

# **Persons, Situations, and Time: Personalized Behavioral Forecasting**

**Emorie D. Beck, PhD**

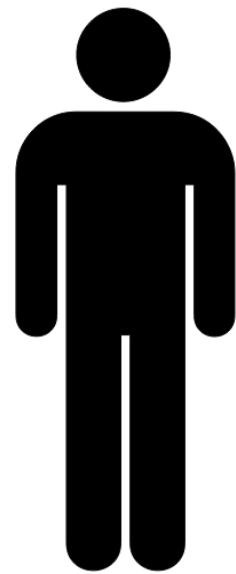
Department of Psychology  
University of California, Davis



**Description**

**Prediction**

**Explanation**



**Thoughts**

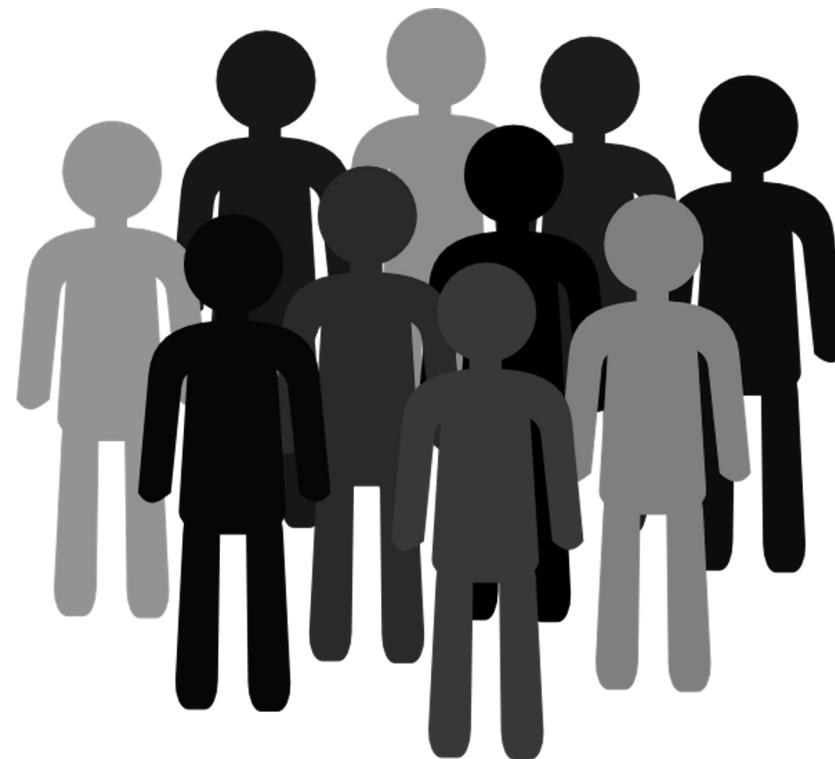
**Feelings**

**Behaviors**

**Description**

**Prediction**

**Explanation**



**Thoughts**

**Feelings**

**Behaviors**

# OUTLINE

**1**

**What is personality and how can it inform behavioral forecasting**

**2**

**Precision Medicine and Personality Forecasting:  
Targeting and Tailoring**

**3**

**Empirical Example: Behavioral Forecasting in  
Everyday Life Using Personalized Machine  
Learning Prediction Models**

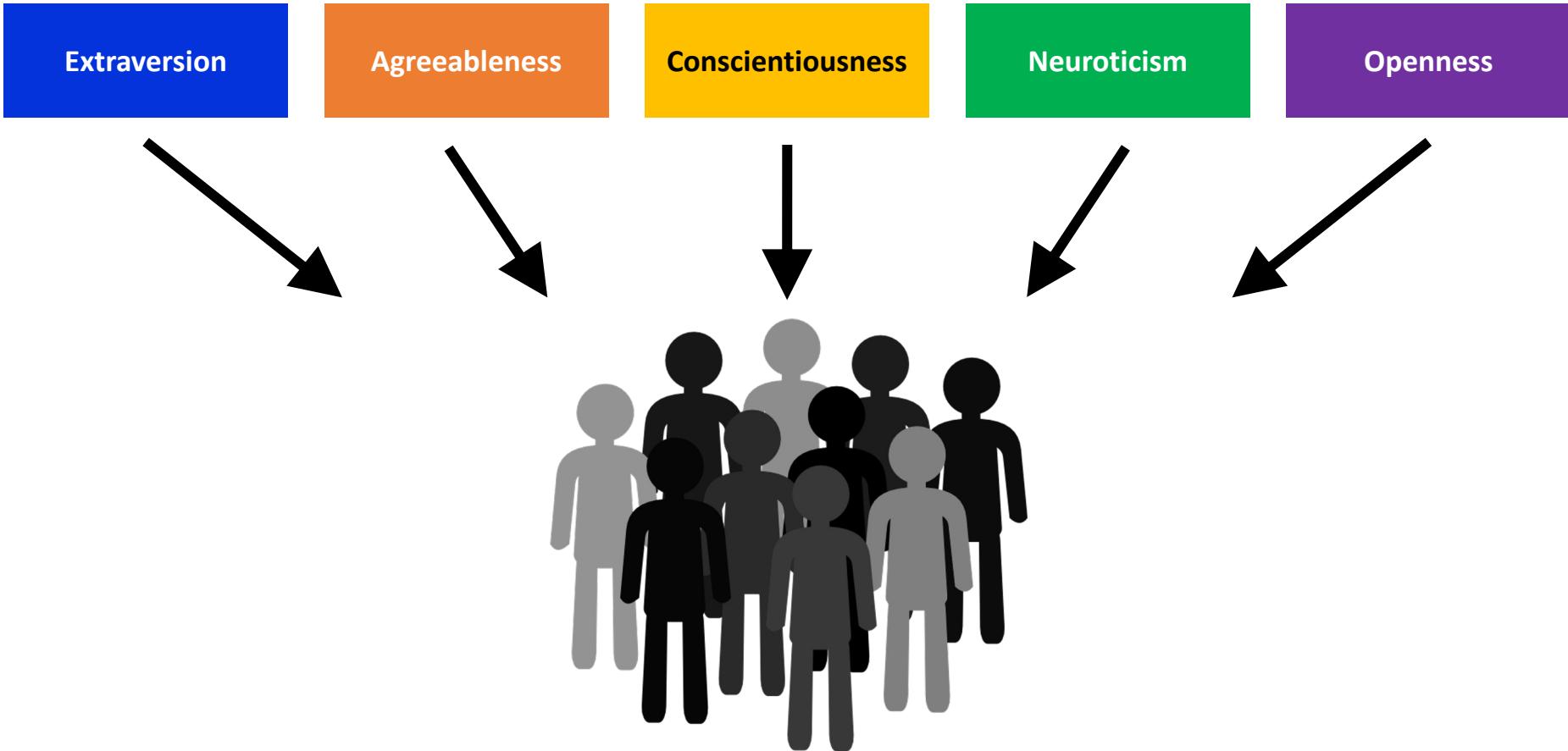
**4**

**Lingering Challenges and Ongoing Directions**

# What is personality?

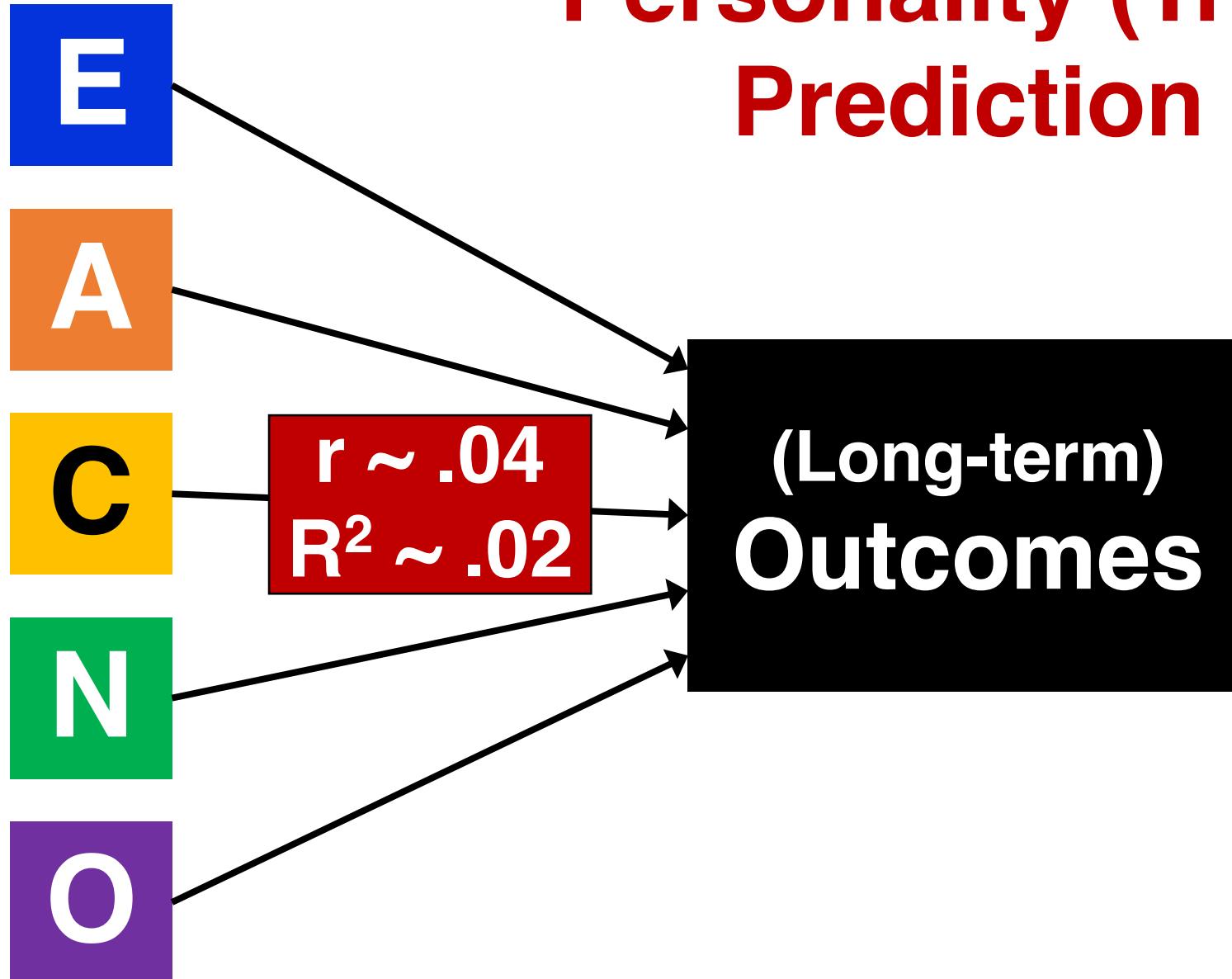
“Personality refers to those characteristics of the person that account for **consistent patterns of feelings, thinking, and behaving.**”

