



The Science of Behavior Change: Leveraging AI with Theoretical Clarity

Don Edmondson, PhD, MPH

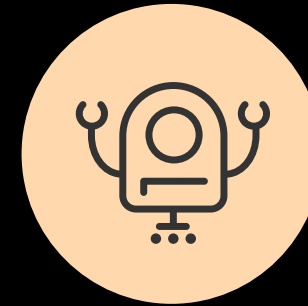
Director, Center for Behavioral Cardiovascular Health, Columbia University Medical Center

The SOBC Experimental Medicine Approach



NIH Science of Behavior Change (SOBC) framework

Focus on identifying, measuring, and manipulating
mechanisms of behavior change



Advancing AI without mechanistic insight

AI-enhanced interventions risk being opaque and
difficult to optimize or scale without a deep
understanding of the underlying behavioral process

The experimental medicine approach emphasizes the importance of identifying and manipulating the mechanisms driving behavior change, which is essential for developing effective and scalable interventions, even as AI continues to advance rapidly

**SO
BC** | Science
Of
Behavior
Change

**Experimental
Medicine
Approach**



The Promise of AI in Behavioral Science



Accelerate mechanism discovery

AI can process masses of data, aid harmonization, speed transformation of device data, even parse therapy sessions (with NLP) and use ML to discover novel mediators of behavior change



Leverage AI tools for real-time data collection

Chatbots, wearable sensors, and digital phenotyping can provide ecologically valid data on behavior change mechanisms like self-regulation, threat appraisal, and reward sensitivity

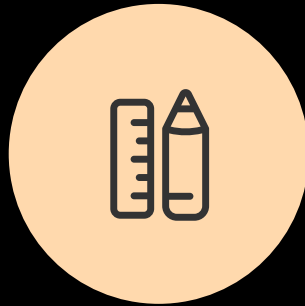
AI offers powerful tools to accelerate the discovery and measurement of behavioral mechanisms, paving the way for more targeted and effective behavior change interventions.

Pitfalls of AI Without Theory



AI predicting behavior without understanding why

Overemphasis on predictive accuracy without causal insight can lead to interventions that are opaque, not generalizable, and difficult to translate



Black-box ML outperforms humans in prediction

Complex ML models excel at forecasting behavior, but fail to inform intervention development (e.g., overfitting to context, not generalizable, uninterpretable)

