How to Build a Theory Based Health Behavior Change Intervention: Lessons from Psychological Test Construction

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Funding and support provided by:

Office of Research Services; University of Colorado Denver

3R01DK111622-02S1; Catenacci, Victoria (PI). Comparison of Weight Loss Induced by Intermittent Fasting Versus Daily Caloric Restriction in Individuals with Obesity: A 1-Year Randomized Trial; NIDDK (NIH); Science of Behavior Change (SOBC)

Thank You

- Stephanie A. Hooker, PhD
- Jennalee S. Wooldridge, PhD
- Kaile M. Ross, PhD
- Anschutz Health and Wellness Center

- No conflicts of interest

Learning Objectives:

- Be able to map the processes of psychological test development onto theoretically based health behavior change intervention development
- Be able to describe theoretical validity as it pertains to behavior change interventions and discuss why it is important and how it can be measured
- Be able to discuss the nature of mechanisms (processes) and their role in behavior change interventions

Overview:

- The Problem and Introduction to Theory
- The Black Box: Moderators, Mediators, Mechanisms, Processes
- The Psychometric Approach to Behavioral Intervention Development

Goals:

- Present a way of thinking about theory based intervention development based on psychometric principles
- If you get caught up in the details – miss the point

The Problem (SOBC):

- Unhealthy behaviors (e.g., smoking, drug and alcohol abuse, overeating and poor diet, sedentary lifestyle, medical nonadherence, unsafe sex) contribute to negative health outcomes and common diseases.
- Unhealthy behaviors account for approximately 40-60% of the risk associated with preventable premature deaths in the United States.
- Changing behavior in the short-term, not too difficult. Changing behavior in the long-term, very difficult.

The Problem:

- What would make behavior change interventions more potent and lasting?

- Possibly better utilization of theory in intervention development

The Problem: Theory – Intervention Gap

- Only 22.5% of 235 behavior-change implementation studies explicitly identified theories of behavior change (Davies et al, 2010)
- Recently, 56% of physical activity interventions reported theoretical base (Prestwich et al., 2014)
  - » **BUT** 90% of these studies did NOT report links between behavior change techniques and specific theoretical constructs

Why use theory?

- Is there evidence that an intervention based on theory is better than one not based on theory?
  - » Not exactly…..Why is that?
  - » Theory is often poorly applied
    - Only 10% of studies of theory-based interventions reported links between behavior change techniques and theoretical constructs (Michie & Prestwich, 2010)
    - A scant 9% reported that all constructs were targeted by behavior change techniques

Why use theory?

- You can’t escape using a theory
  - There is some reason you are doing what you are doing
  - Might be implicit, unsystematic, “folksy”
  - Better to be explicit and systematic?

Potential benefits of theory

- Facilitate intervention development through identification of key constructs to target for behavior change
- Supports accumulation of evidence, supportive and nonsupportive, regarding the particular theory, its range of applications, etc.
- By identifying mechanisms of change, theories aid in determining why an intervention was or was not successful – changes to make, etc. (Michie & Prestwich, 2010)

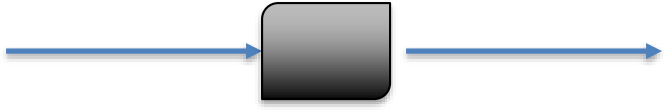
What is a theory in behavioral science?

- “A set of concepts and/or statements with specification of how phenomena relate to each other. Theory provides an organizing description of a system that accounts for what is known, and explains and predicts phenomena” (Davis et al., 2014, p. 5).

What is a theory in behavioral science?

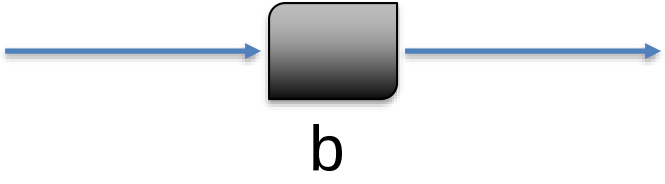
- “A theory presents a systematic way of understanding events or situations. It is a set of concepts, definitions, and propositions that explain or predict these events or situations by illustrating the relationships between variables’ (Rimer & Glanz, 2005, p. 4).

What do theories do for us?

- Open the black box
- Provide some explanation for an observed phenomenon (c) and suggest factors that may predict the occurrence of c (a) and what might be the mechanisms that connect a to c (b)
- a  c

What do theories do for us?

- a → b → c



a = behavior change intervention

c = outcome

b = mechanism/process

Terminology: Basic but confusing

(Kraemer et al., 2002; Kazdin, 2007; SOBC)

- Mediator – an intervening variable that may account (statistically) for the relationship between the IV and DV. Technically a mediator may or may not be the mechanism of change but must be at least related to it. (analogous to a risk factor vs. cause of disease)

Terminology: Basic but confusing

(Kraemer et al., 2002; Kazdin, 2007; SOBC)

- Mechanism (process) – the basis for the effect, i.e., the processes or events that are responsible for the change; the reasons why change occurred or how change came about
- (Mechanism - biological basis for the effect)
- (Process – psychological-social basis for the effect)
  - » Must occur during the intervention
  - » Must come between what is mediated and outcome
  - » Answers questions of why and how intervention worked

Terminology: Basic but confusing

(Kraemer et al., 2002; Kazdin, 2007; SOBC)

- Moderator – a characteristic that influences the direction or magnitude of the relationship between IV and DV. E.g., if the relationship between a and c is different for males and females, sex is a moderator of the relation.
  - » Must be a baseline or prerandomization characteristic
  - » Exists/Occurs before intervention
  - » Answers who and/or under what circumstances differential effect found

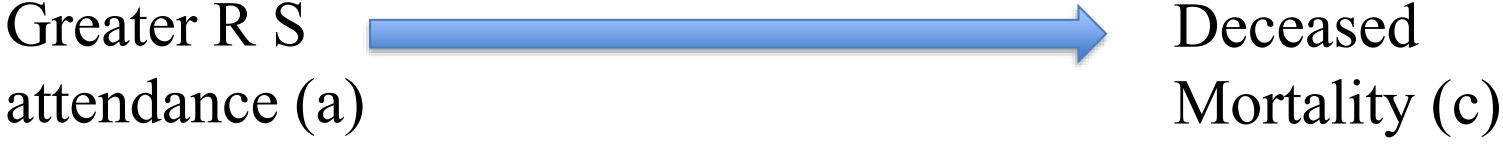
Terminology: Basic but confusing

(Kraemer et al., 2002; Kazdin, 2007; SOBC)

Moderators are related to mechanisms and processes (M/P) because they suggest different M/P that may be involved (in this case for males and females).

