

On Your Best Behavior:

Applying the science of behavior change
to medical device research and design

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Table of Contents

- Introduction
- Key Behavioral Theories
- The Science of Decision Making
- Practical Applications
- Takeaways
- Q&A
- References

Introduction

Introduction

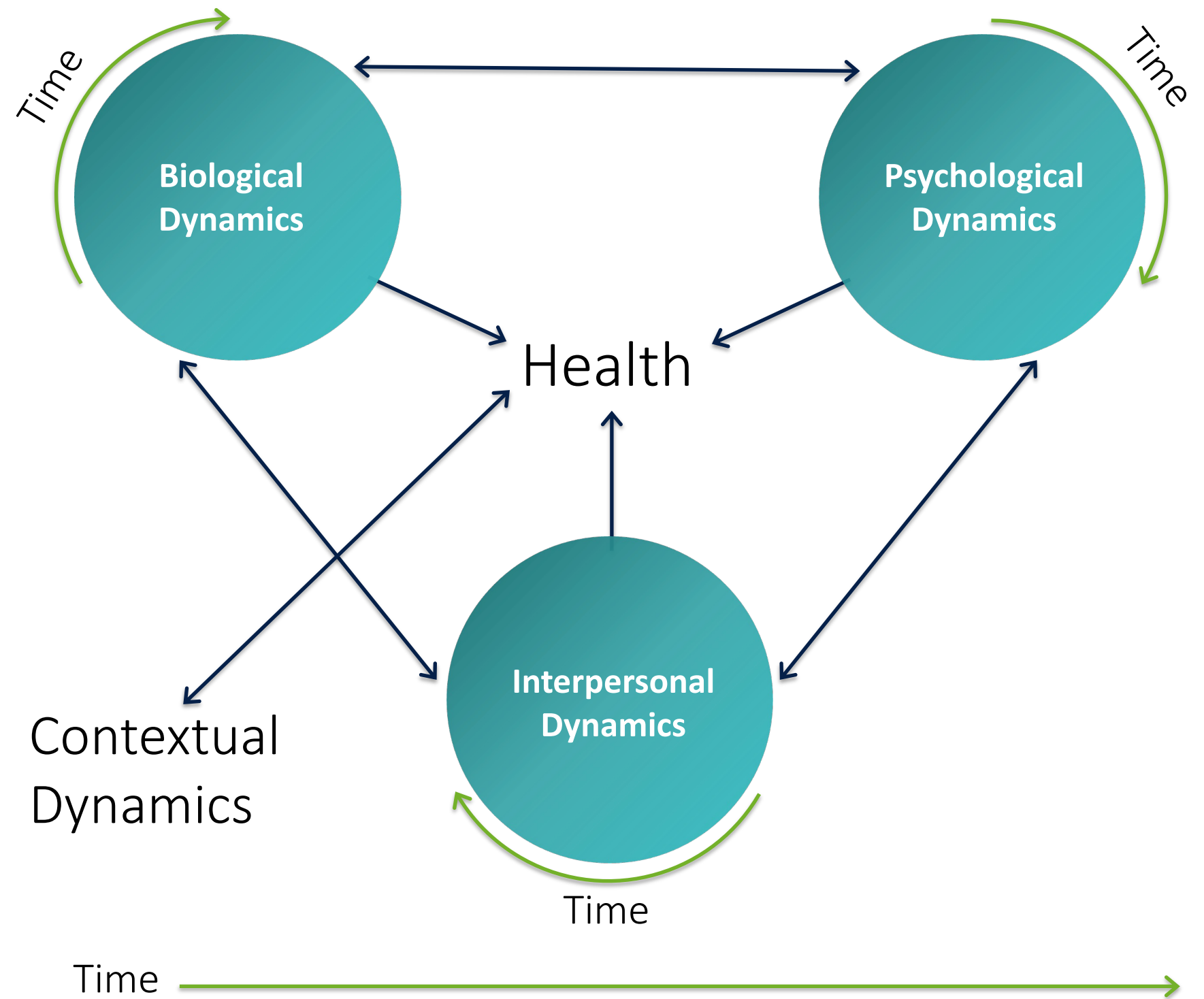
How do we influence patient behavior in order to encourage desirable interactions with a medical device, or increase adherence to a particular therapy?



