

# JITAI Development in Mobile Health



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The Methodology Center  
advancing methods, improving health



# Overview

- Session 1: Introduction to JITAIs: Just-in-Time Adaptive Interventions
- Session 2: Micro-randomized Trials for Developing mHealth JITAIs
- Session 3: Data Analytics for Developing JITAIs

# Session 1: JITAIs

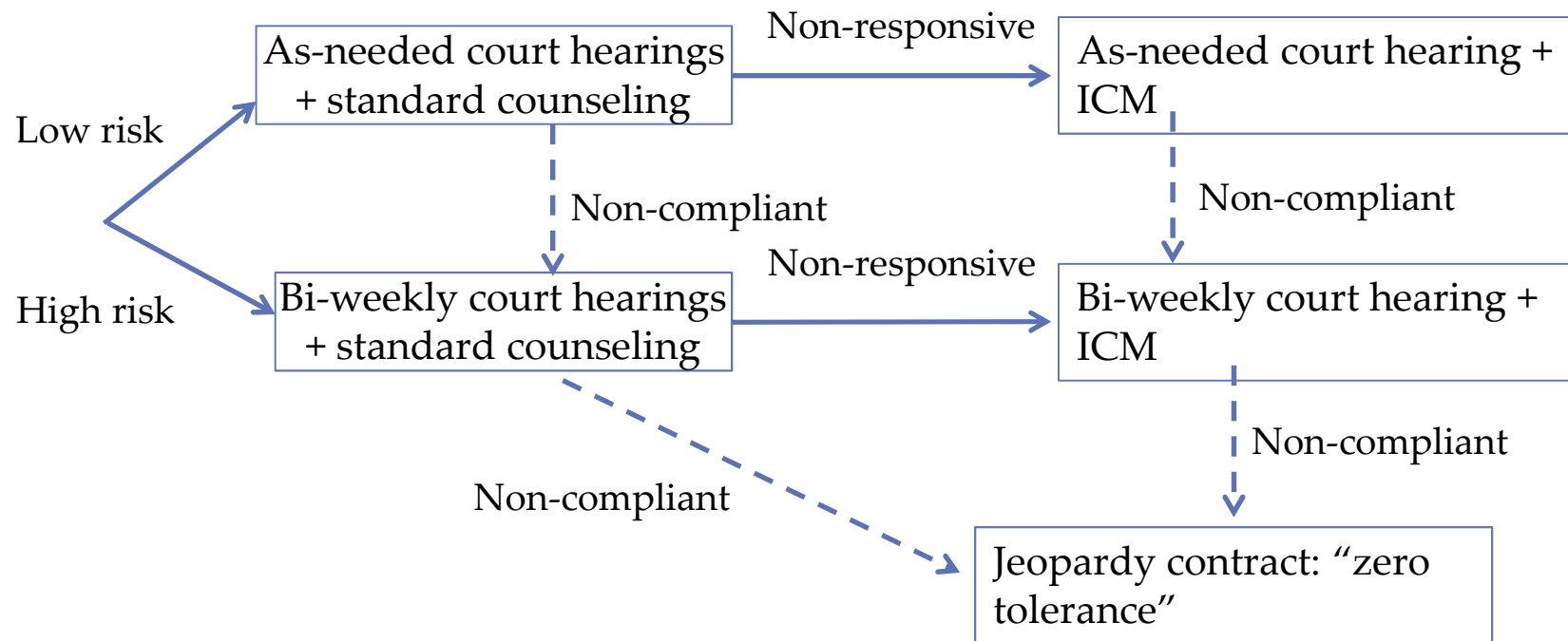
- Adaptive Interventions
- Just-in-Time Adaptive Interventions
- Examples

# Adaptive Interventions

- Intervention design that takes advantage of systematic response heterogeneity by individualizing treatments to individuals
- Example: Adaptive drug court program for drug abusing offenders