E.g., mindfulness in ELMS (Enhancing Lifestyles for Metabolic Syndrome)

Example: Religious service attendance and decreased mortality



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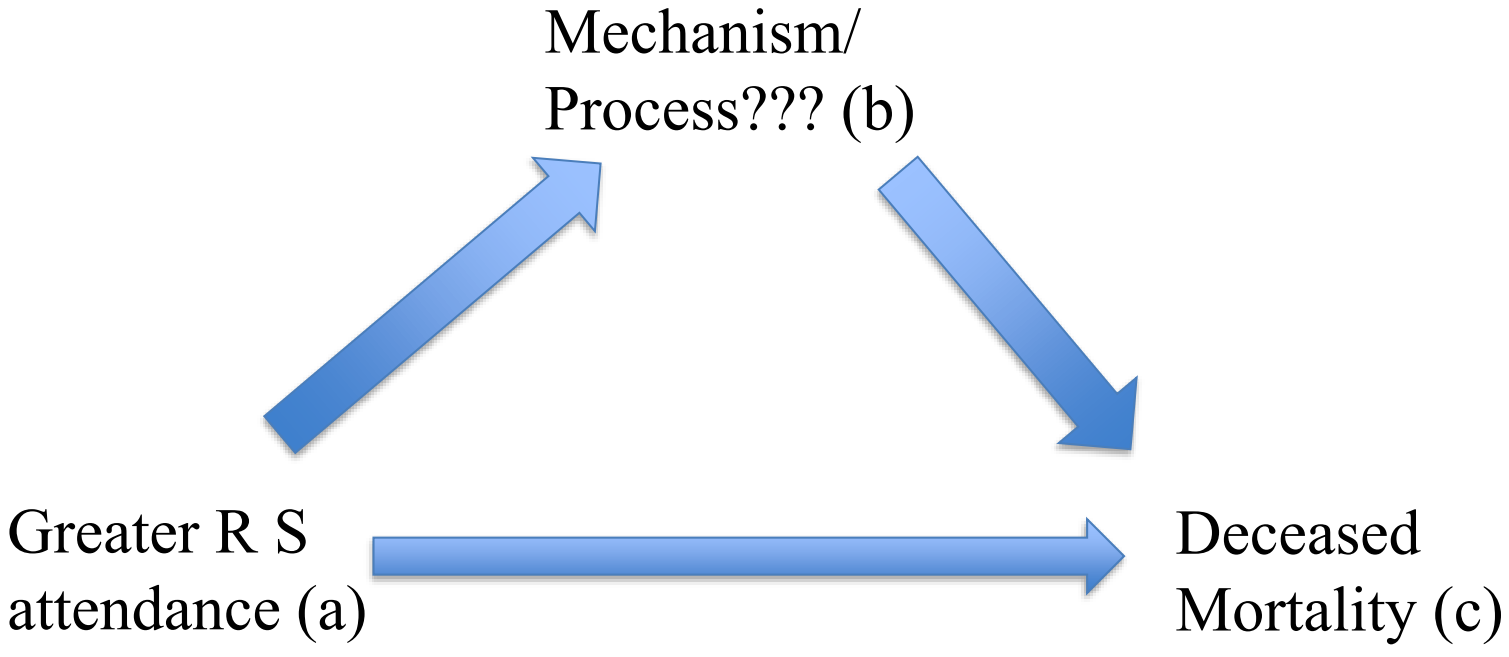


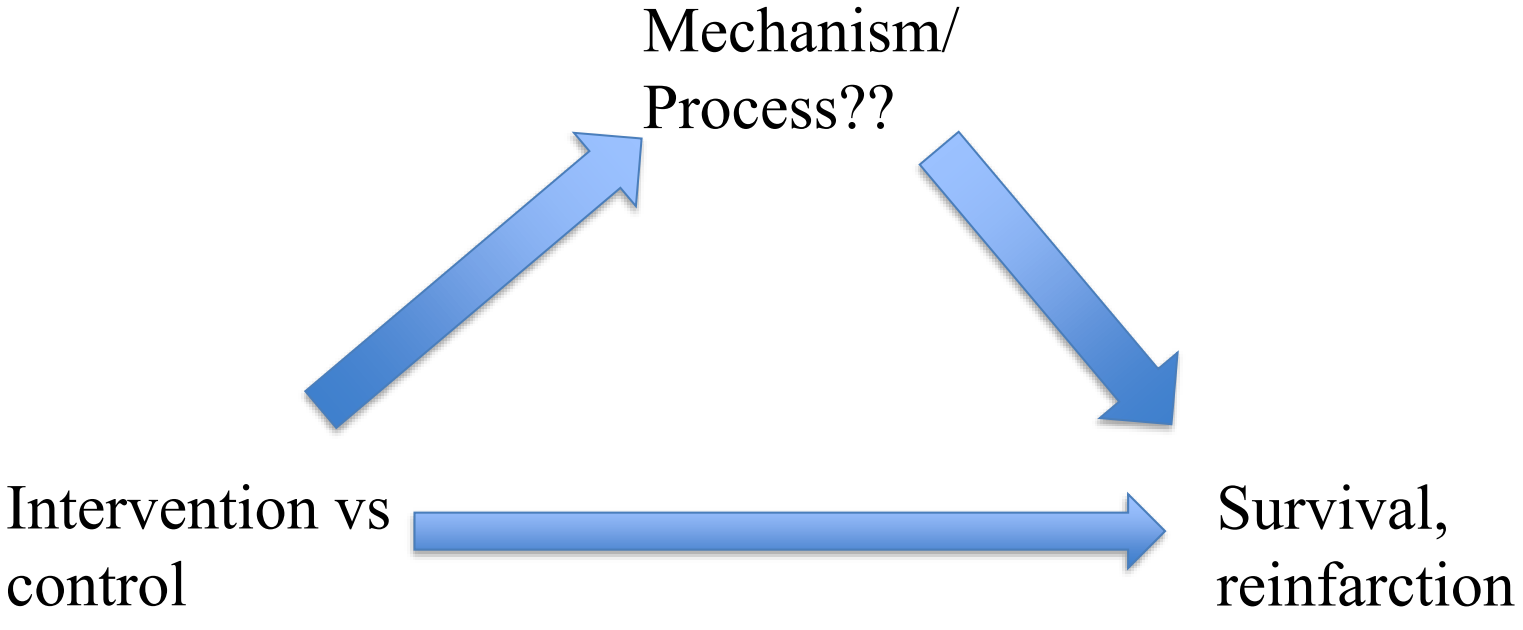
Example: Enhancing Recovery in Coronary Heart Disease (ENRICHD)

- Multisite RCT
- Depression and lack of social support predict recurrence of CHD
- Intervention targeting depression and lack of social support
- Primary outcomes: survival and reinfarction