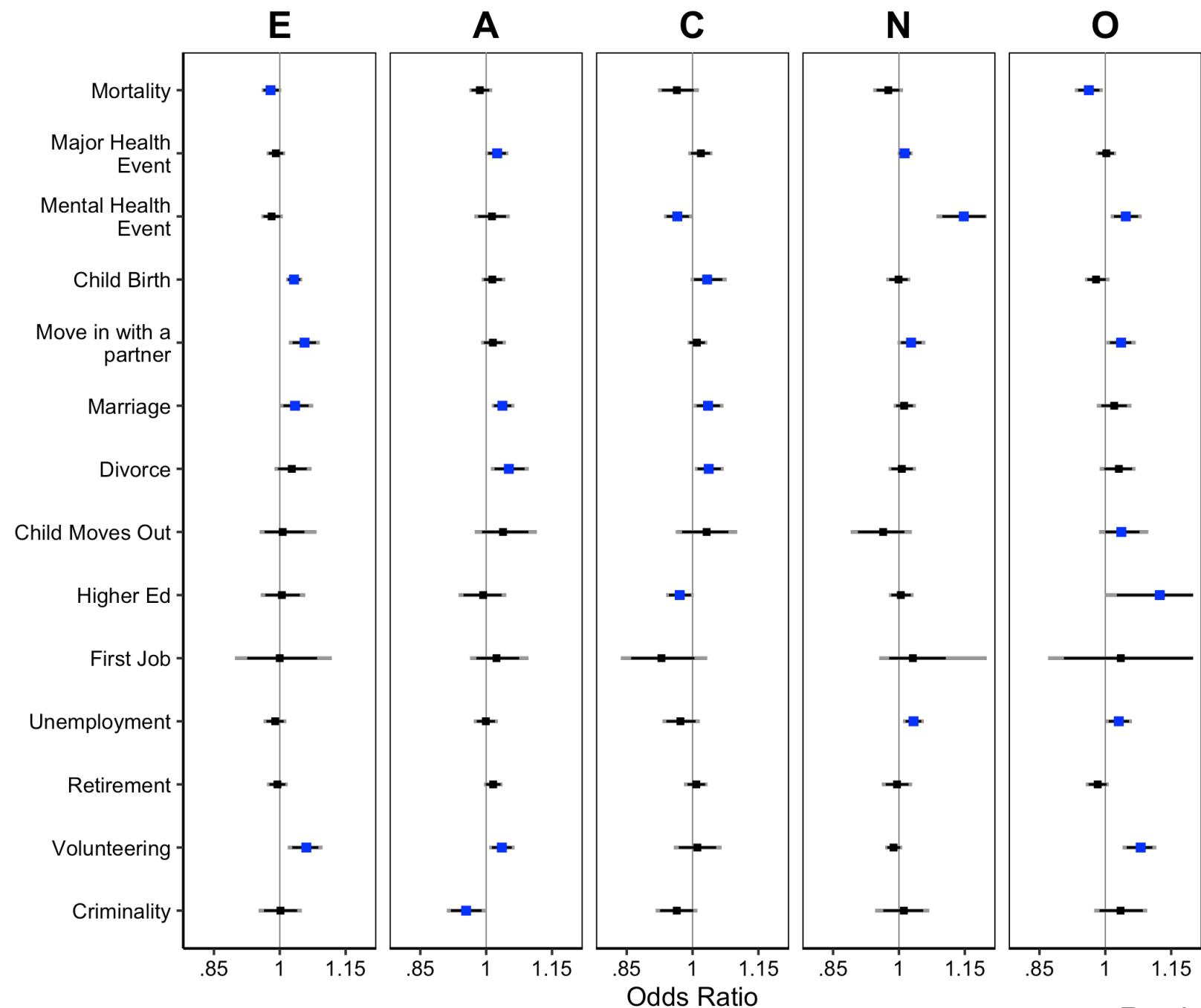
(Pervin, Cervone & John, 2005, p. 6)



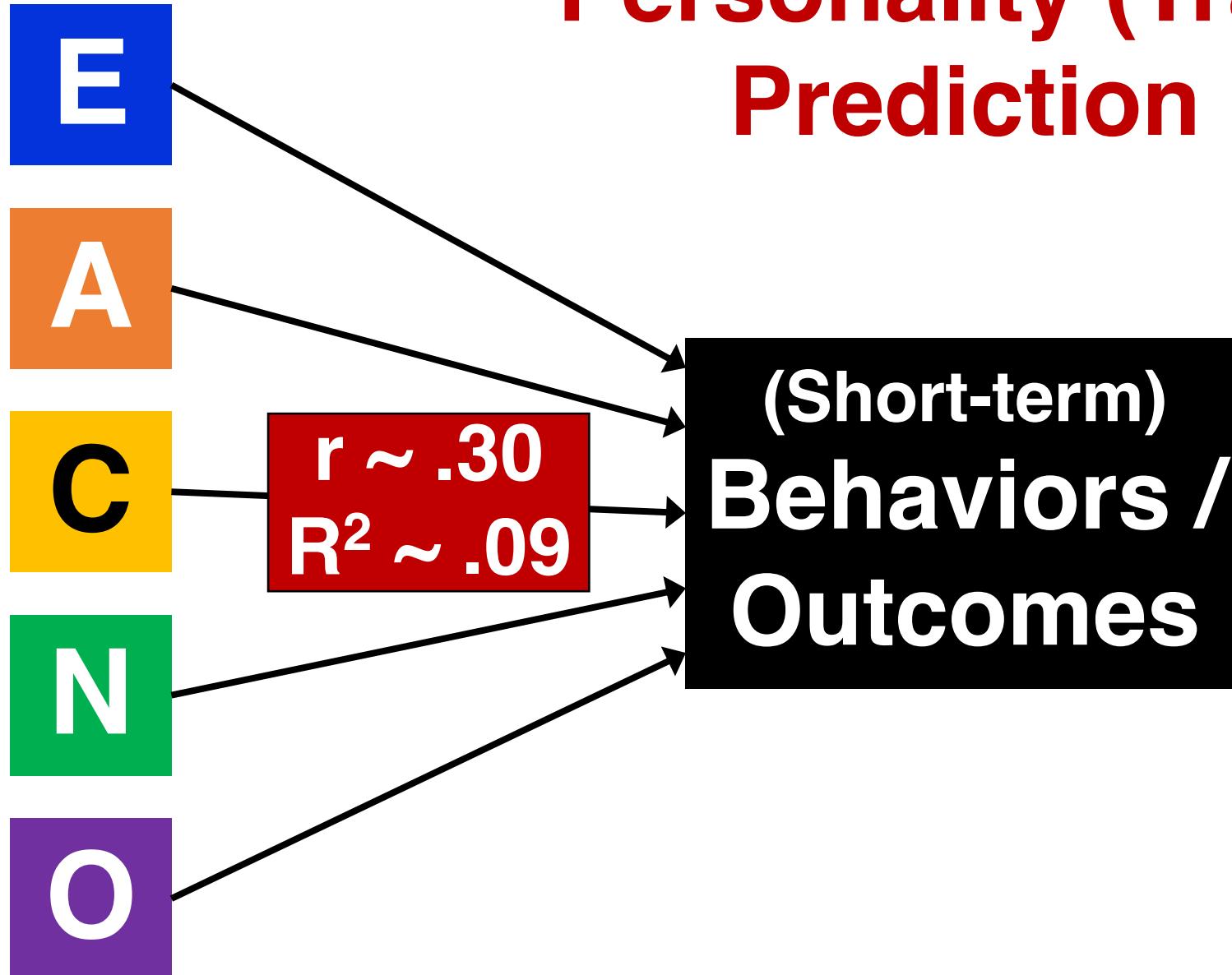
**Nomothetic  
Between-Person  
Variable Centered**

# Personality (Trait) Prediction

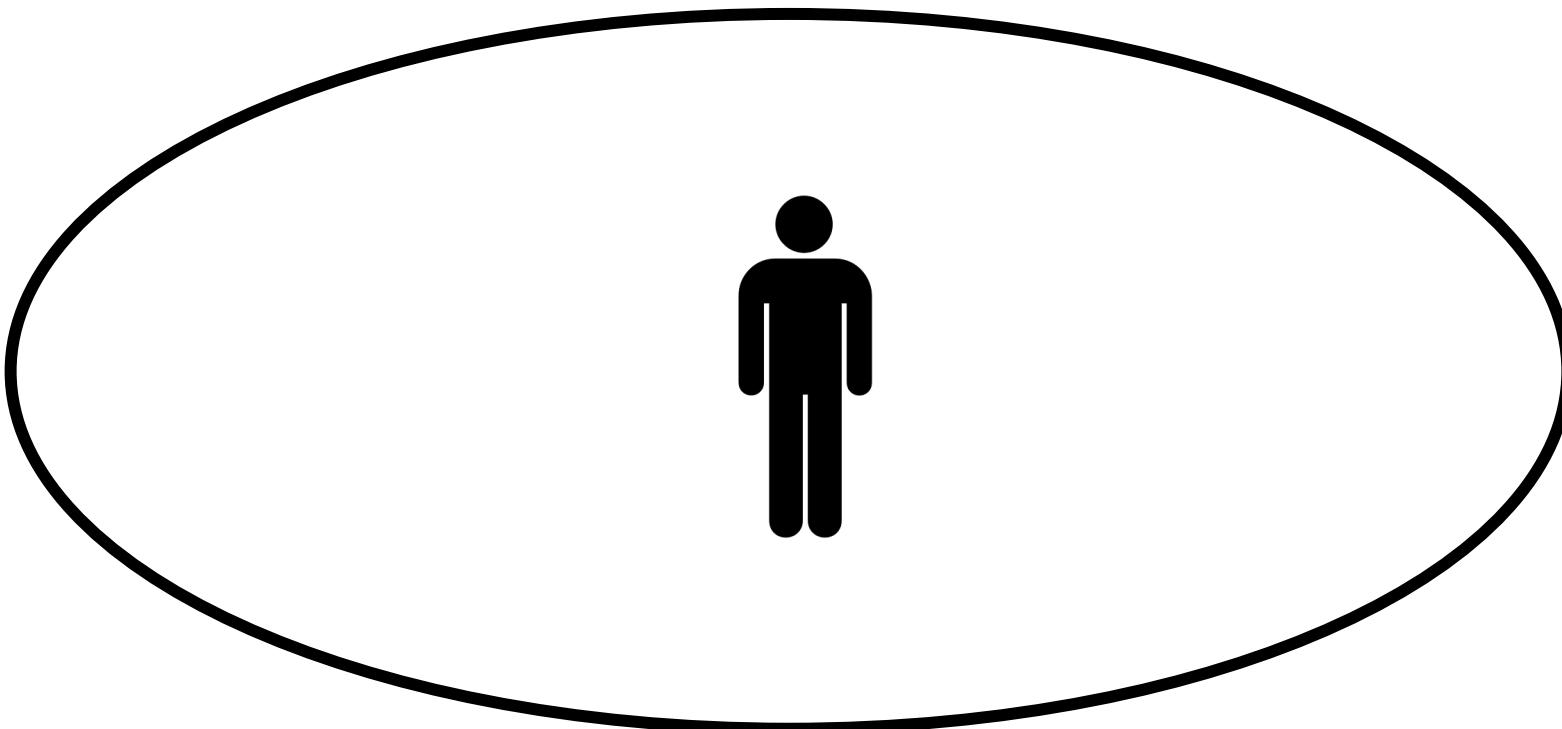




# Personality (Trait) Prediction



# Persons in Context



e.g., Lewin, 1936

# What is personality?

“Personality refers to those characteristics of the person that account for **consistent patterns of feelings, thinking, and behaving**.”