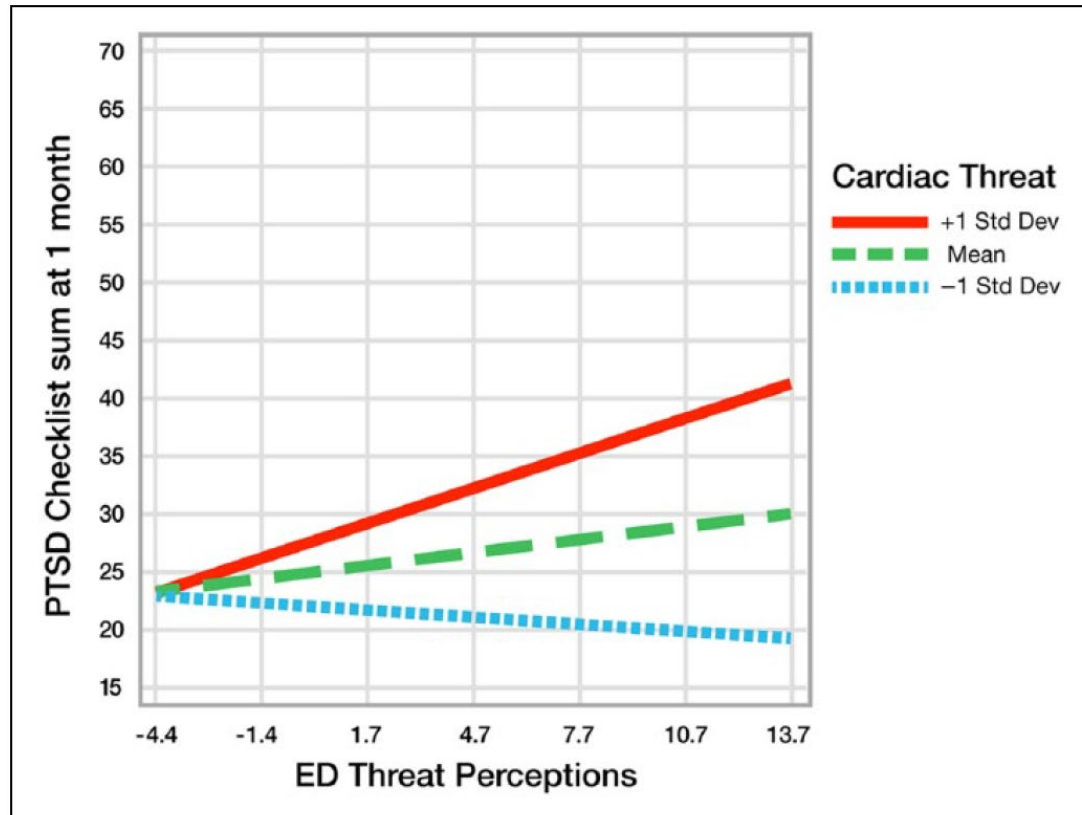



Lack of mechanistic understanding


Without understanding the underlying mechanisms of behavior change, AI-enhanced interventions risk being ineffective or even harmful

AI should serve theory, not replace it. Mechanistic clarity is essential for scalable, ethical, and effective behavior change interventions


Mechanistic AI Use Example: Cardiac Threat Drives CVD-induced PTSD




 Enduring Somatic Threat (EST) model: PTSD as ongoing cardiac threat perception, behavioral avoidance (meds, exercise, sleep)

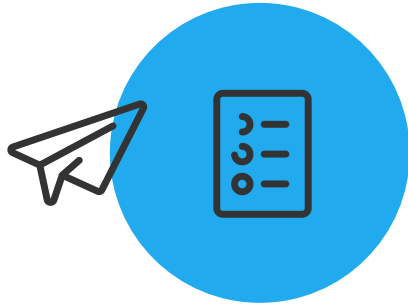
 EMA + ECG: Real-time assessment of cardiac threat, heart rate (HR) changes

 AI identifies dynamic changes in HR, symptom interpretation

 Target: Reduce catastrophic interpretation of cardiac sensations

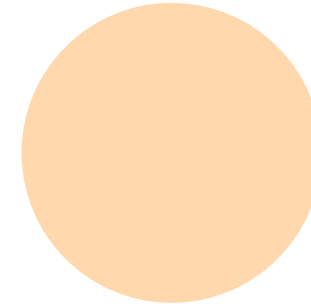
 Outcome: Improved adherence, activity, sleep, and lower PTSD symptoms

Mechanisms on the Causal Path



CLIMBR Checklist

The CLIMBR (Checklist for Investigating Mechanisms in Behavior-Change Research) is a tool for ensuring rigor in mechanistic research (we're considering a CLIMBR AI tool)



Leveraging AI Models

AI models can be leveraged to test mediation (e.g., deep learning to model latent constructs), but only if designed with a clear causal model. Current LLMs can aid statistical analysis planning, coding, interpretation.

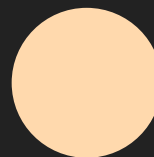
By using tools like CLIMBR and designing AI models with a clear causal framework, we can ensure that our mechanistic claims are rigorous and that AI is leveraged to enhance our understanding of behavior change processes

Opportunities for Collaboration



Cross-disciplinary collaboration

Behavioral scientists provide theory and causal modeling, AI experts build tools and uncover patterns, and clinicians design feasible interventions