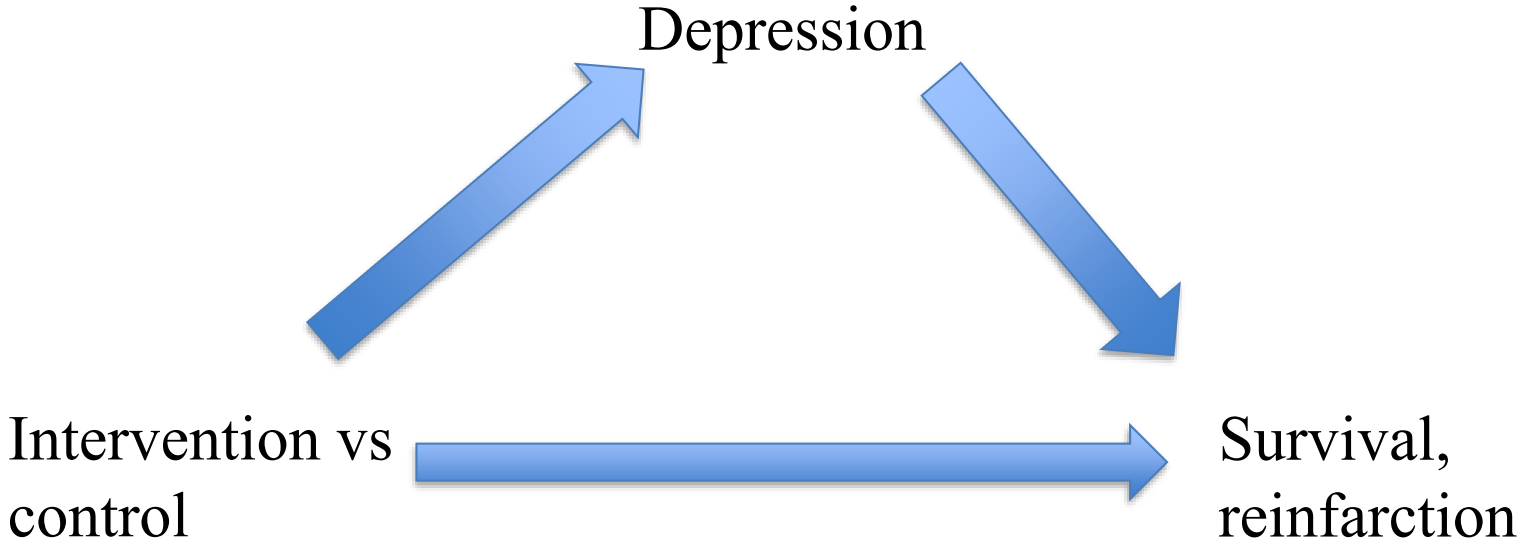
Example: Enhancing Recovery in Coronary Heart Disease (ENRICHD)

Intervention vs. control → Survival, reinfarction

Example: ENRICHD



Example: ENRICHD



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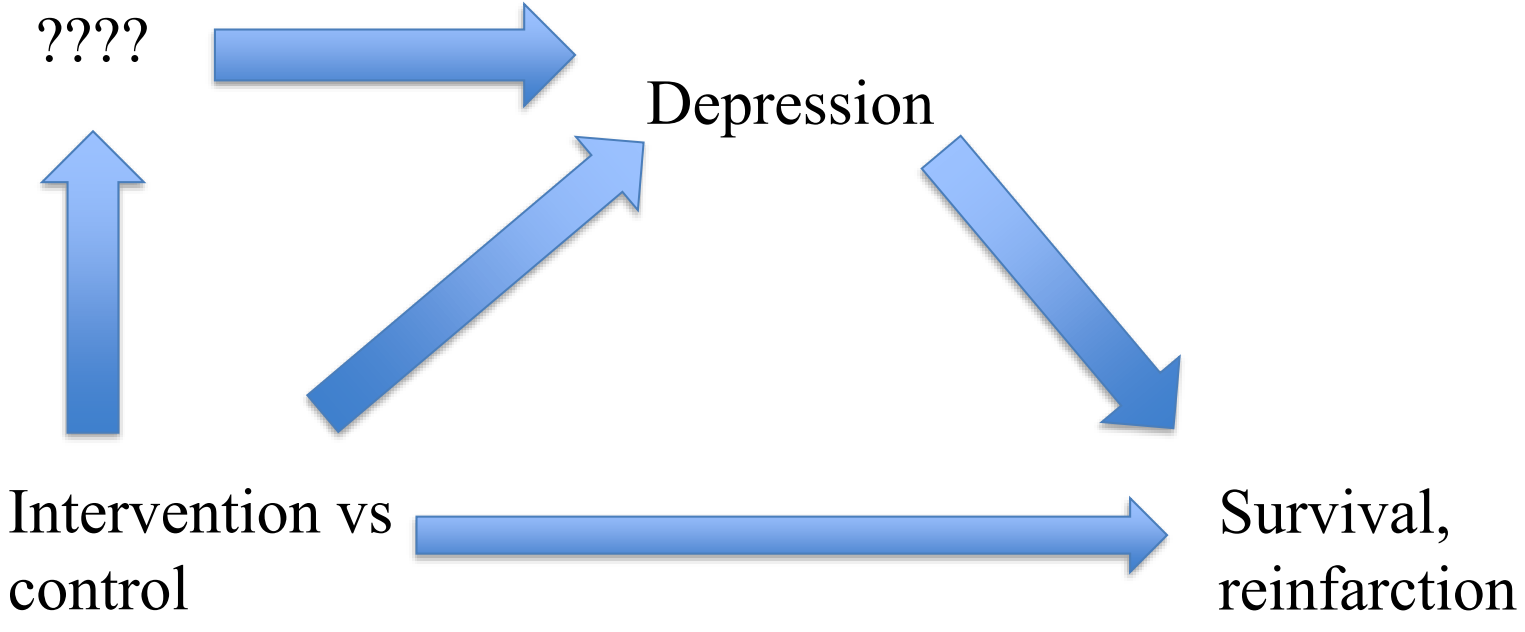
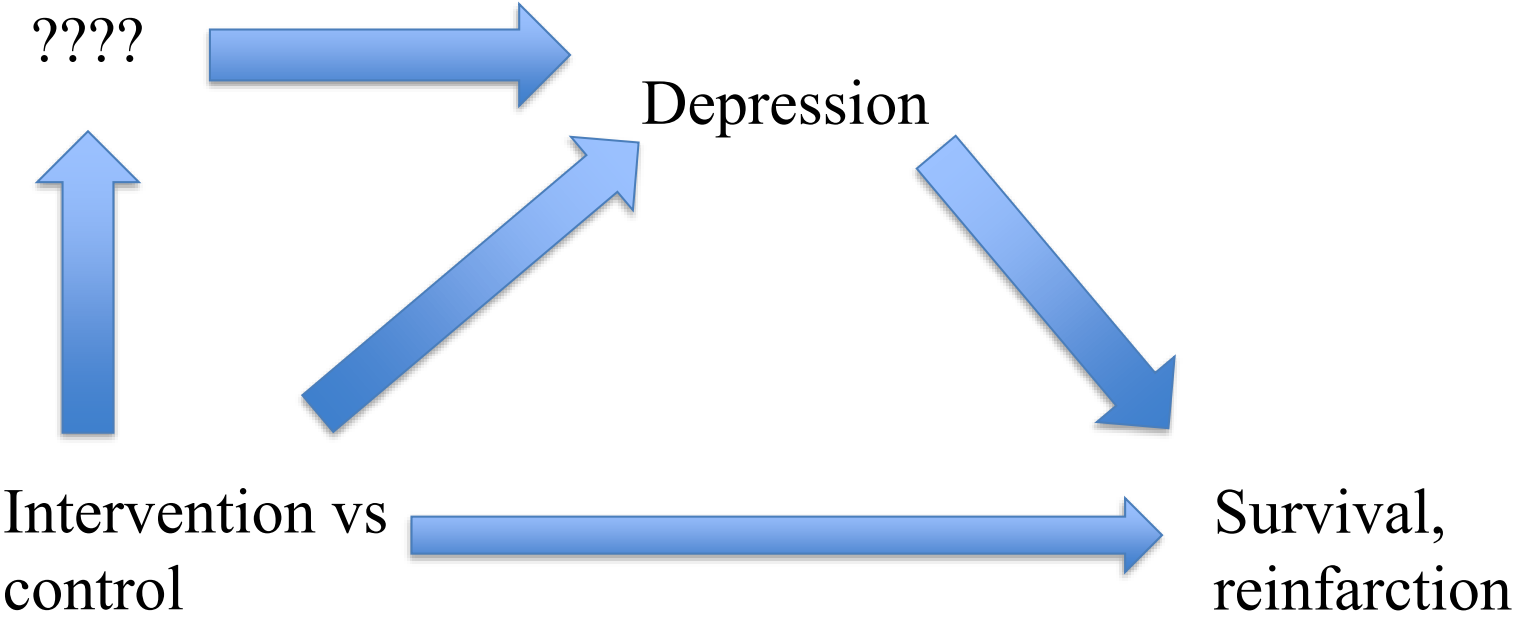