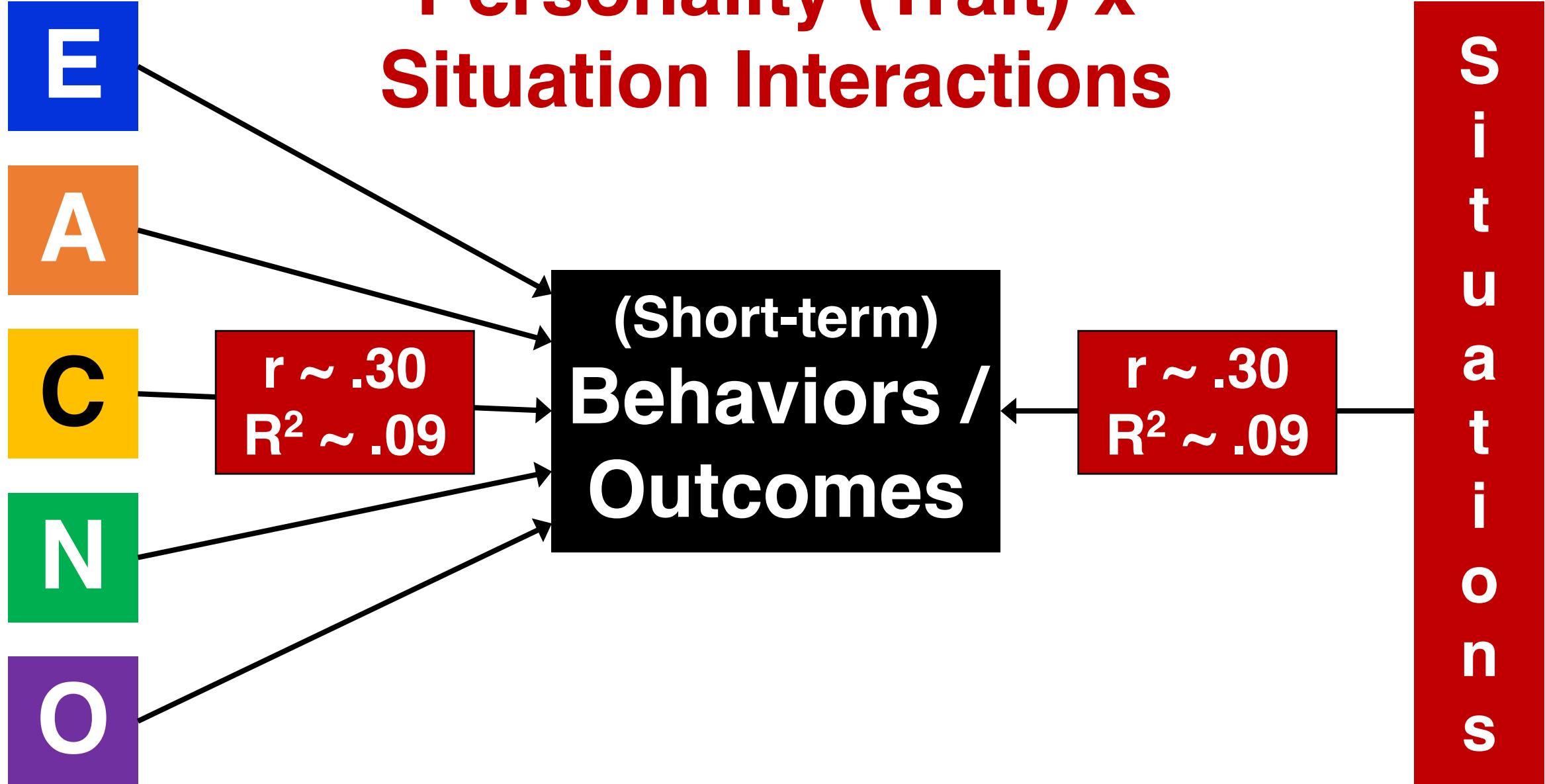
(Pervin, Cervone & John, 2005, p. 6)

# What is personality?

“Personality is the **dynamic organization within the individual** of those psychophysical systems that determine his **unique adjustments to the environment**.”

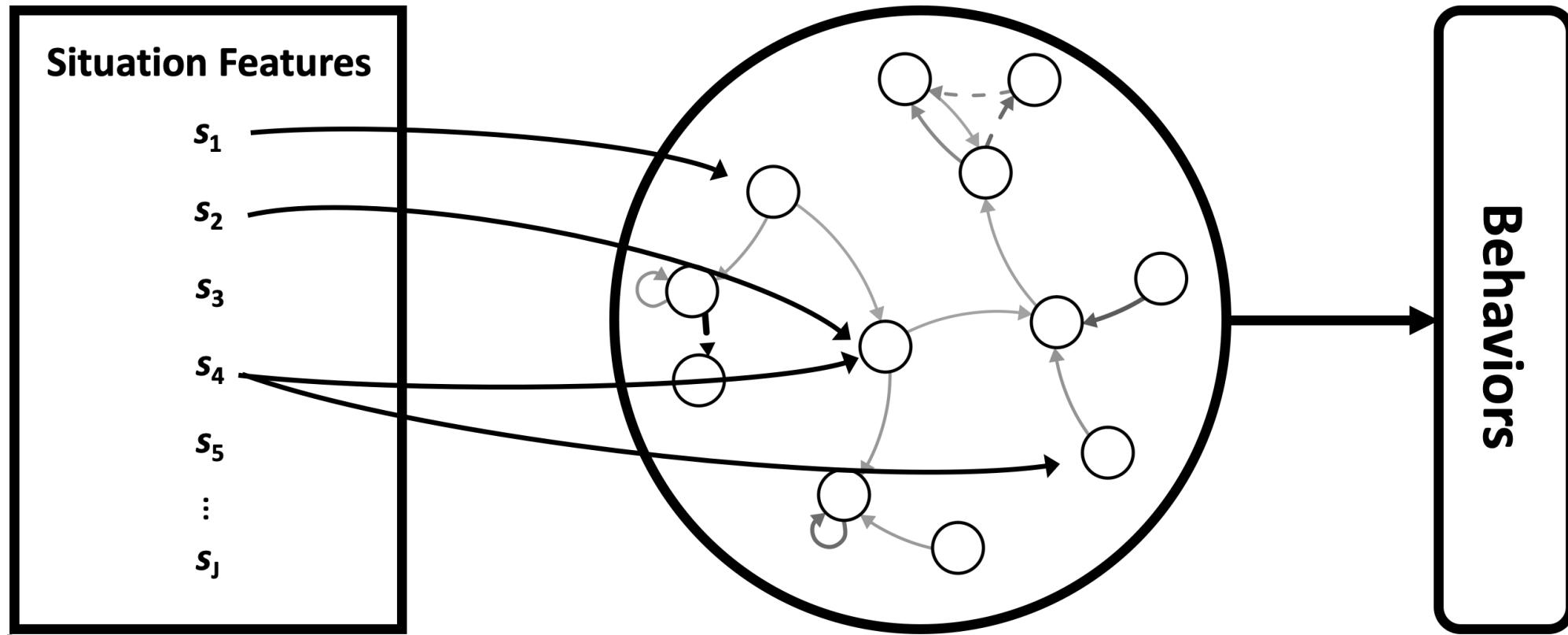
(Allport, 1937, p. 32)

# Personality (Trait) x Situation Interactions



# Persons in Context:

## Personality as a Dynamic Complex System with Many Components



# Research Questions

1

What are the limits of prediction when using ensembles of person and situation factors in a machine learning framework?

2

For whom do person or situation factors better predict short- and long-term outcomes?

# OUTLINE

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**What is personality and how can it inform behavioral forecasting**

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**Precision Medicine and Personality Forecasting:  
Targeting and Tailoring**

**3**

**Empirical Example: Behavioral Forecasting in  
Everyday Life Using Personalized Machine  
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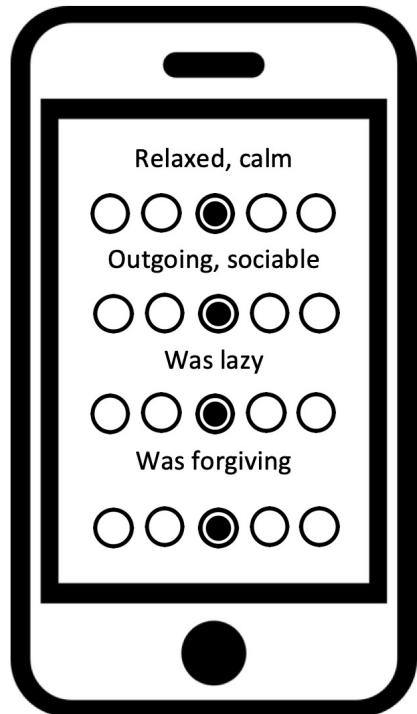
**Lingering Challenges and Ongoing Directions**

## Basic Surveys



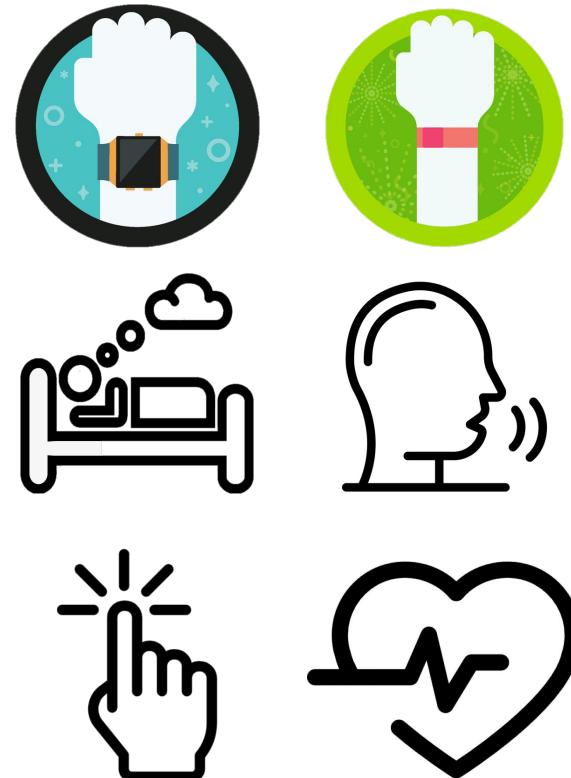
e.g., Beck & Jackson,  
2021c, *JPSP*

## ESM / EMA



e.g., Beck & Jackson,  
2020a, *JPSP*

## Mobile Sensing



e.g., Beck & Jackson,  
2022, *Psych Sci*

## Open-Ended Responses



e.g., Beck & Jackson,  
2021d, *EJP*

Basic  
Surveys

ESM / EMA

Mobile  
Sensing

Open-Ended  
Responses



# How do we use these to forecast a person?



e.g., Beck &  
Jackson, 2022a, *JPSP*

e.g., Beck &  
Jackson, 2020a, *JPSP*

e.g., Beck &  
Jackson, 2022a,  
*Psych Sci*

e.g., Beck &  
Jackson, 2021d, *EJP*

# Precision Medicine

## Targeting

Identifying risk-factors of an outcome or populations of people most likely to respond to a treatment

