-cessation counseling, patch, gum, and post-cessation inperson counseling (intensive v. minimal), phone counseling (intensive v. minimal), NRT (intensive v. minimal)
- Study design: 2⁶⁻¹, within cluster randomization



School-based Drug Abuse and HIV intervention

PFNNSTAT

- > Objective: To build most effective implementation intervention with no inactive components
- Intervention components: Enhanced teacher training;
 teacher support, structure, and supervision; enhancedschool environment
- Study design: 2³ full factorial; 56 schools randomized to experimental conditions





Opt-in: Weight management intervention

- > Objective: To build the most effective intervention that can be delivered for under \$500/person
- Intervention components:
 - Phone sessions (12 v. 24), PCP letter, text messages, meal replacements, buddy training
- Study design: 2⁵⁻¹; individual randomization





Neat features of factorial experiments

- Can assign a 'constant' component so that everybody gets something
- Can do them randomizing groups to condition
- Can be applied to implementation and dissemination studies
- Because have more empirical evidence of the black box, researchers can take information from one study and apply to their situation more easily





Definition: Optimization

"The process of finding the best possible solution... subject to given constraints"

-The Concise Oxford Dictionary of Mathematics

- Optimized does not mean best in an absolute or ideal sense
- Instead, realistic because it includes constraints (e.g., time, money)





Evaluation and optimization: Both important; not the same thing.	Evaluation: Is the intervention's effect <i>statistically significant</i> ?		
Optimization: Is the intervention the best possible, given constraints?	No	Yes	
No	May wish to optimize using effect size as criterion	Intervention can probably be improved	
Yes	Different intervention strategy needed	What we should be aiming for	





Fractional factorial designs: Trade-offs

- Effects are aliased with other effects
- > Aliasing is a calculated risk
 - Our theoretical model does not predict large four-way and three-way interactions
 - Therefore, "bundled" estimate will be primarily due to main effect or two-way interaction