Example: ENRICHD

Medication – SSRI – serotonin reuptake
Cognition – negative triad – global, stable, internal
Behavior – behavioral activation – energy, reinforcers



Science of Behavior Change (SOBC)

- The SOBC Program aims to implement a mechanisms-focused, experimental medicine approach to behavior change research …The experimental medicine approach involves:
  - 1) identifying an intervention target (presumed mechanism; I added),
  - 2) developing assays (measures) to permit verification of the target (measure the mechanism; I added),
  - 3) engaging the target through experimentation or intervention,
  - 4) testing the degree to which target engagement produces the desired behavior change.

- Behavioral Medicine Research Council story
- Does SOBC mention theory?

Properties of theory based interventions

- The intervention will include particular features – call them “Intervention Ingredients” – based on the theory of what changes human behavior in this domain
  - If we do certain things then predictable changes will result
  - These things that we do (ingredients) will influence something in the person, environment, social group that will result in a change in behavior
  - A – B -- C

If the world works as we desire…

- We will find that our theoretically driven intervention will demonstrate improved outcomes (behavior changes) relative to our comparison interventions and control
- We will find that the intervention differentially influences the mechanisms/processes (M/P) in the way predicted by the theory...the M/P behave the way the theory says they should
- We will find that the M/P predict the outcomes…the M/P are potent

Psychometric approach to theory based intervention development

Psychological test

- Construct definition based on theory
- Nomological network (Cronbach & Meehl, 1955)
- Generation of test items based on understanding of construct and concern for content validity
- Initial testing of new measure (reliability, validity)
- Final testing of psychometrics and validity

- Let’s build a psychological test for depression

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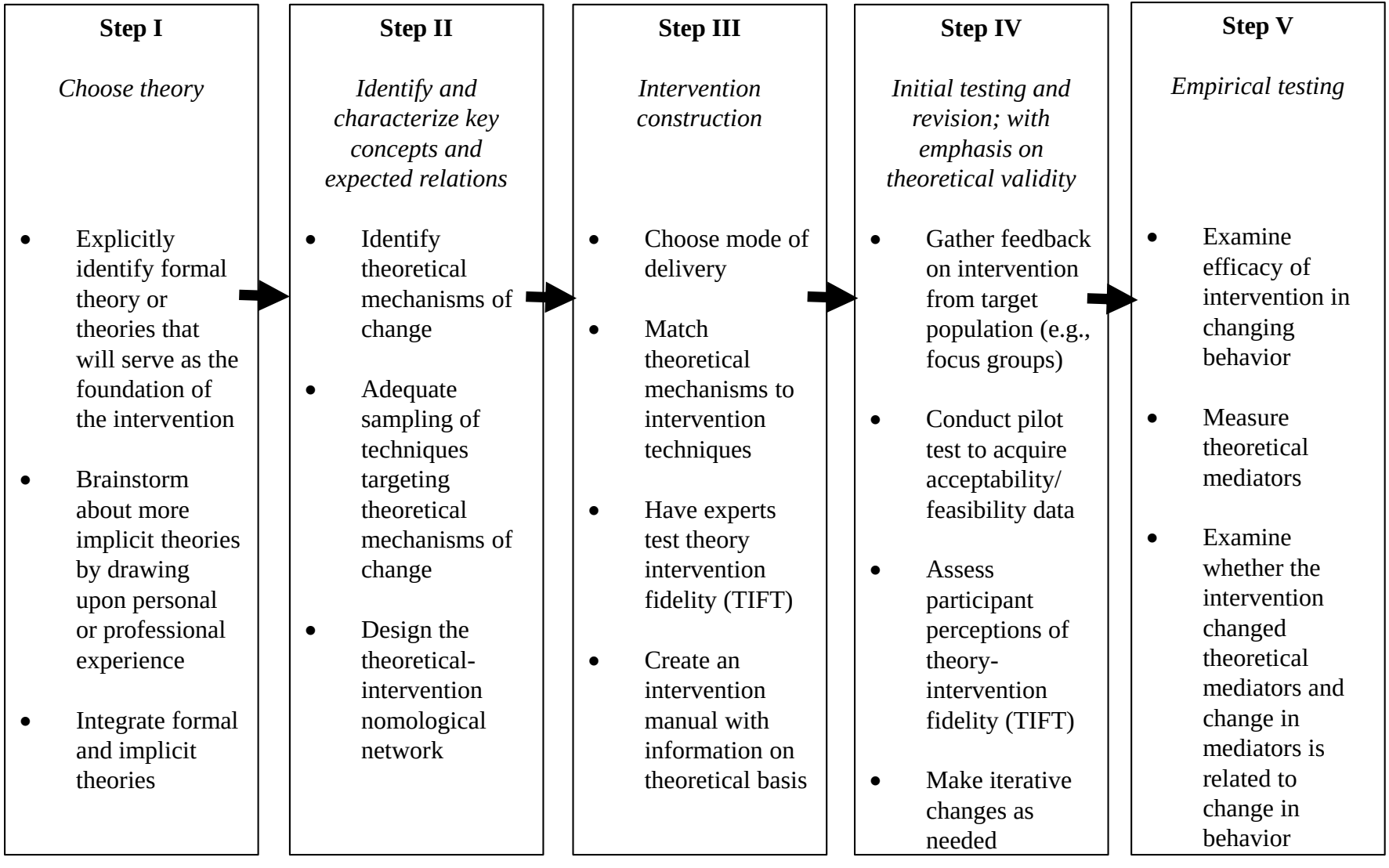
Theory based intervention

- Clear and explicit theory definition
- Identification of key constructs of behavior change theory – intervention nomological network
- Initial construction of intervention, techniques to operationalize theory
- Initial testing and revision of intervention – emphasis on how intervention techniques relate to mechanisms (theoretical validity)
- RCT with tests of mediation/moderation