- Understanding and mitigating patient non-adherence issues is critical to achieving better clinical outcomes.
- While research often provides possible root causes of non-compliance or non-adherence, solutions are more difficult to identify.
- We propose taking a broader view of the holistic factors that shape human behavior.
- Theories and models from other scientific fields like social psychology, cognitive neuroscience, and behavioral economics could have tangible impacts on medical device design and user experience design.
- We will review several theories of behavior and decision-making and explore the practical implications they could have on device and user experience design.

Introduction

The BioPsychoSocial Model of Health purports that dynamic interpersonal, biological, and psychological systems interact with contextual factors to shape health over the life span.



Key Behavioral Theories

Behavioral Theories

Operant Conditioning

by B.F. Skinner



- Behavior is determined by its consequences (reinforcements or punishments), which make it more likely or less likely that the behavior will occur again.
 - 1. Antecedent** - The prompt, or initial situation, leading to a behavior—e.g., the child's desire for interaction.
 - 2. Behavior** - The action or behavior in response to the antecedent—pulling on a parent's leg.
 - 3. Consequence** - The reinforcement mechanism associated with the behavior—attention, positive or negative.
- One can systematically alter the consequences to either reinforce desired behaviors or discourage undesired behaviors.
- This theory is the basis for ABA therapy, often used for patients with ASD, ADHD, OCD, anxiety, phobias, and more.

Behavioral Theories

Social Cognitive Theory

by Albert Bandura



- Agrees with the theories of operant conditioning but expands upon those ideas.
- Behavior is learned from the environment through the process of observational learning (Bobo doll experiments).
- Mediating processes occur between stimuli and responses; one does not automatically observe behavior and imitate it, there is some thought first.
- A person's behavior is influenced by:
 - their capabilities or knowledge,
 - positive and negative reinforcements,
 - self-control (e.g., setting and meeting goals),
 - perceived outcomes of performing behaviors and the values placed on those outcomes, and
 - self-efficacy (i.e., confidence in overcoming barriers).

Behavioral Theories

The Health Belief Model

by Marshall Becker



- The theory that public health messages will achieve optimal behavior change if they successfully target perceived barriers, benefits, self-efficacy, and threat.
- Proposes 6 constructs that predict health behavior:
 - 1. Risk susceptibility** – patient must regard themselves as susceptible to the condition.
 - 2. Risk severity** – they must believe it would have potentially serious consequences.
 - 3. Benefits to action** – must believe that a course of action available to them will reduce the susceptibility or severity or have some other positive outcome.
 - 4. Barriers to action** – must perceive few negative attributes related to taking action.
 - 5. Self-efficacy** – believe that they can successfully complete the behavior of interest despite considered barriers.
 - 6. Cues to action** – specific cues in one's environment (internal or external) can impact the final action one takes.

Behavioral Theories

Reasoned Action

by Azjen & Fishbein

- The theory that behavioral achievement depends on both motivation (intention) and ability (behavioral control).
- Behavioral intentions are influenced by the attitude about the likelihood that the behavior will have the expected outcome and the evaluation of the risks and benefits of that outcome.
- Six constructs to consider:
 1. **Attitudes** - the degree to which a person has a favorable or unfavorable evaluation of the behavior of interest.
 2. **Behavioral intention** - the motivational factors that influence a given behavior.
 3. **Subjective norms** - the belief about whether most people approve or disapprove of the behavior.
 4. **Social norms** - the customary codes of behavior in a group or people or larger cultural context.
 5. **Perceived power** - the perceived presence of factors that may facilitate or impede performance of a behavior.
 6. **Perceived behavioral control** - perception of the ease or difficulty of performing the behavior of interest.