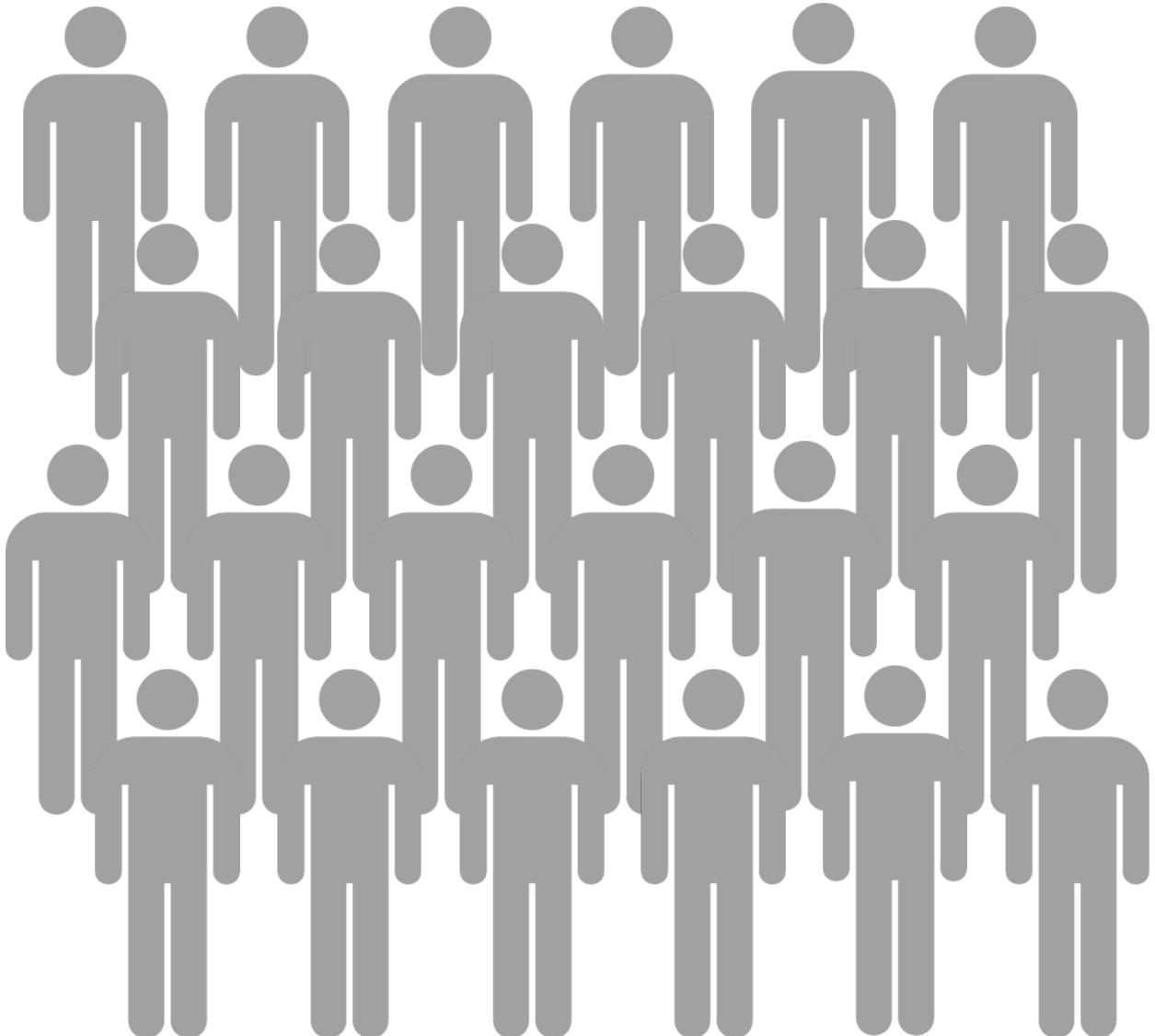
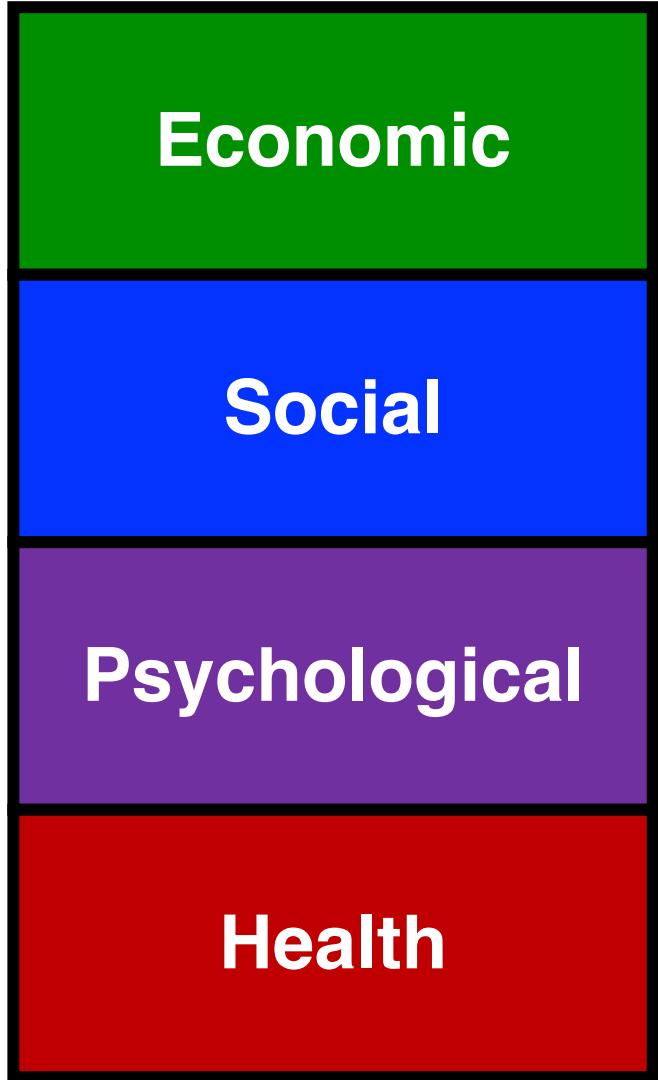
## Tailoring

Tailoring treatment of a person to their physical or digital biomarkers

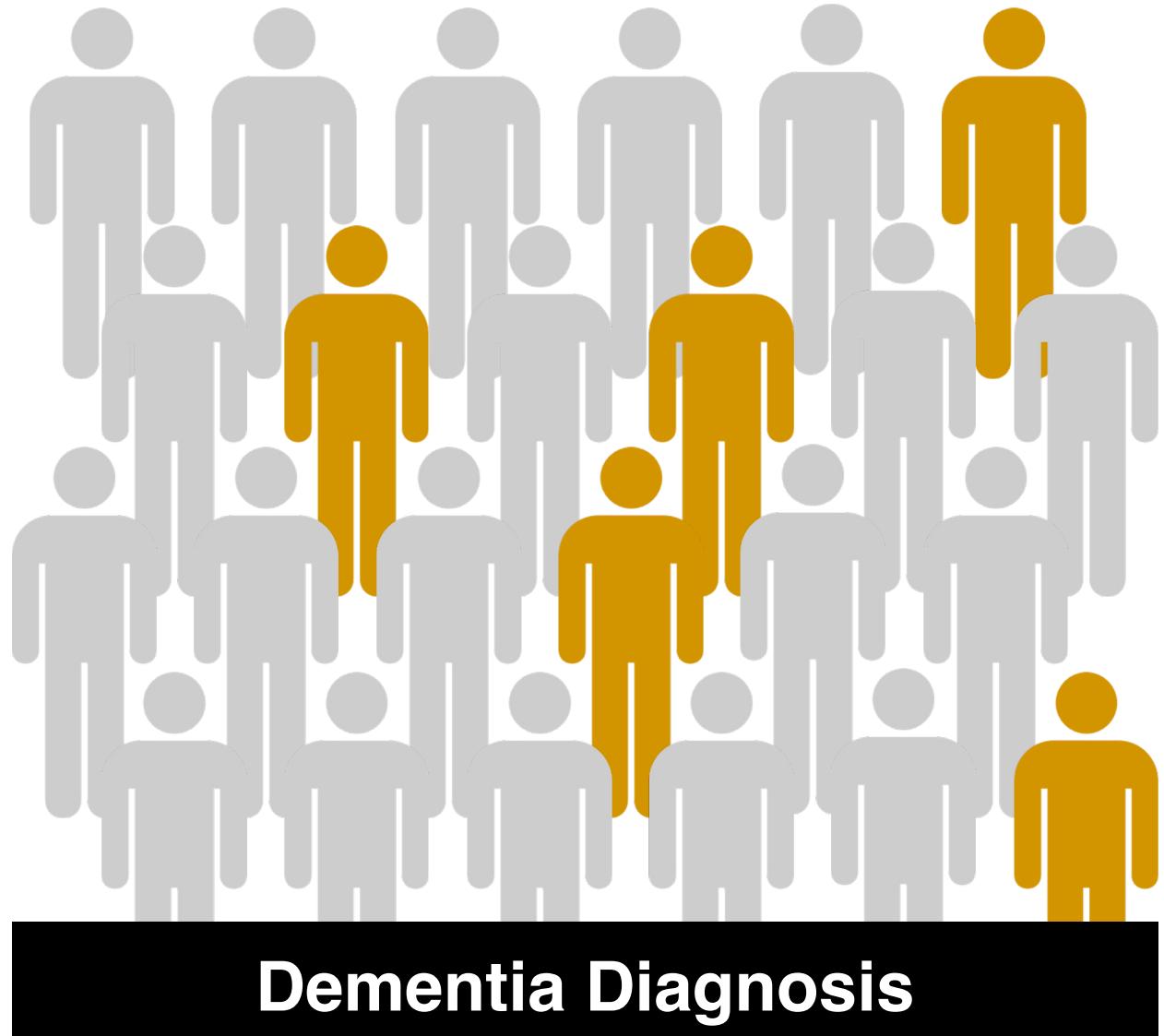
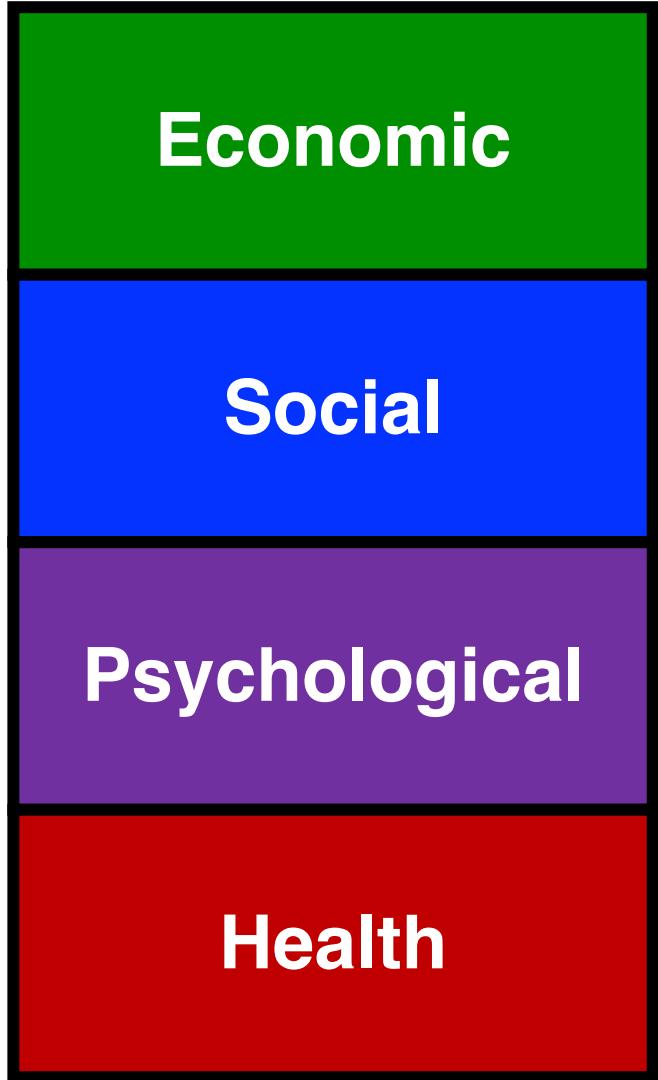
# Targeting: Building Algorithms to Predict Who's At Risk