Psychometric approach to theory based intervention development

- *Deliberately designing the intervention to target theoretically derived mechanisms (processes) of change is the essence of theory-based intervention development*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Choose theory
Explicitly identify formal theory or theories that will serve as the foundation of the intervention
Brainstorm about more implicit theories by drawing upon personal or professional experience
Integrate formal and implicit theories
Step II
Identify and characterize key concepts and expected relations
Identify theoretical mechanisms of change
Adequate sampling of techniques targeting theoretical mechanisms of change
Design the theoretical-intervention nomological network
Step III
Intervention construction
Choose mode of delivery
Match theoretical mechanisms to intervention techniques
Have experts test theory intervention fidelity (TIFT)
Create an intervention manual with information on theoretical basis
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Gather feedback on intervention from target population (e.g., focus groups)
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Step V
Empirical testing
Examine efficacy of intervention in changing behavior
Measure theoretical mediators
Examine whether the intervention changed theoretical mediators and change in mediators is related to change in behavior

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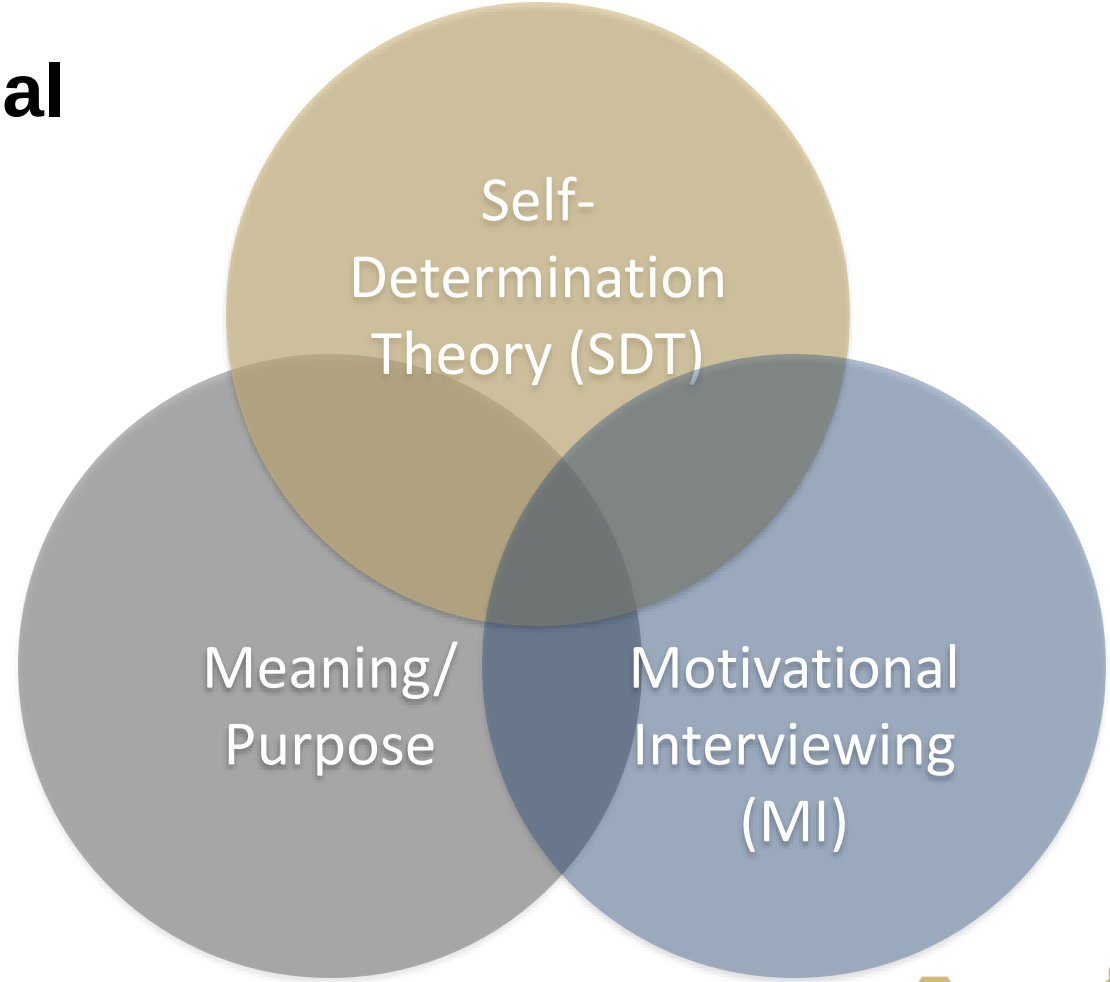
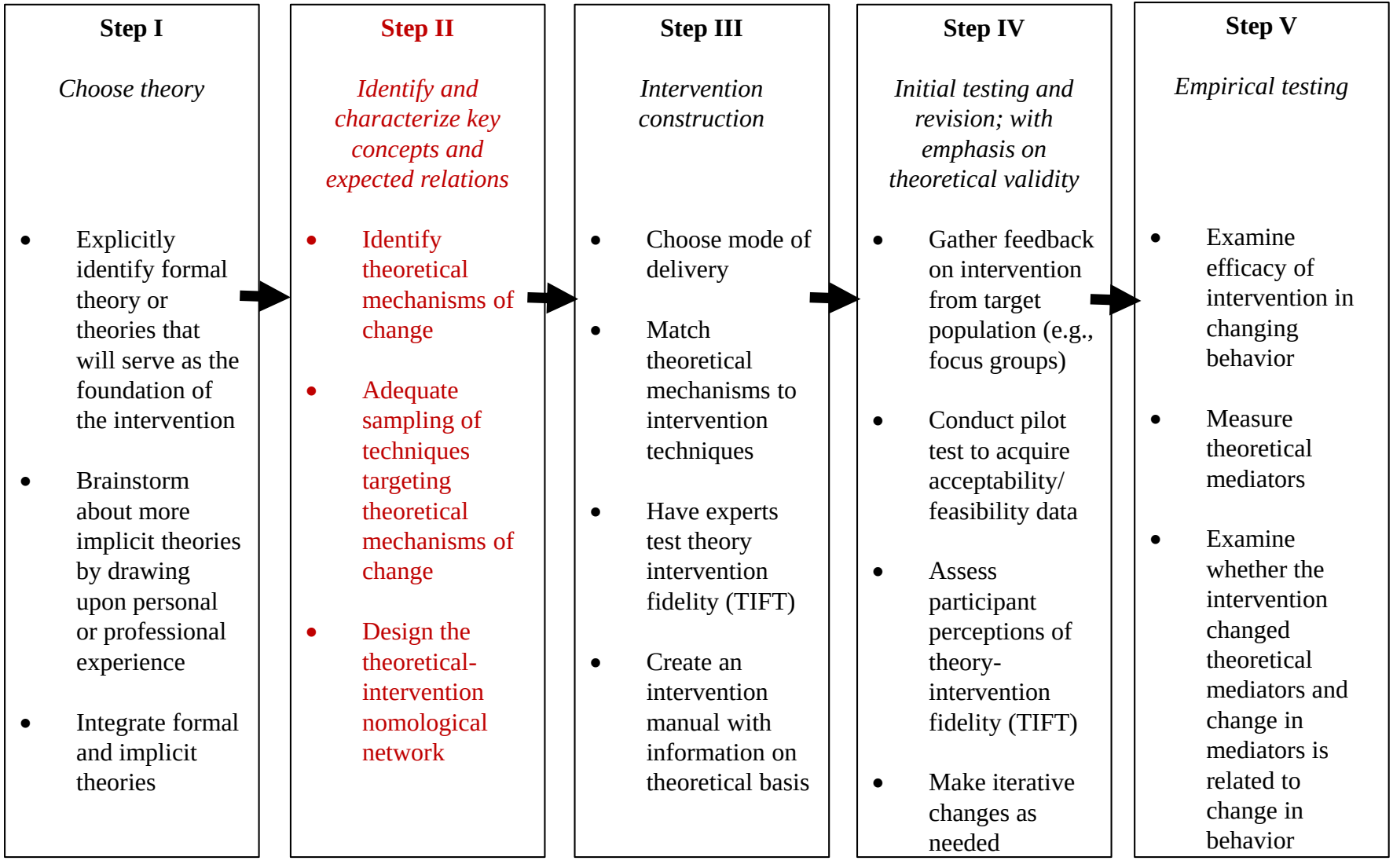
- Brainstorm about more implicit theories by drawing upon personal or professional experience
- Integrate formal and implicit theories