Marlowe et al., 2008; 2009; 2012

# Adaptive Drug Court Program



# Adaptive Intervention: 5 Elements

The adaptation is guided by consideration of

(1) Distal Outcome and Proximal Response

The adaptation process is composed of

(2) Tailoring Variables,

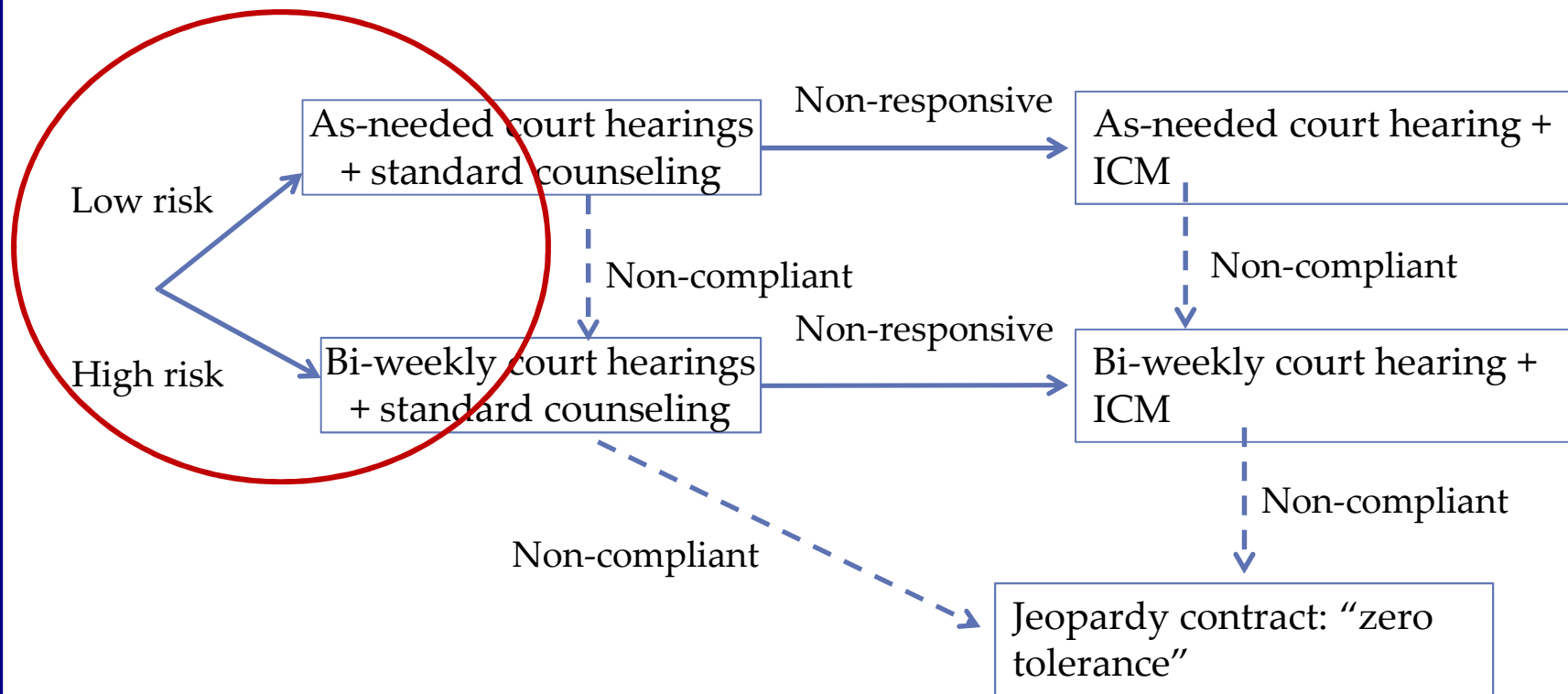
(3) Decision Rules and

(4) Treatments

The adaptation is triggered at

(5) Decision Points

# Adaptive Drug Court Program



# First Stage Decision Rule

## 4. Decision rule

At point of entry into the program

*If* risk = low

*Then*, treatment= {As-needed + SC}

*Else if* risk=high

*Then*, treatment= {Bi-weekly + SC}

## 3. Treatments:

Type/Dose

## 5. Outcomes:

Distal → Longer-term goal of intervention:

Program graduation (14 consecutive weekly negative drug urine specimens)

Proximal → Shorter-term goal of decision rules:

Adherence and abstinence in the course of intervention (mediator)

## 2. Tailoring Variable:

Patient information used to make treatment decisions

## 1. Decision Point:

A time in which treatment options should be considered based on patient information



# Two Types of Treatments



# JITAI: Just-in-Time Adaptive Interventions

- A JITAI is an adaptive intervention
- That is
  - delivered when needed
  - & where-ever needed



(Kaplan & Stone, 2013; Spruijt-Metz & Nilsen, 2014)

# Example

## Reducing Sedentary Behavior by Office Workers

- Software on the computer measures uninterrupted computer time via mouse and keyboard activity
- Smartphone delivers a message to encourage a walking activity *only* if 30 min. of uninterrupted computer activity occurs

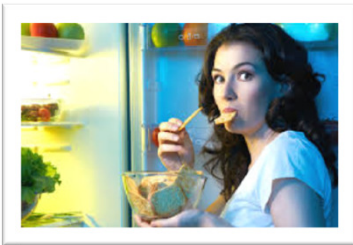


(Dantzig et al., 2013)

# Example

## iCrave for weight management

- Mobile app containing a button that participants can press whenever they experience craving for unhealthy snacks
- A visualization task is provided as soon as they press the button;
- Next, the participant is prompted to make a choice between: (1) not eat at all; (2) a healthy snack; or (3) an unhealthy snack.
- A congratulating message is provided *only if* the participant selects (1) not eat at all.