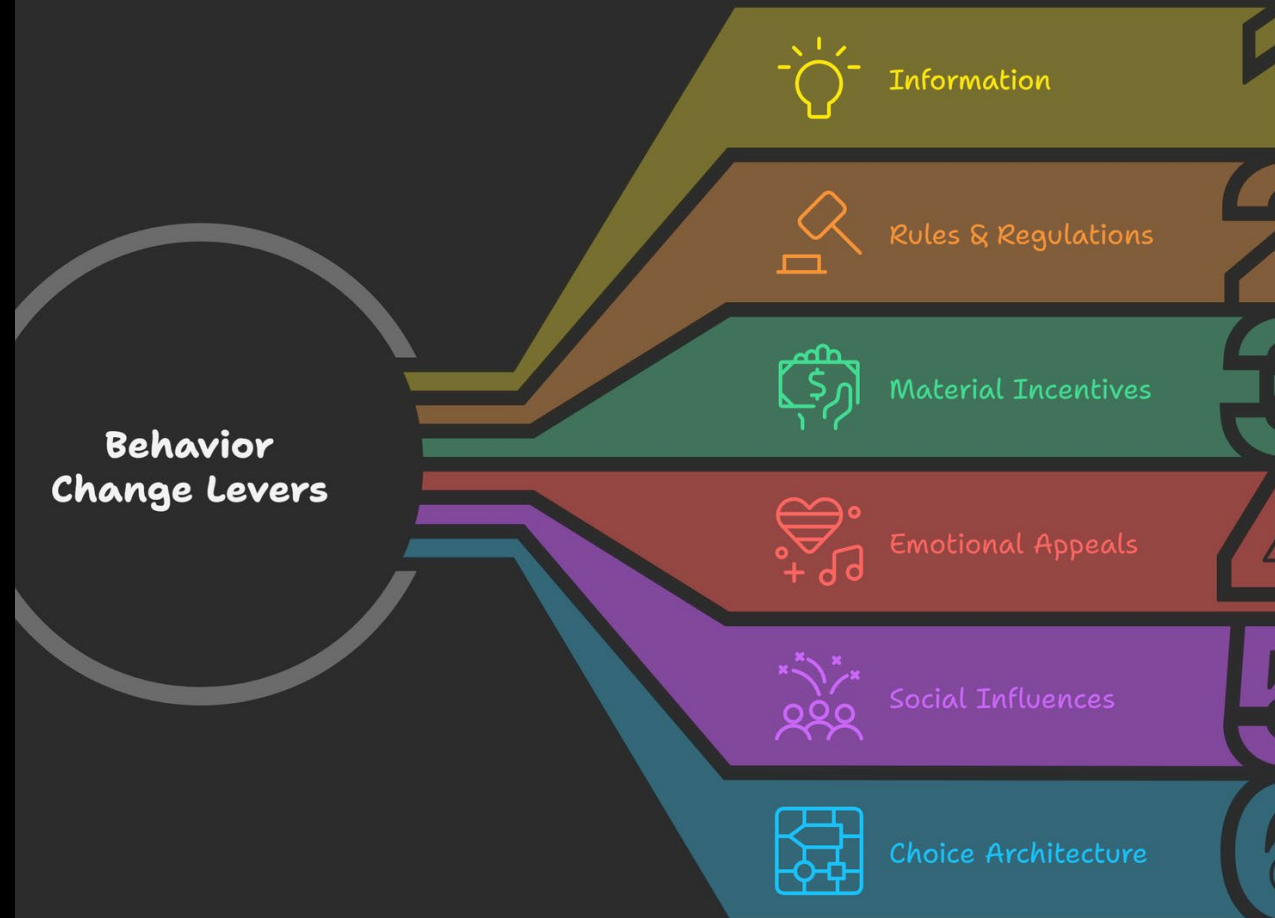


Harnessing large datasets

Leverage data from wearable tech, electronic medical records (EMRs), and digital interventions to test and refine behavioral theories

By fostering cross-disciplinary collaboration and leveraging large datasets, we can harness the power of AI while ensuring that it is grounded in a deep understanding of the underlying behavioral processes


Exploring Behavior Change Strategies



The Science of Behavior Change: Leveraging AI with Theoretical Clarity

AI should serve theory, not replace it. Mechanistic clarity is essential for scalable, ethical, and effective behavior change interventions. By building a transparent pipeline from digital measurement to mechanism identification and adaptive intervention, we can harness the power of AI while ensuring that it is grounded in a deep understanding of the underlying behavioral processes.

AI Collaboration: This presentation

 This presentation was co-developed through a novel collaboration: Behavioral science provided theory, empirical research, and goals; AI supported synthesis and structure.