Economic	Social	Psychological	Health
<ul style="list-style-type: none"><li>• Income</li><li>• Debt</li><li>• Education</li><li>• Occupational Prestige</li><li>• Parental Education</li><li>• Parental Occupation</li><li>• ... And more!</li></ul>	<ul style="list-style-type: none"><li>• Marital Status (e.g., married)</li><li>• Social participation</li><li>• Social support</li><li>• Isolation</li><li>• Household Composition</li><li>• Childbearing and rearing</li><li>• ... and more!</li></ul>	<ul style="list-style-type: none"><li>• Big Five Personality</li><li>• Life Satisfaction</li><li>• Domain Satisfaction</li><li>• Subjective Stress</li><li>• Coping Strategies</li><li>• Loneliness</li><li>• ... And more!</li></ul>	<ul style="list-style-type: none"><li>• Chronic conditions</li><li>• Self-Rated Health</li><li>• Health Behaviors</li><li>• Alcohol / tobacco use</li><li>• Healthcare utilization</li><li>• BMI</li><li>• ... And more!</li></ul>

# Targeting: Building Algorithms to Predict Who's At Risk



# Targeting: Building Algorithms to Predict Who's At Risk



# Targeting: Building Algorithms to Predict Who's At Risk

Econo

Soci

Psychol

Health

**Can we classify individuals with > .90 accuracy in a new sample?**

**Which set of features performs the best?**

Dementia Diagnosis

# Precision Medicine

## Targeting

Identifying risk-factors of a disease or populations of people most likely to respond to a treatment

Build algorithms that can accurately predict who is at risk, so they can be targeted for treatment.

## Tailoring

Tailoring treatment of a person to their physical or digital biomarkers

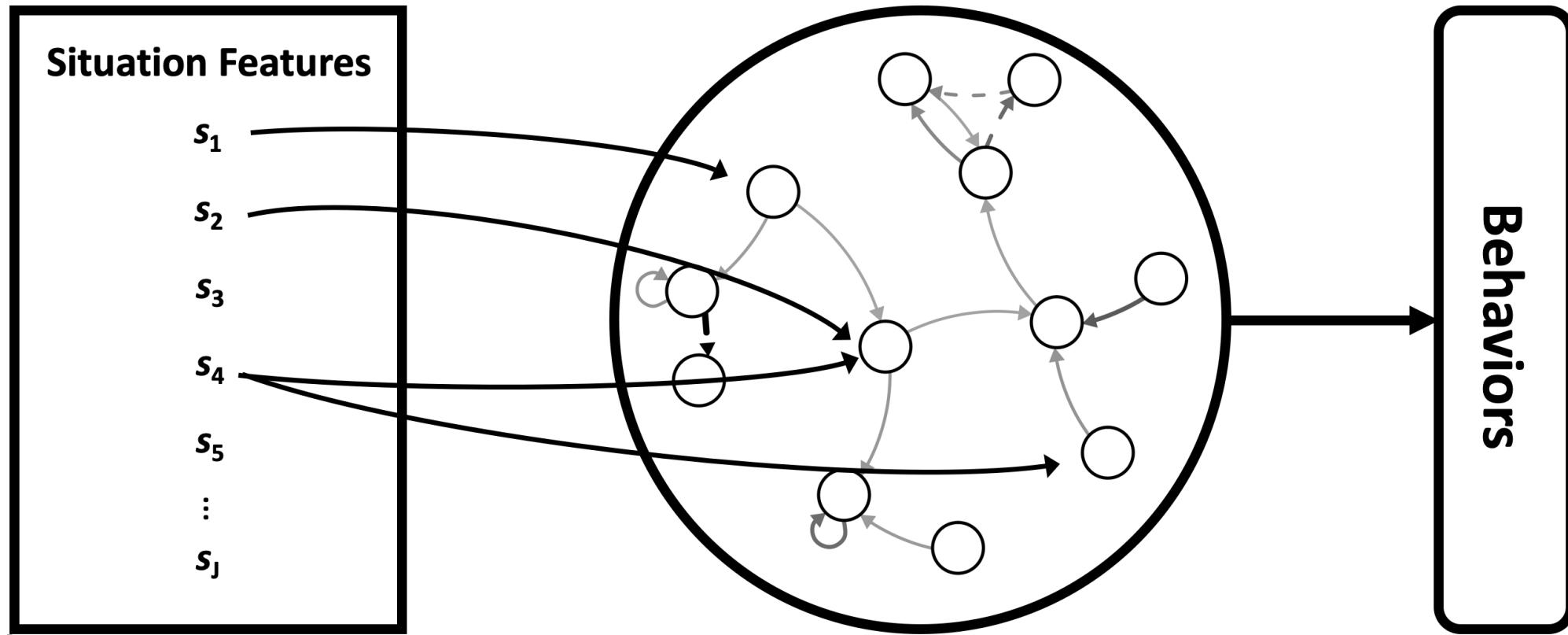
# What is personality?

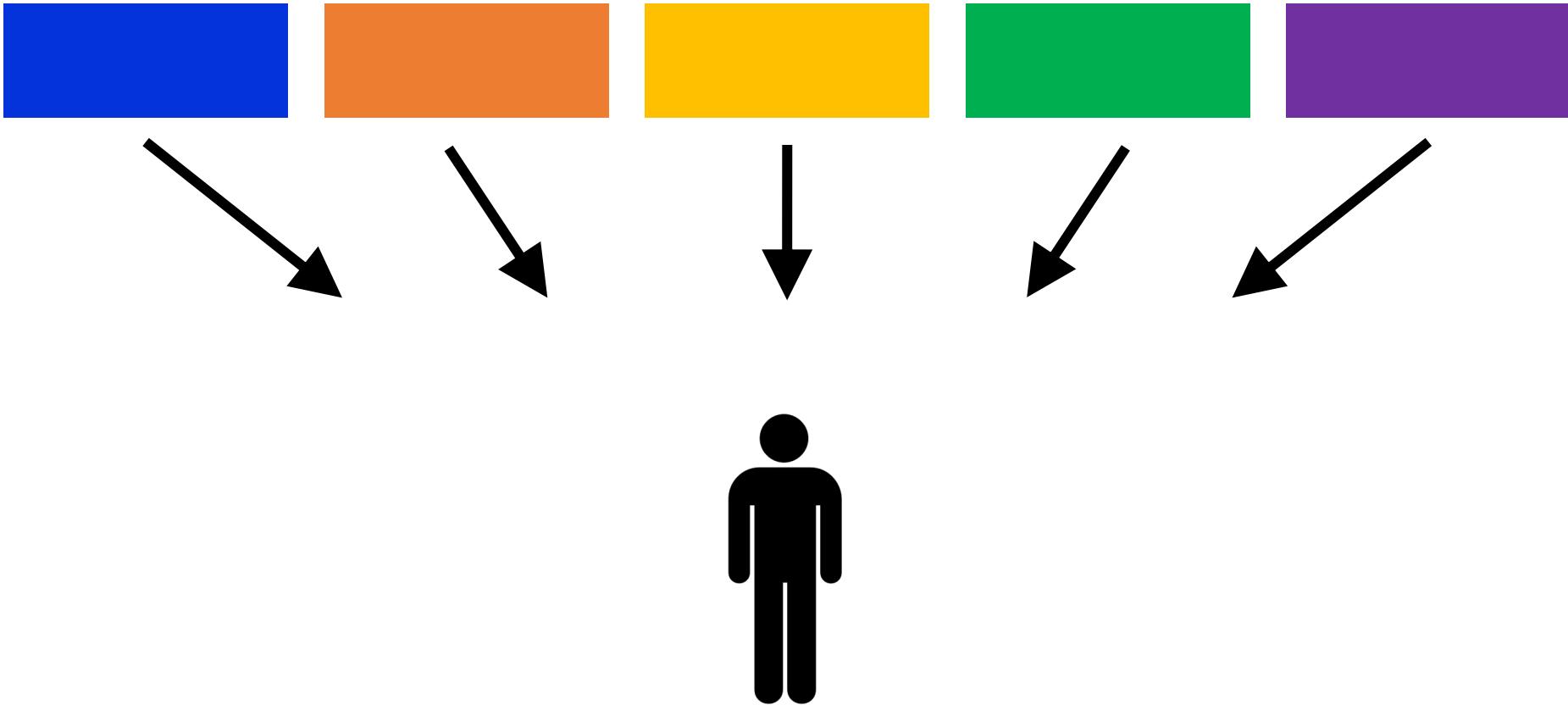
“Personality is the **dynamic organization** within the individual of those **psychophysical systems** that determine his **unique adjustments** to the environment.”