Same

Change



Behavioral Theories

Self-Management

by Frederick Kanfer

- The theory that behavior can be modified if one follows a systematic process to manage cues, manage their own cognitive processes and consequences.
- Underlying belief that individuals are capable of self-control; if they want to change their behavior, it is possible through a process called self-regulation.
 1. **Self-monitoring** – turning attention to the behavior and determining how it affects one's health.
 2. **Self-evaluation** – comparing the behavior to acceptable standards and taking corrective action if needed.
 3. **Self-reinforcement** – reassuring self of the positive consequences.



The Science of Decision Making

The Science of Decision Making

Intuitive Judgment



FOLLOW YOUR GUT

- Subjective feelings and the decisions reached on that basis, which cannot be articulated easily and is not fully conscious.
 - Often associated with stressful or threatening situations
- Counter to rational judgment – **add periods to end of bullets**
- Not easily swayed by factual counter-arguments
 - More easily ‘comforted’ away – associated to emotional security
- Does not use facts, analytics, or schemata
- Often a “gut reaction”
- Generally considered a subset of automatic thought, typically focused,
 - reacting to a certain feature or quality of a situation
 - Does not always consider the big picture or broader context

The Science of Decision Making

Motivation

- Assumes behavior is goal-directed
 - focused on and motivated by desired future end states of action
- Motivational decision making includes:
 - pre-decisional processes that lead to the choice of a goal
 - the persistence in pursuing a selected goal
 - the intensity in the performance of instrumental activities chosen to realize selected goals
- Avoidance of sunk costs – what have you already invested in the process?
- Like intuitive judgment, motivation is not always conscious
- Motivation (i.e., value, expectancy, wish, intention) influences how we process incoming information and act upon it (or not)
 - Doesn't often get sick (low perceived probability), wants to avoid pain is greater than their perceived value of getting vaccinated, unlikely to get the flu shot
 - Traveling to a country requiring a specific vaccination, much more likely to get vaccinated



The Science of Decision Making

Goal Oriented Action



- Suggests all behavior is acted out with the intention of producing/achieving a result
- Result could be defensive (e.g., maintain comfort or avoid threat)
- Result could be proactive (e.g., improved health or ‘feeling better’)
- Most goals require effort to achieve, so how much effort can an individual exert at any given moment?
- The human brain is constantly trying to maximize efficiency to minimize effort
- High overlap between the neural networks associated with cognitive control/goal-oriented action and uncertainty
 - When uncertain, the brain identifies as many opportunities as possible to *avoid* exerting control (i.e., maximizing cognitive efficiency)
 - Juxtaposition between goals of maintaining cognitive efficiency and exerting cognitive effort to make an informed decision

The Science of Decision Making

Uncertainty & Ambiguity



- Information can be interpreted in multiple ways, both in and out of context
- When meaning is unclear, we “compress” probabilities towards a mental default of 50:50.
 - In the face of uncertainty, the brain convinces itself that both options are equally viable/likely so that it can choose the option it prefers
- Individuals underreact to increasing informativeness
 - undervalue high-quality information
 - disproportionately prefer information that may yield certainty
- Higher ambiguity increases the likelihood of reliance on schemata (*Tuckey et al., 2003*)
 - Reliance on schemata increases the chance of biases and errors
- Removing uncertainty decreases cognitive load, leaving more cognitive resources available for information processing, self-regulation, and goal-oriented action

The Science of Decision Making

Example of Decision-Making Process



Coronavirus Pandemic Example: Do I wear a mask to the grocery store?

- Intuitive Judgement – I rarely get the flu, and this probably isn't different; I feel unattractive or insecure in a mask; I'm afraid people will harass me; I don't think it makes much of a difference.
- Motivation – I went through a lot of effort to find surgical grade masks; I really don't want to get this virus; I can help to 'flatten the curve'.
- Goal-oriented Action – "The masks are located right next to my coat." vs. "Where did I even put the masks when they arrived?"
- Uncertainty and Ambiguity
 - I'm 38 and healthy except for mild asthma. I don't know whether this virus will affect me or not (more reliant on schemata, such as 'older adults are in danger').
 - I'm 73, smoked for 25 years, and was recently diagnosed with COPD. I'm certain that I would have to be hospitalized if I got the virus (more likely to take precautions and follow CDC guidelines).