Colorado Meaning Activity Project: CO-MAP

- Initial interview
  - Discover meaning/purpose for individual
  - Identify opportunistic times to increase activity
- Customize smart phone application
  - Deliver messages at time of opportunity
  - Tailor to include meaning/purpose
  - Attempt to “hook” meaning/purpose with activity

Theoretical overview

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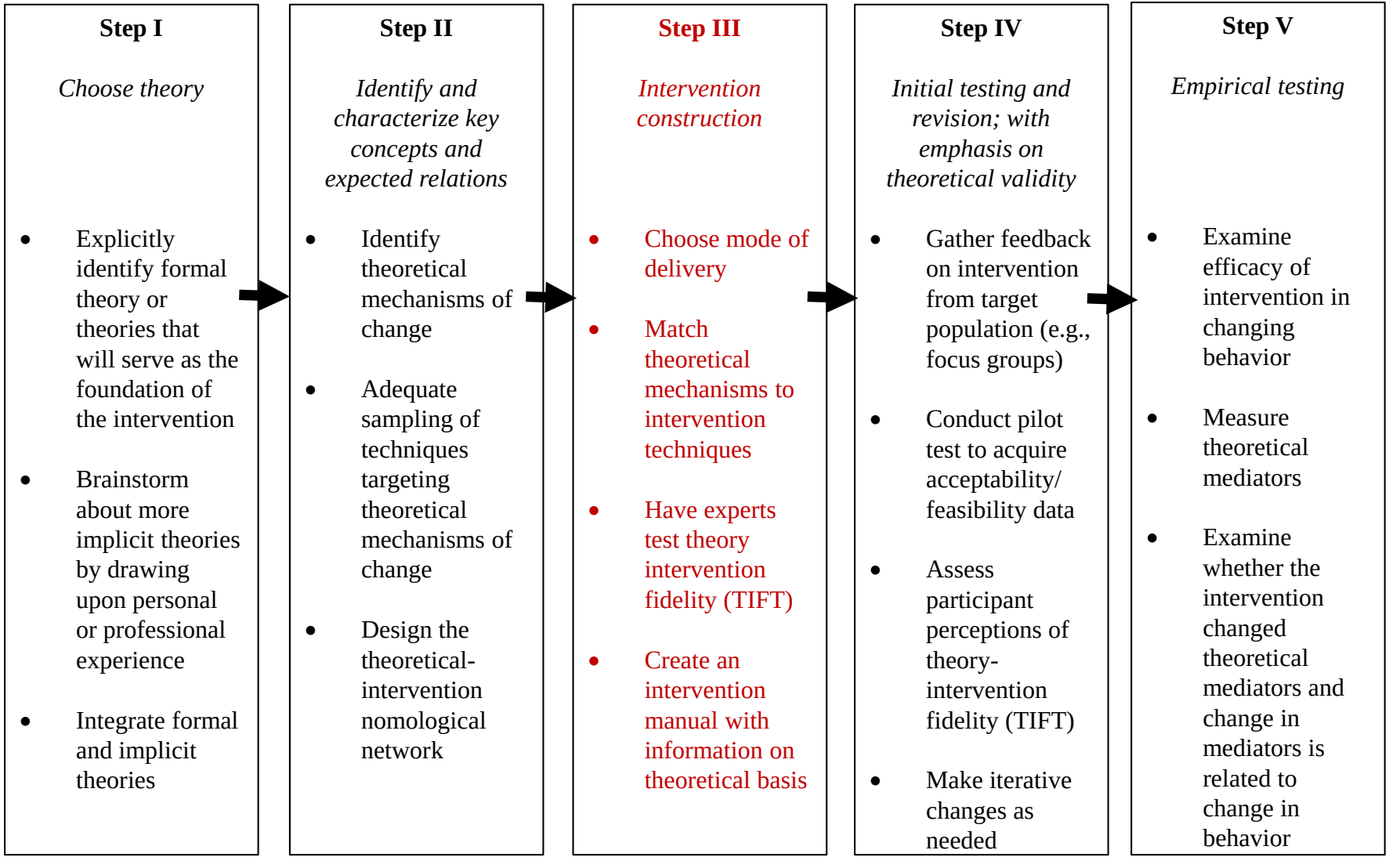
Step II

Identify and characterize key concepts and expected relations

- Identify theoretical mechanisms of change
- Adequate sampling of techniques targeting theoretical mechanisms of change
- Design the theoretical-intervention nomological network

Step II: Identify and characterize key concepts and expected relations – the Nomological Network

- Self-determination theory:
  - Autonomy
  - Relatedness
  - Competence
- Meaning/purpose
  - Meaning salience
- Motivational interviewing
  - Approach consistent with SDT and M/P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Intervention construction

- Choose mode of delivery
- Match theoretical mechanisms to intervention techniques
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- Create an intervention manual with information on theoretical basis

Step III: Develop the intervention

- List intervention approaches
- Create a chart to the theory
  - How does each approach connect to the theory?
  - Do you have intervention approaches included that do not connect to the theory? Why? Do you need them?