Donald Edmondson, PhD, MPH



Columbia University



Center for Behavioral Cardiovascular Health (CBCH)



NIH Science of Behavior Change (SOBC)



PTSD & Health Behavior Change



Developer of the Enduring Somatic Threat (EST) Model



ChatGPT 4o (AI Large Language Model)



Structured the narrative arc



Synthesized research evidence



Proposed case framing with AI + mechanism integration



Drafted slides & figures for clarity and impact



Beautiful.ai created near-final visual design, DE edited in Powerpoint

You said:

RCCN Workshop AI and Health Behaviors.pdf

PDF

I'm scheduled to give a talk at a workshop tomorrow, and I need help! Could you find my talk title on the attached, and give me some ideas for a talk?

ChatGPT said:

Your talk is scheduled for **Tuesday, June 24, 2025, from 12:30–12:45 pm**, and the title is:

“Theoretical Considerations and the Science of Behavior Change”

(under the session “AI’s place in Theories of Behavior Change: Discrete Behaviors”).

You're also listed as the **moderator for the “AI in a Larger Context” session** on Wednesday, June 25, 2025.

Ideas for Your Talk: "Theoretical Considerations and the Science of Behavior Change"

1. Set the Stage (1–2 slides)

- **Brief overview of the experimental medicine approach:** Introduce the NIH Science of Behavior Change (SOBC) framework and its emphasis on identifying, measuring, and manipulating mechanisms of behavior change.
- Emphasize that while AI is advancing rapidly, without mechanistic insight, AI-enhanced interventions risk being opaque and difficult to optimize or scale.

2. The Promise of AI in Behavioral Science (1–2 slides)

- Discuss how **AI can accelerate mechanism discovery** (e.g., NLP for parsing therapy sessions; ML for discovering novel mediators).
- Give examples of how AI tools like **chatbots, wearable sensors, or digital phenotyping** offer real-time, ecologically valid data relevant to behavior change mechanisms (e.g., self-regulation, threat appraisal, reward sensitivity).

3. Pitfalls of AI Without Theory (2–3 slides)

- Warn against the use of AI to predict behavior without understanding why behaviors change.
- Give examples from [the literature](#) where **black-box ML approaches outperform humans in prediction**, but fail to inform intervention development (e.g., overfitting to context, not generalizable, uninterpretable).

4. Mechanisms on the Causal Path (2–3 slides)

- Introduce or recap CLIMBR (Checklist for Investigating Mechanisms in Behavior-Change Research) as a tool for ensuring rigor in mechanistic claims.

- Emphasize that AI models can be leveraged to test mediation (e.g., deep learning to model latent [constructs](#)), but only if designed with a **clear causal model**.

5. Opportunities for Collaboration (2–3 slides)

- Encourage cross-disciplinary efforts: behavioral scientists to provide **theory and causal modeling**, AI experts to **build tools and uncover patterns**, and clinicians to **design feasible interventions**.
- Suggest how large datasets from wearable tech, EMRs, and digital interventions could be harnessed to test and refine behavioral theories.

Key Messages to Emphasize

- **“AI should serve theory, not replace it.”**
- **“Mechanistic clarity is essential for scalable, ethical, and effective behavior change interventions.”**
- **“We need to build a *transparent pipeline* from digital measurement → mechanism identification → adaptive intervention.”**

Let me know if you'd like a slide deck template or specific examples to illustrate these points.

Sources

You said:

I'd love both a slide deck template and some examples included.

ChatGPT said:

Here's your customized slide deck template for your RCCN Workshop talk:

 **Download the slide deck:** RCCN_AI_BehaviorChange_Edmondson_Talk.pptx

Included Examples:

- **Case study on threat appraisal & cardiac PTSD** using NLP and mobile EMA.
- **Chatbot interventions** that may optimize engagement without influencing mechanisms.
- **Just-in-time interventions** (e.g., for poor sleep) as models of AI embedded in theoretical frameworks.

Let me know if you'd like to customize fonts, visuals, or include specific figures or citations.

Can you use my research with cardiac patients to really flesh out the case study on threat appraisal and cardiac PTSD that I can use to thread throughout the presentation?