Practical Applications

User Research

- Do your research to determine and understand antecedents, behaviors, rewards and what motivates particular user groups.
 - Probe users on their underlying decision-making process to try to understand subconscious motivations or implicit judgements they can't articulate well.
 - What specific rewards or information will motivate these users to change behavior?
- Consider demographic differences and social norms as related to gender, culture and different value systems (subjective and social norms).
- What barriers exist in the device's ecosystem? Are there self-efficacy obstacles that design can address?
- Determine how the device under development could be folded into current behavioral habits as opposed to having to encourage new ones.

Health Education & Training

- Educate patients on the risks related to their condition (risk susceptibility)
- Balance this with the positive effect of the therapy to encourage benefits of action and to avoid mental shutdown in the face of threat
- Incorporate device-led walk-throughs as part of training to model the desired interaction behaviors. Have patients imitate and correct

User Documentation

- Differentiate packaging from typical household items (i.e., to present a cue to action, increase noticeability of package)
- Leverage quick reference guide in addition to IFUs to improve patient self-efficacy
- Include simple public health data or compliance statistics to encourage (e.g., pamphlet) desired behaviors positive social pressure
- Develop how-to videos with realistic end users modeling the desired actions

Device Design

- Make it easy to do the desired action!
 - Lighten cognitive load (reduce burden of memory to take meds, lower complexity of workflow/tasks, increase resilience for error)
 - Storage location/make access convenient by placing the device or therapy in the patient's pathway to fit in with their natural habits
 - Similar appearance to non-medical to reduce stigma and minimize social consequences
 - Design easy to open packages, especially for non-controlled substances
- Reduce fears of negative consequences through design (e.g., the materials you choose, colors, delivery method)

App Design

- Help patients set small, incremental goals
- Set reminders / provide a platform on which to plan and execute a schedule (per training)
- Reward them based on what motivates them (find out in generative research, refer to behavioral economics) to further induce motivation
 - E.g., gamification of metrics/activities
 - E.g., financial incentive (coupons, discounts, etc.)
- Increase motivation by showing patients they have invested something (sunk cost)
- Encourage patient self-monitoring (i.e., check-ins) by pushing adherence data
 - including a narrative on the implications of their failure/success
- Choose default purposefully to suggest desired behavior is common (social norms)
- Data sharing
 - Share efficacy data with patients so they believe a course of action is available and could lead to positive result
 - Social persuasion through data (X% of people your age or in your city do this behavior)

Service Design

- Provide avenues that make it easy for patients to access the care (shuttle service, home visits, work/errand presence)
- Provide avenues for patients to connect with peers, i.e. social platforms and forums (patient advocate communications, chat rooms, meet-ups, conferences)
- Auto refill supplies – free shipping/don't demand mobility

Marketing & Advertising

- Target places the patients are likely to be
- Use models and actors that appear relatable (self-relevance)
- Provide positive messaging (not fear mongering)
- Communicate social norms and expectations (storytelling, demonstration/modeling)
- Remove ambiguity, when possible (explicit messaging)
- Provide evidence for claims to further decrease doubt and uncertainty

Takeaways

Key Themes

Root Cause and Motivation – *Kate to condense this section to single slide*

- we're used to looking for *error* root cause, but all behaviors have root cause
- constantly behaving towards or away from something (comfort, achievements, consequences)

Belief in agency – empowerment

- requires recognition of capability
- requires feeling of knowledge

Risk/benefit analysis

- typically implicit (automaticity)

Key Themes

Cues to action

- Internal and external catalysts

Modeling and imitation

- peer pressure and social psychology
- Increases cognitive efficiency

Mental models

- top-down processing affects perception of information as well as behavior

Questions?

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