(Allport, 1937, p. 32)

# Persons in Context:

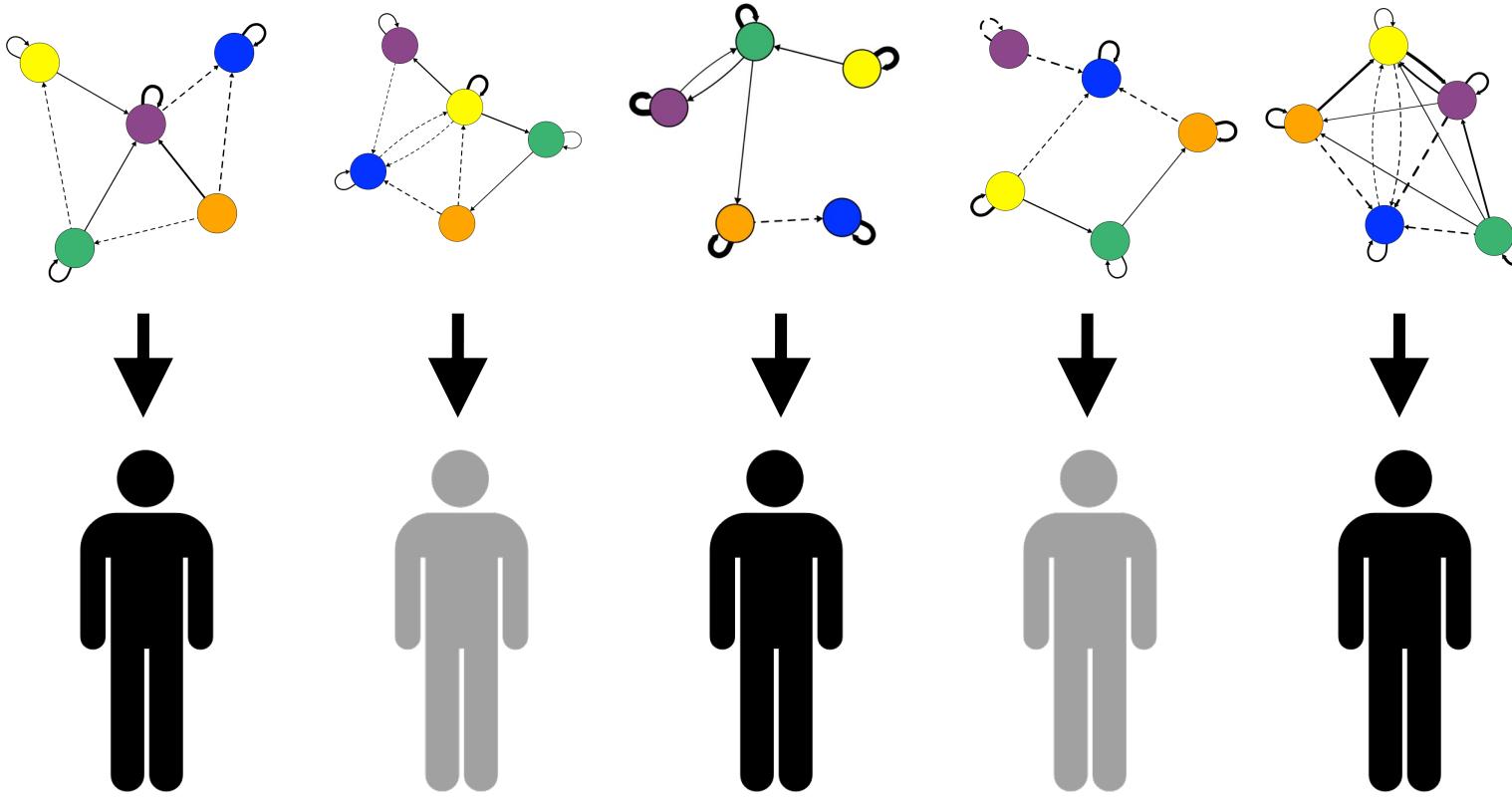
## Personality as a Dynamic Complex System with Many Components





# Idiographic Person-Specific

e.g., Beck & Jackson, 2020a, *JPSP*; 2020b, *CDPS*



**Idiographic  
Person-Specific**

# Critical Assumptions of Trait and Situation-Based Approaches

**Situations and experiences  
should have similar  
consequences across people.**

**People with similar levels of a  
personality characteristic  
should behave in similar ways.**



# Alternative Assumptions

## Idiographic, Persons-in-Contexts Approaches

Situations and experiences  
should have *different*  
consequences across people.

People with similar levels of a  
personality characteristic *may*  
*not* behave in similar ways.