Examples from CO-MAP

Intervention Component	Targeted Mediating Construct(s)	Rationale
Initial individual interview	Meaning/Purpose (M/P)	Explore with individuals what is valuable and meaningful to them
Individually tailored messages (push notifications) with reference to significant others	Relatedness (SDT)	Relating activity with important people in their lives
Individually tailored messages regarding meaning delivered at opportunistic times	Meaning/Purpose	Connect M/P to activity on daily basis; increase salience of M/P
Text message: affirmation/ positive reinforcement	Competence (SDT)	Reflect participant's progress and provide encouragement

Step III: Develop the intervention

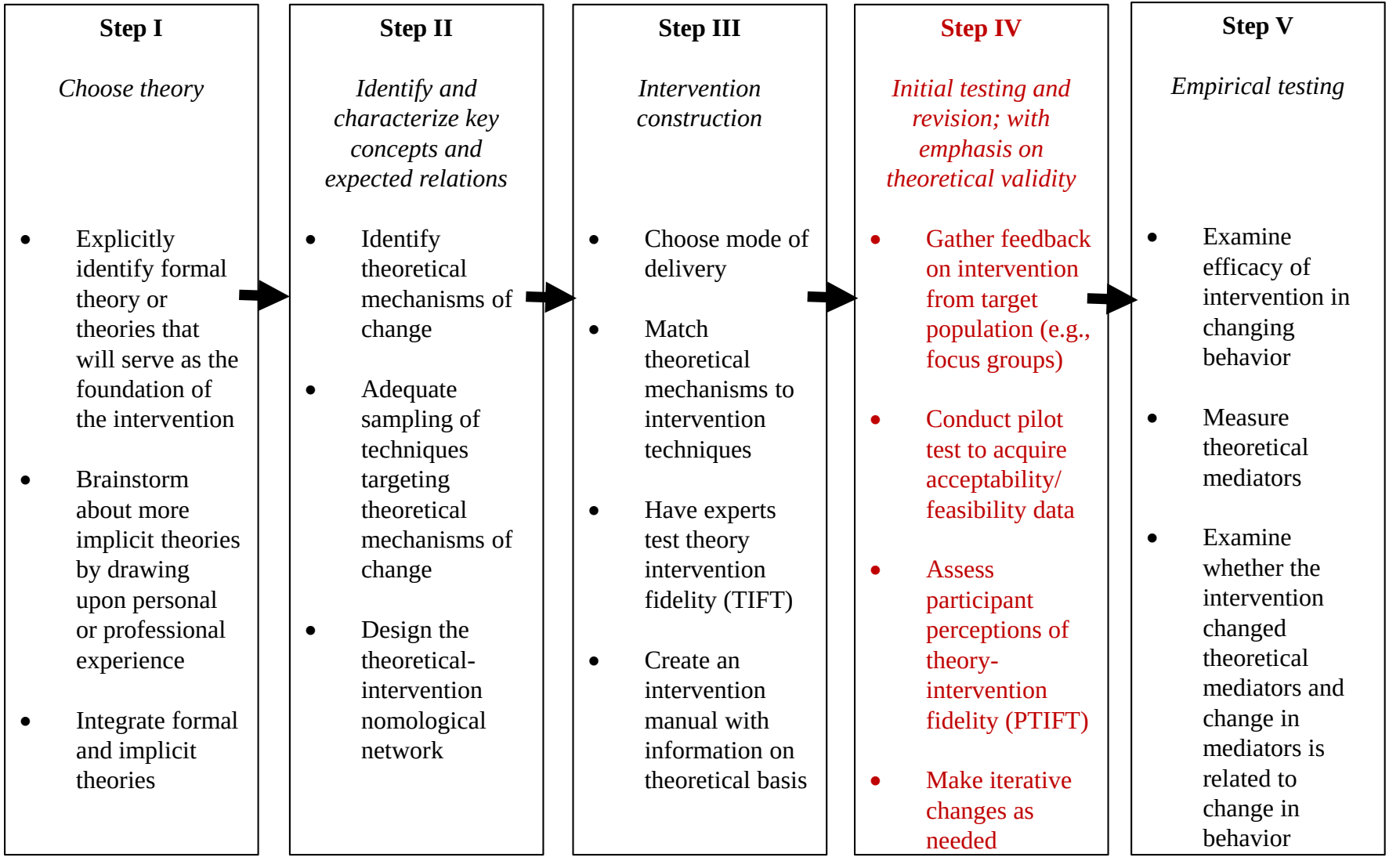
- Build psychometric validity checks into intervention development
- Ask experts to rate aspects of the intervention
- Theory-Intervention Fidelity to Treatment (TIFT) questionnaire
  - For experts/raters with knowledge of behavioral theory
  - For participants

Step III: Develop the intervention

- TIFT example for experts

1. An initial interview with an interventionist to explore with participants what is valuable and meaningful to them

Meaning/purpose	0	1	2	3	4	5	6	7	8	9	10
Social support	0	1	2	3	4	5	6	7	8	9	10
Relatedness	0	1	2	3	4	5	6	7	8	9	10
Competence	0	1	2	3	4	5	6	7	8	9	10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Initial testing and revision; with emphasis on theoretical validity

- Gather feedback on intervention from target population (e.g., focus groups)
- Conduct pilot test to acquire acceptability/feasibility data
- Assess participant perceptions of theory-intervention fidelity (PTIFT; focus groups)
- Make iterative changes as needed

Step IV: Initial testing & revision: Emphasis on theoretical validity

- Targeted Population Review of Proposed Intervention
  - » Present the proposed intervention and components to members of the target population
  - » Hold focus groups to get feedback on components and whether or not they would be interested in participating in a similar intervention
  - » Using the qualitative feedback, revise intervention as need while remaining consistent with theory
- **All with an eye toward the theory**

Step IV: Initial testing & revision: Emphasis on theoretical validity

- Initial pilot test of intervention
  - » Qualitative Feedback
  - » Quantitative Feedback
- Psychometric validity checks - participants (PTIFT)
- Feasibility
- Outcomes?

Step IV: Initial testing and revision: Emphasis on theoretical validity

- PTIFT example for participants

For the following questions, we want you to think about your experience in the program you participated in for the past two weeks. Think about your experience the initial interview and the iPhone app as you make your rating.

1. Overall, I felt like this program was respectful of my right to make my own decisions. (Autonomy)

Step IV: Initial testing and revision: Emphasis on theoretical validity

- PTIFT example for participants

For the following questions, we want you to think about your experience in the program you participated in for the past two weeks. Think about your experience the initial interview and the iPhone app as you make your rating.

1. The program adapted to my current level of confidence in my ability to be physically active. (Competence)

Examples from CO-MAP: Focus group themes

- Specific Changes to the Intervention/App
  - » Add meaning/purpose and mood graphs to main page
  - » Share questions to interview prior to meeting with person
  - » Have the app provide feedback (great job! you hit your goal!)
- Accountability
- Personalization – name, personalized pronouns