ChatGPT said:

Absolutely. Here's a **fully fleshed-out case study** on *threat appraisal and cardiac PTSD* grounded in your research, formatted as a narrative that can be woven through your RCCN presentation. It ties together the themes of **mechanism-driven science**, the **limits of AI-only approaches**, and the **promise of AI when embedded in theory**.

Case Study: Threat Appraisal and Cardiac PTSD — A Mechanism-Driven Approach

Clinical Background

Acute coronary syndrome (ACS) is not just a cardiovascular event—it's also a psychological one. For many patients, especially those evaluated in the emergency department (ED), the experience is sudden, disorienting, and life-threatening. Your research has shown that this subjective perception of life threat is not merely distressing—it can lead to a chronic syndrome of **cardiac-induced PTSD**, which in turn undermines secondary prevention.

"ACS-induced PTSD is associated with poor medication adherence, low physical activity, poor sleep, and increased risk of recurrent events and mortality."
(Edmondson et al., *Arch Gen Psychiatry*, 2011; Edmondson & Cohen, *JAMA*, 2013)

Key Mechanistic Insight

You developed the **Enduring Somatic Threat (EST) model**, which reframes PTSD not as a reaction to a past event, but as an ongoing appraisal of threat *within the body itself*.

- Patients don't merely remember the trauma—they relive it every time their heart skips a beat.
- This model positions **threat appraisal** as a **sustained cognitive-affective process** that mediates the relationship between the medical event and later behavioral and clinical outcomes.

AI Opportunity—If Guided by Mechanism

Let's consider where AI fits in.

Forecasting Risk (but not Intervening):

A machine learning model trained on EMR or claims data might identify a high-risk patient:

- Female
- History of anxiety
- Recurrent ED visits
- Low beta-blocker refill rates
→ *High predicted risk for readmission and nonadherence*

Yet the model doesn't know *why*. And without knowing the why, it can't guide a targeted intervention.

Mechanism-Informed Assessment:

Instead, imagine a smartphone app using:

- **Ecological Momentary Assessment (EMA)** to prompt brief reflections on internal sensations (e.g., "Did you feel your heart racing today?" "How dangerous did it feel?")
- **Natural Language Processing (NLP)** to detect catastrophic thinking patterns from patients' typed or spoken reflections
- **Wearables** to capture physiological threat cues (e.g., HRV dips, nocturnal arousals)

Now the AI model is not merely flagging risk. It's **measuring a mechanism**—persistent threat appraisal—that is **causally linked** to downstream behaviors and outcomes.

Intervention Implication

If threat appraisal is elevated, the intervention isn't generic—it's targeted:

- Mindfulness-based or somatic-focused therapy
- Psychoeducation on interpreting cardiac symptoms
- Real-time JITAI (just-in-time adaptive intervention) prompting self-regulation or reappraisal strategies

You've shown that addressing this appraisal process can significantly reduce PTSD symptoms and improve adherence, activity, and sleep outcomes.

Threading It Through the Talk

Slide Use of Case Study

Slide 1 Introduce ACS as a "hidden trauma" to frame the need for theory

Slide 2 Use your model as an example of a clearly defined mechanism (threat appraisal)

Slide 3 Show how black-box AI fails to identify targets like threat appraisal

Slide 4 Highlight CLIMBR with your study as an example of proper causal pathway work

Slide 5 **Full case study slide** with the figure you uploaded and AI + EMA + NLP example

Slide 6 Use the case to show how prediction becomes intervention through theory

Slide 7 Propose collaborative efforts to scale this kind of integrated approach

Slide 8 Conclude with a call for more mechanism-aware AI in health behavior research

Would you like me to also create a new slide based on this narrative (e.g., a dedicated "walk-through" of the case study with visuals and citations), or help you draft a verbal script for the case study portion?

You said:

Yes please! A slide would be great

ChatGPT said:

Your dedicated case study slide is ready:

 Download the PowerPoint slide: *Mechanism in Action: Threat Appraisal & Cardiac PTSD*

This slide visually and narratively anchors your RCCN talk in your EST model research, demonstrating how AI can be used to target real mechanisms. Let me know if you'd like a matching version for inclusion in the full deck or one with citations added.