# Tailoring: Identifying antecedents & providing personalized solutions



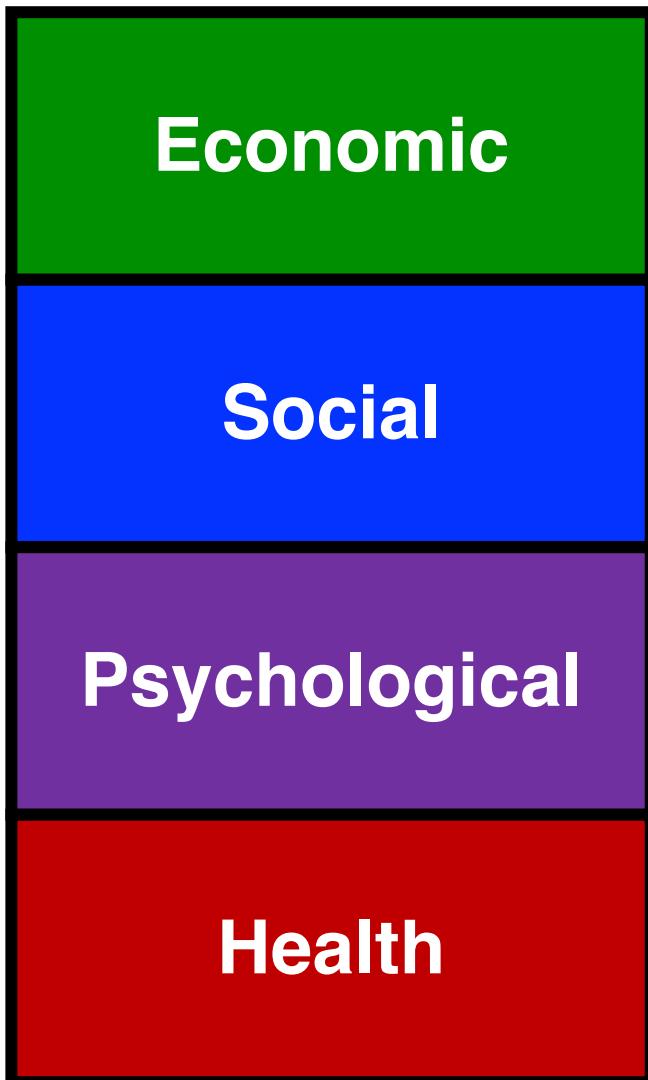
Dementia Diagnosis

# Tailoring: Identifying antecedents & providing personalized solutions



Dementia Diagnosis

# Tailoring: Identifying antecedents & providing personalized solutions

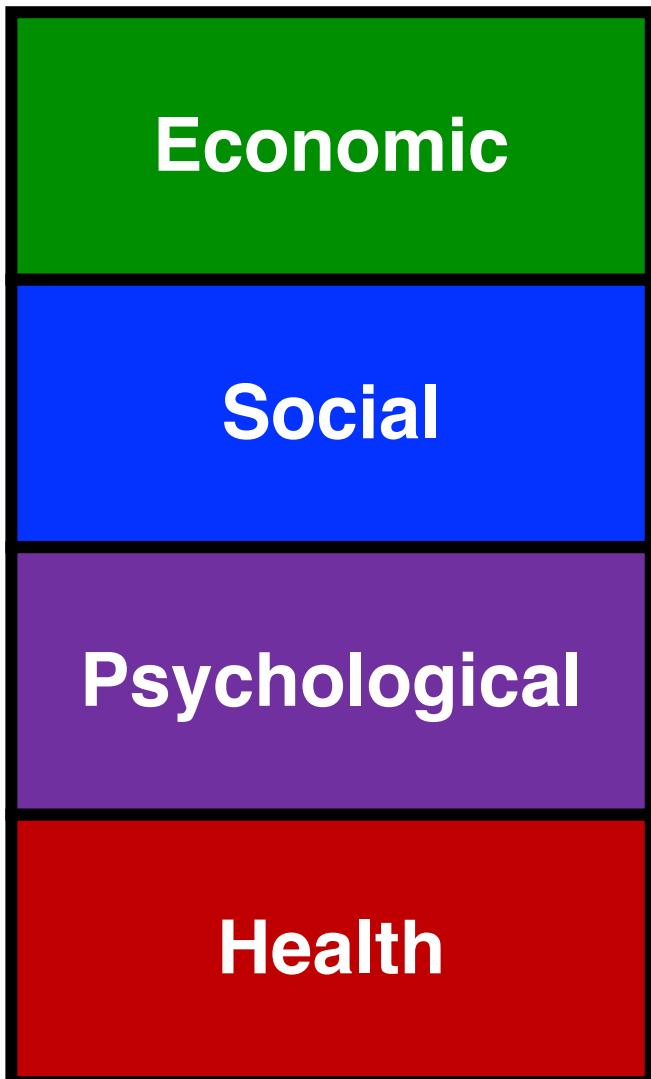


**Cognitive Functioning**



**Dementia Diagnosis**

# Tailoring: Identifying antecedents & providing personalized solutions

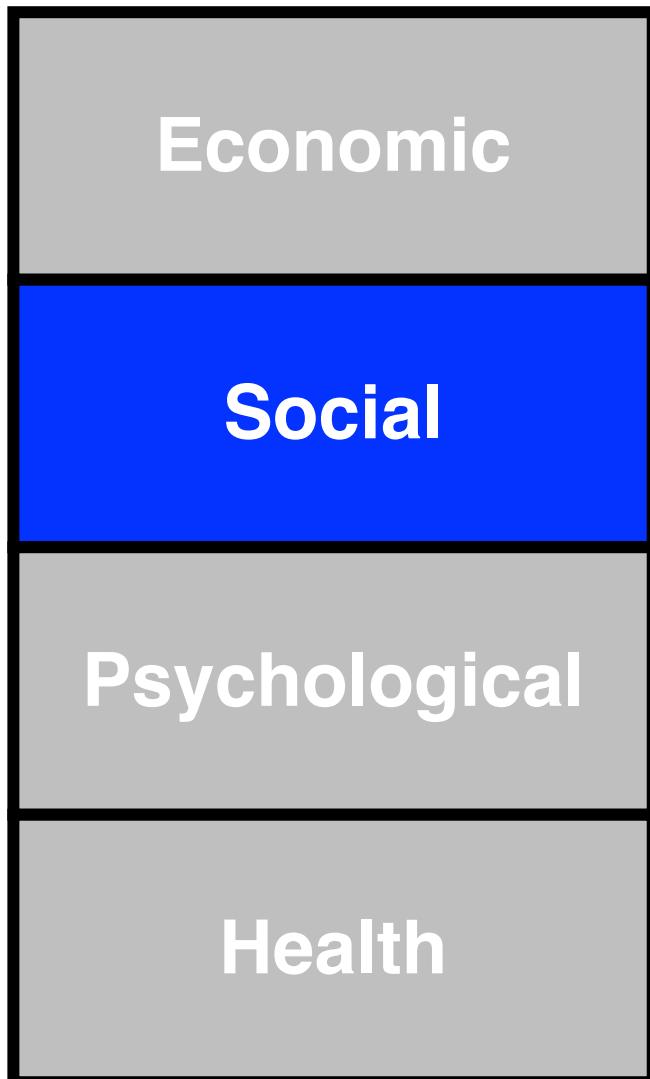


**Cognitive Functioning**



**Dementia Diagnosis**

# Tailoring: Identifying antecedents & providing personalized solutions



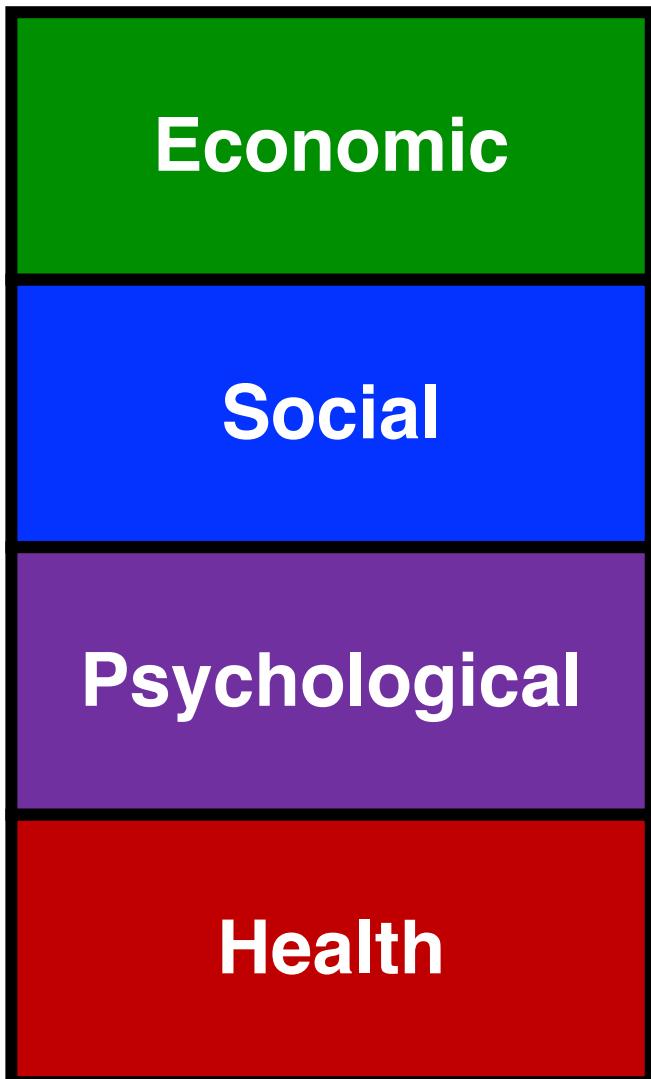
- Interacting with others (+)
- Arguments (-)

## Cognitive Functioning



## Dementia Diagnosis

# Tailoring: Identifying antecedents & providing personalized solutions

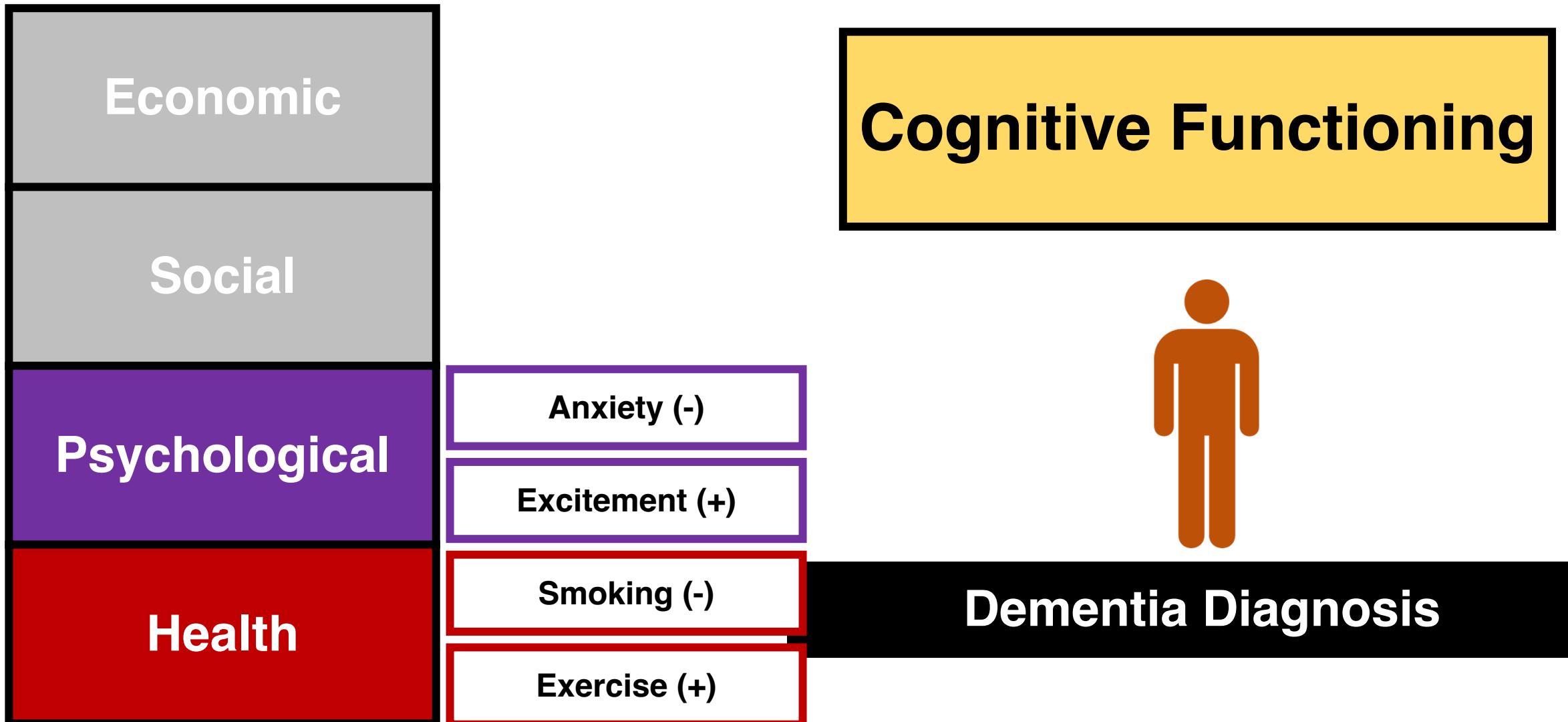


**Cognitive Functioning**



**Dementia Diagnosis**

# Tailoring: Identifying antecedents & providing personalized solutions



# Precision Medicine

## Targeting

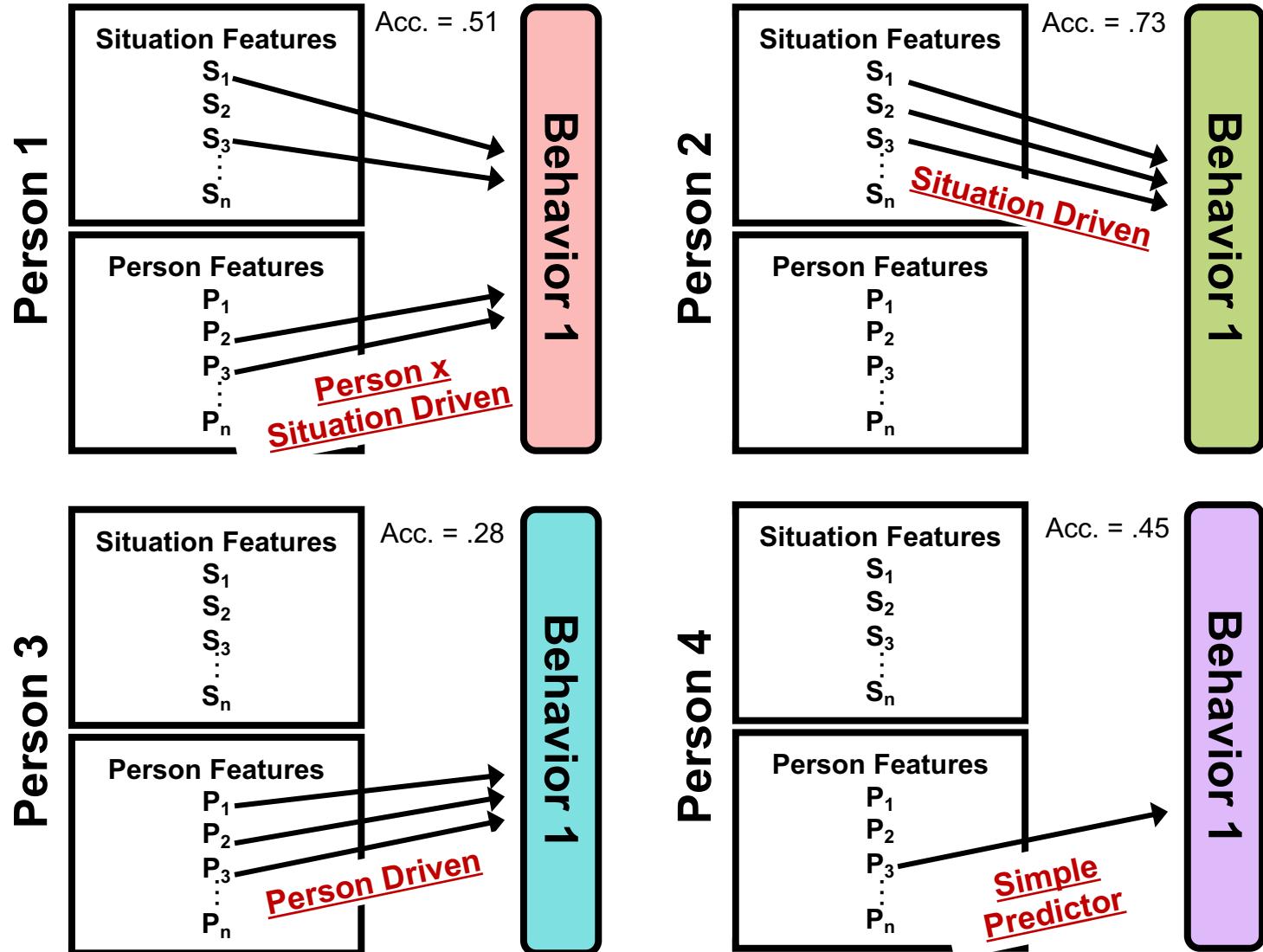
Identifying risk-factors of a disease or populations of people most likely to respond to a treatment