Step IV: Initial testing & revision: Emphasis on theoretical validity

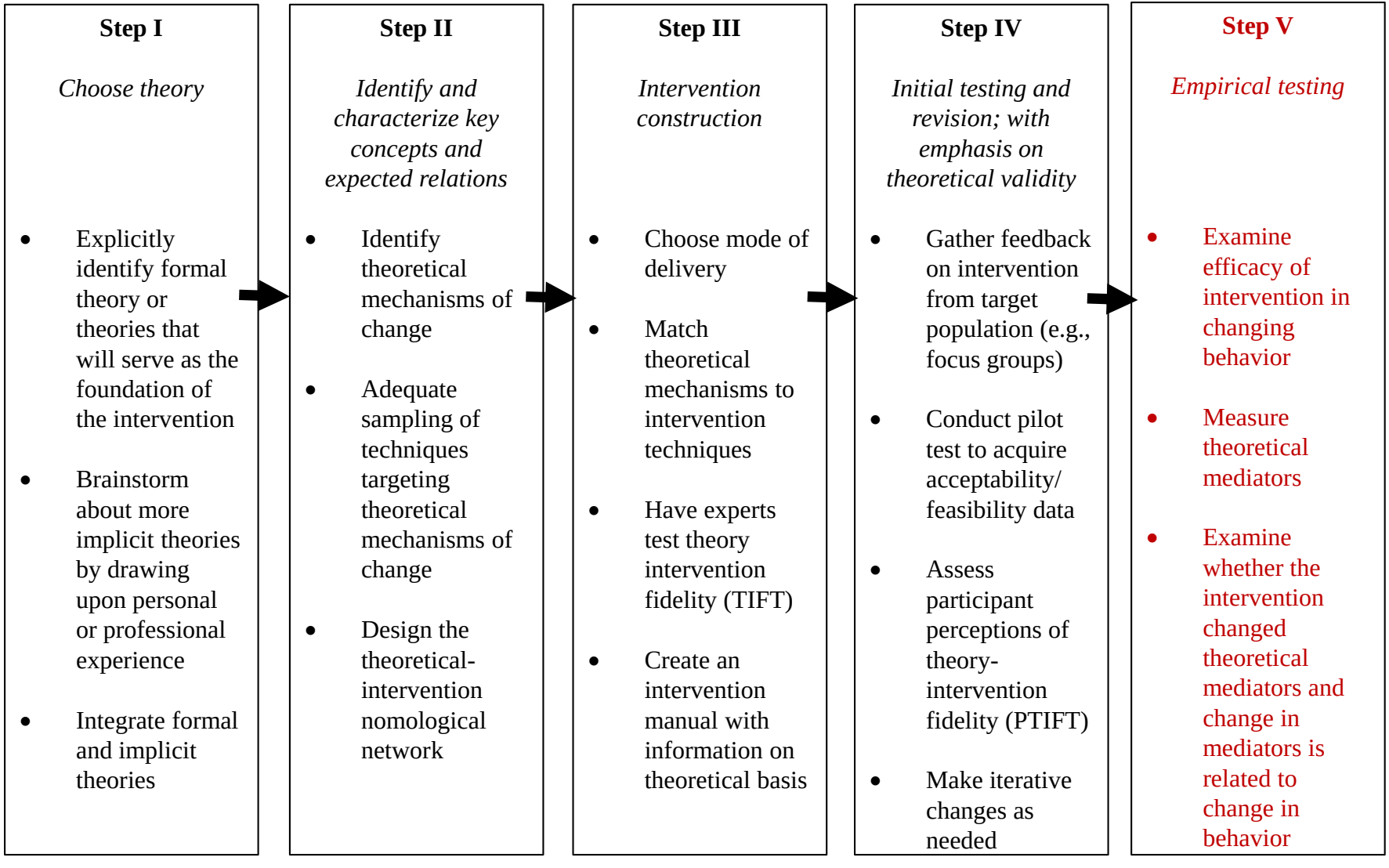
- Professional review of intervention
  - Have **intervention development team** members rate each component on where they think the intervention falls
  - Have a consensus meeting regarding the goal rating for each component of the intervention
  - Have **group of experts** (in theory or behavioral interventions) rate the intervention components
  - Examine mean ratings and see how close you are to a consensus

Example from Co-MAP

An initial MI style interview with an interventionist to demonstrate a current mismatch between participants' values and how they are currently behaving regarding physical activity (MI principle).

Example 1- If a person strongly values family and wants to start exercising so that s/he can be able to do more with her/his daughter and be a good parent: “So on the one hand, physical activity is really important to you because you want to be a good parent to your daughter - you want to be healthy and be around to see her graduate college, but on the other hand you haven’t been very active lately."

	Self-efficacy	Meaning/ Purpose	Developing Discrepancy	Autonomy
Team ratings	0	6	10	3.5
Expert ratings	5.13	7.30	8.80	5.44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Empirical testing

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Step V: Empirical testing

- What design is best?
  - RCT?
  - MOST?
  - SMART?
- What stage of research?

Step V: Empirical testing

- Researchers also need to measure components of the theory that are theoretical mechanisms of change
  - Does the intervention behave based on theory?
  - Ideally the intervention affects mechanisms/processes and outcome in ways predicted
  - Either way, researchers have data to plan the next intervention

Testing processes of change

	Good outcome	Bad outcome
Mechanisms change	Good theory Good intervention	Bad theory
Mechanisms don't change	Bad theory	Bad intervention Bad theory

Selected references:

Masters, K.S. et al., (2018). A psychometric approach to theory-based behavior change intervention development: example from the Colorado Meaning-Activity Project. *Annals of Behavioral Medicine, 52,* 463-473.

Kraemer, H.C. et al., (2002). Mediators and moderators of treatment effects in randomized clinical trials. *Archives of General Psychiatry, 59,* 877-883.

Kazdin, A.E. (2006). Mediators and mechanisms of change in psychotherapy research. *Annual Review of Clinical Psychology, 3*, 1-27.

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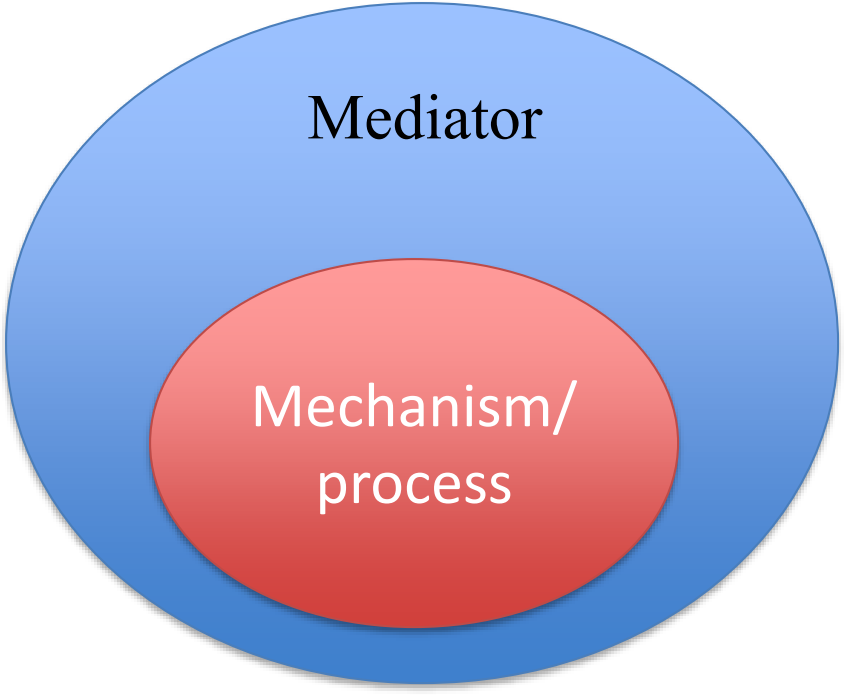
(Kraemer et al., 2002; Kazdin, 2007; SOBC)



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- Psychometric validity checks (PTIFT)
- Feasibility