(Hsu et al, 2014)

# Commonalities?

- Both adaptive interventions and JITAIs are time-varying and adaptive
  - Both have “Push and Pull” treatments
- However in JITAIs technology plays a critical role
  - Information can be obtained when/where needed
  - Treatments can be delivered when/where needed

# Just-in-Time Adaptive Intervention

## 5 Elements

The adaptation is guided by consideration of

(1) Proximal Response and Distal Outcome



In-the-Moment Impact

The adaptation process is composed of

(2) Tailoring Variables,

(3) Decision Rules and

(4) Treatments (push)

The adaptation is triggered at

(5) Decision Points



Real-Time

# Distal Outcomes

The goal is to improve a longer-term, distal, outcome

- Change behavior and/or maintain behavior change
  - Substance use cessation & prevent relapse
  - Increase physical activity & maintain increased activity level
  - Improve medication adherence & maintain adherence

To improve the distal outcome, the treatments are often formulated to target proximal responses

# Proximal Responses

*Mediators* that may be critical to achieving the long-term goal

- 1) Short term targeted behavior
  - Substance use over x hours
  - Physical activity over x minutes
  - Adherence over next hour
- 2) Short term risk
  - Current craving, current stress
- 3) Engagement with mobile app and intervention burden



# Treatments

- In-the-moment push treatments:
  - Behavioral strategies, cognitive strategies, self-monitoring, social linkages, motivational,...
  - Reminder to use supportive apps or reminder to self-monitor
  - How to deliver a treatment
  - “Provide nothing” option
- Theoretically/scientifically driven (Klein et al., 2011)



# Tailoring variables

*Tailoring variables are moderators that inform which treatment is best when, where and for whom.*

- Often past proximal responses: stress, activity
- Risk & protective factors: busyness of calendar, current mood or craving, location, social context
- Adherence & burden

# Decision Points

Typical decision points in JITAIs:

- Intervals in time (every x seconds, every x minutes, every x hours)
- When user requests help (presses “help” button”)

Frequency is guided by the dynamics of the tailoring variables and “in-the-moment nature” of the treatment effect.

# Decision Rules

Link individual information to treatments at decision points

- A decision rule is implemented at each decision point
- A JITAI often includes many different decision rules
- Development of decision rules is guided by an integration of empirical evidence, theory and clinical experience.

# Decision Rules: Example 1

What to do when composite risk assessment at random prompt indicates risk

At self-report assessment

*If composite substance abuse risk  $\geq R_0$*

*Then, Tx = {reminder to access intervention}*

*Else if composite substance abuse risk  $< R_0$*

*Then, Tx = {do nothing}*

Treatments

Tailoring Variable

Proximal Response: Craving

Decision Point

# Decision Rules: Example 2

What to do when composite risk assessment indicate risk + user does not access intervention

At M minutes following a self-report assessment:

*If* composite risk  $\geq R_0$

*and* intervention access in past M minutes = NO

*Then*, Tx = {message encouraging intervention use}

*Else if* risk  $< R_0$  or intervention access in past M minutes = YES

*Then*, Tx = {do nothing}

# Decision Rules: Example 3

At 1 minute intervals

*If* current accumulated computer activity  $> P_0$

*Then*, Tx = {recommend movement}

*Else if* current accumulated computer activity  $\leq P_0$

*Then*, Tx = {do nothing}

# Summary of JITAI elements

## 1. Outcomes

- Distal (scientific/clinical goal) & Proximal Response (guided by mediational theories pinpointing the necessary processes needed to achieve the distal outcome)

## 2. Treatments

- Guided by the proximal responses

## 3. Tailoring variables

- Guided by theory concerning moderation.

## 4. Decision points

- Guided by the dynamics of the tailoring variable and in-the-moment nature of the effect of the treatment.

## 5. Decision rules



# Example



## MD2K Sense2Stop

- Wearable bands measure activity, stress, cigarette smoking; smartphone sensors provide location,.....
- In which contexts should the wrist band provide supportive stress-reduction “cue” and smartphone activate to highlight associated stress-regulation exercises?

# Sense2Stop

- Goal: Develop a Just-in-Time Adaptive Intervention for Delaying Time to Relapse to Smoking



# Sense2Stop

**Distal Outcome:**  
Time to Relapse.

**Proximal Response:**  
Fraction of time stressed over next x minutes.

# Sense2Stop

## **Treatments:**

Whether to provide a reminder to practice stress regulation exercises? Yes/No

## **Decision points:**

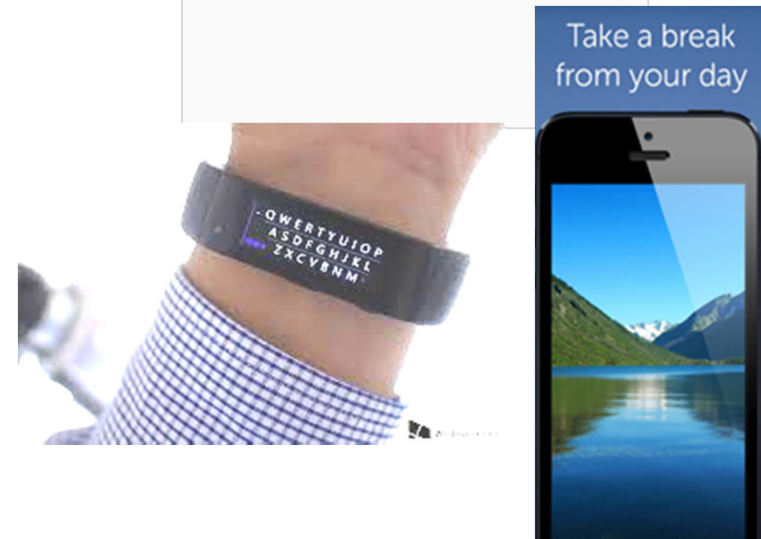
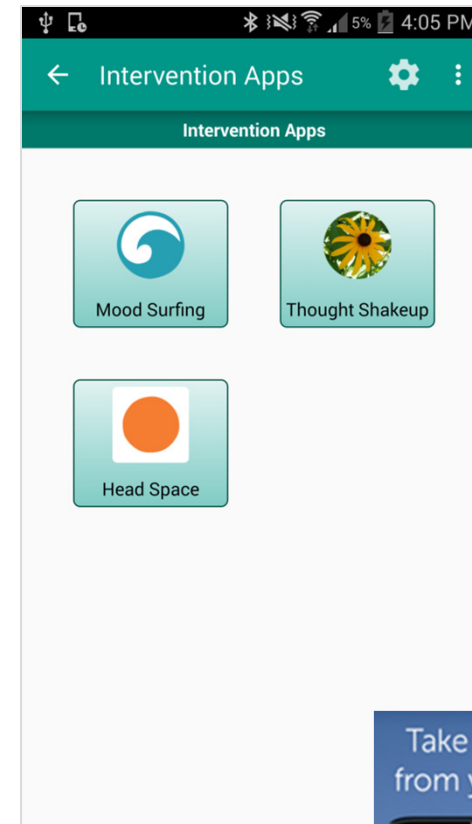
Approximately every minute of a 10 hour day

# Reminder to use stress-regulation exercise

No Message

OR

MS band vibrates and displays reminder;  
Stress-regulation app opens on phone



# Sense2Stop

## **Potential Tailoring Variables:**

availability, current stress, location, volatility in stress over prior x hours, craving (self-report)

# Potential Decision Rule using Stress as a Tailoring Variable

Every minute

IF available,

Then,

*If* passively sensed stress = Yes,

*Then* Tx= prompt stress-regulation

*Else if* passively sensed stress = No

*Then* Tx= 'do nothing'

Else If not available,

Then Tx= 'do nothing'

# Practice forming your own JITAI!

1. Problem Behavior & Population?
2. Outcomes?
  - Distal (scientific/clinical goal) & Proximal Response (guided by mediational theories pinpointing the necessary processes needed to achieve the distal outcome)
3. Treatments?
  - Guided by the proximal responses
4. Tailoring variables?
  - Guided by theory concerning moderation.
5. Decision points?
  - Guided by the dynamics of the tailoring variable and in-the-moment nature of the effect of the treatments.
6. Decision rules?



# Collaborators