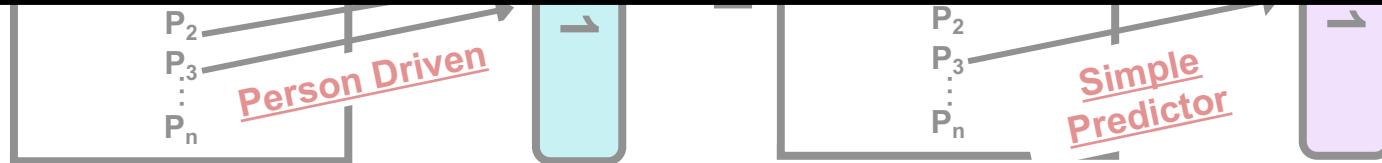
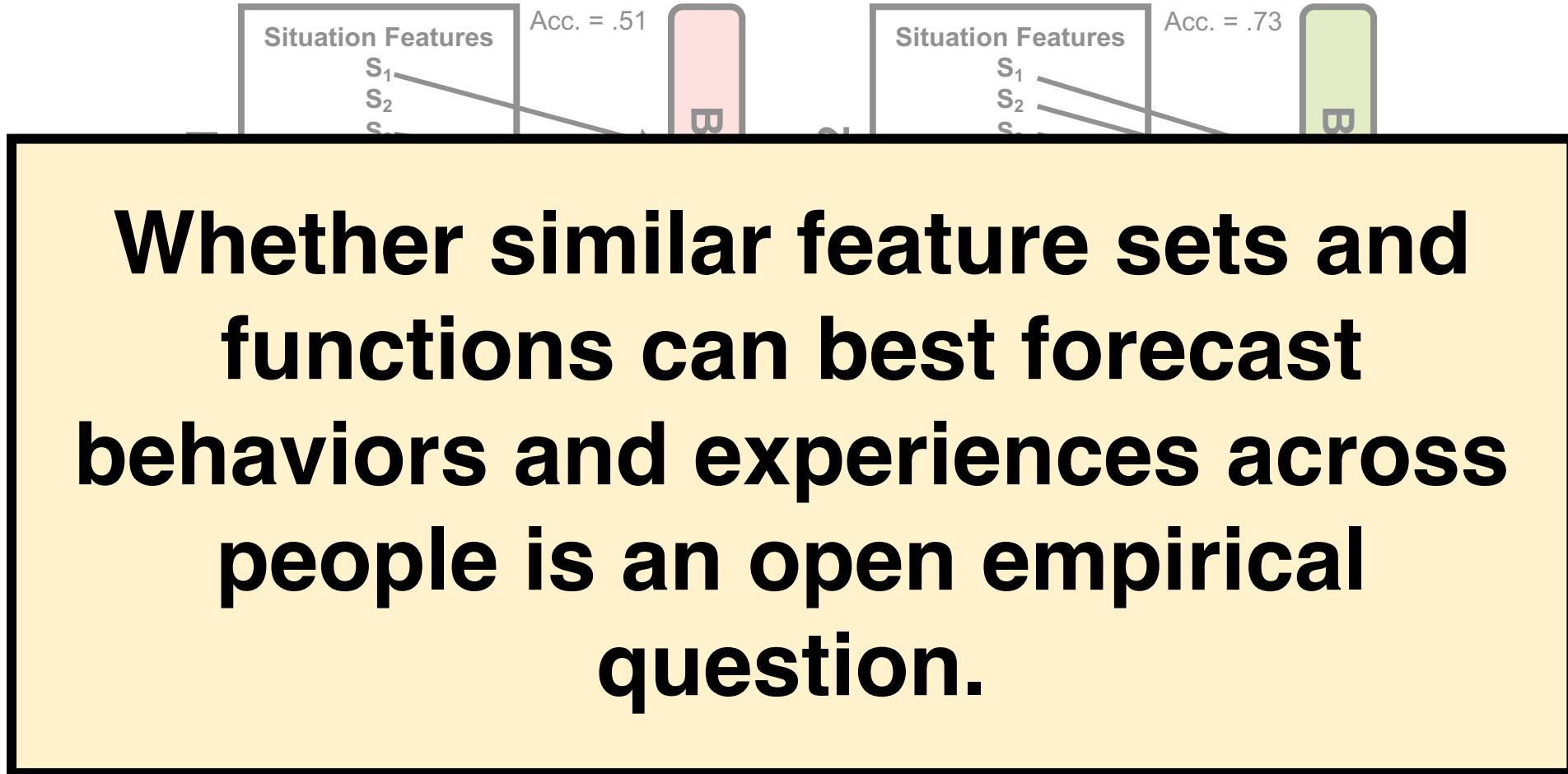
Build algorithms that can accurately predict who is at risk, so they can be targeted for treatment.

## Tailoring

Tailoring treatment of a person to their physical or digital biomarkers

Build algorithms that can actually predict momentary relevant health markers and tailor treatment to most predictive features.





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# EMPIRICAL DEMONSTRATION



Beck & Jackson (2022, *Psychological Science*)

# Questions

**1**

**How well and for whom can we predict behaviors and experiences?**

**2**

**Do certain categories of features (e.g., persons, situations, and time) out-predict others?**

**3**

**Are there individual differences in which features play the strongest roles?**

# Measures

## Personality & Affect

Full BFI-2, administered with 75% planned missingness

Subset of the PANAS-X (items redundant with the BFI-2 removed)

5-point Likert-like scale from 1 “disagree strongly” to 5 “agree strongly.”

Binary indicators of procrastination, loneliness, interacting, arguments, feeling sick, feeling tired, studying

0 = no, 1 = yes

## Situations

Binary indicators generated by undergraduate research assistants

0 = no, 1 = yes

**Ultra-brief DIAMONDS scale**

3-point scale from 1 “not at all” to 3 “totally.”

## Outcomes

lead 1 (previous features predict future outcomes)

## Time

Derived from time stamps:

1. Time of day (morning, midday, evening, night)
2. Day of week

0 = no, 1 = yes

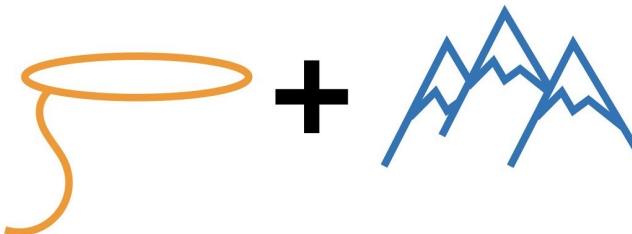
3. Linear, Quadratic, & Cubic Trends

4. 1 & 2 period sine and cosine

# Analytic Plan

3 machine learning classification methods:

## Elastic Net

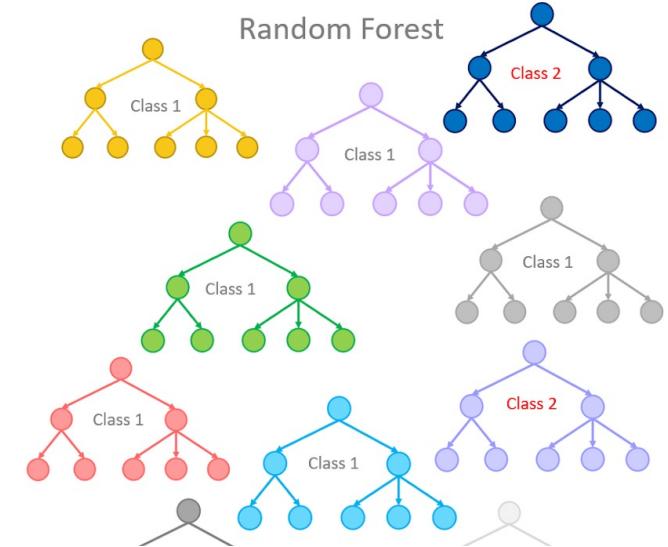


- Classification Accuracy
- Area under the receiver operating curve (AUC)

## BISCWIT



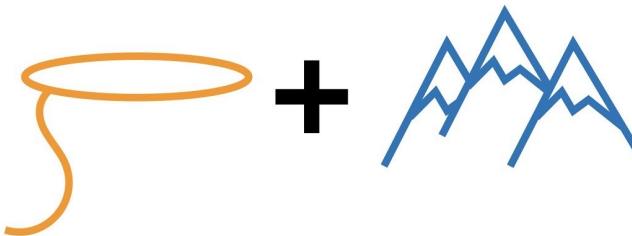
## Random Forest



# Analytic Plan

3 machine learning classification methods:

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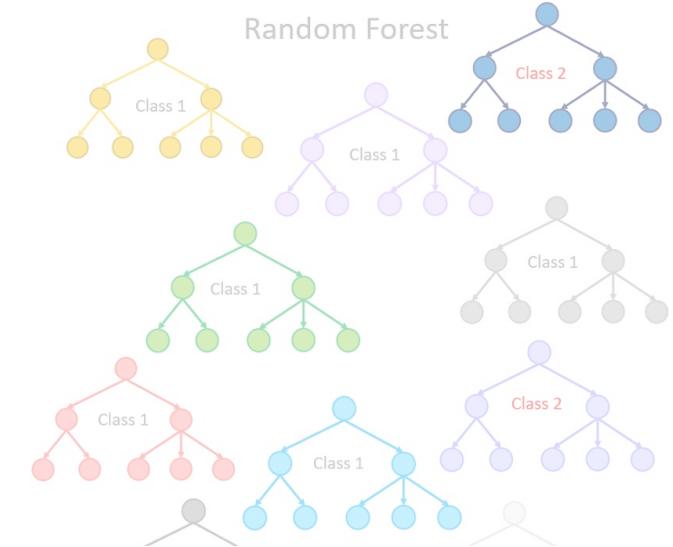


- Classification Accuracy
- Area under the receiver operating curve (AUC)

## BISCUIT



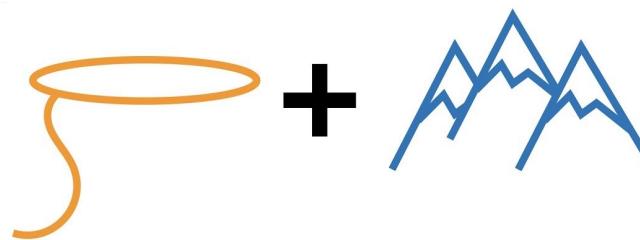
## Random Forest



# Analytic Plan

3 machine learning classification methods:

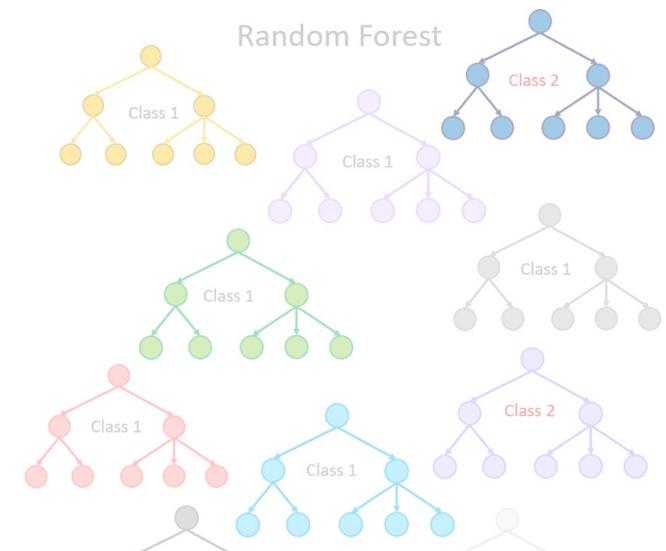
## Elastic Net



## BISCWIT



## Random Forest



- Classification Accuracy
- Area under the receiver operating curve (AUC)



# RESULTS

## Classification Accuracy

	Elastic Net	
	Median (SD)	N
<hr/>		
Procrastination		
Loneliness		
Argument		
Interacted		
Studying		
Sick		
Tired		



## Classification Accuracy

Elastic Net

**Classification accuracy was high, on average, with some variability across outcomes.**

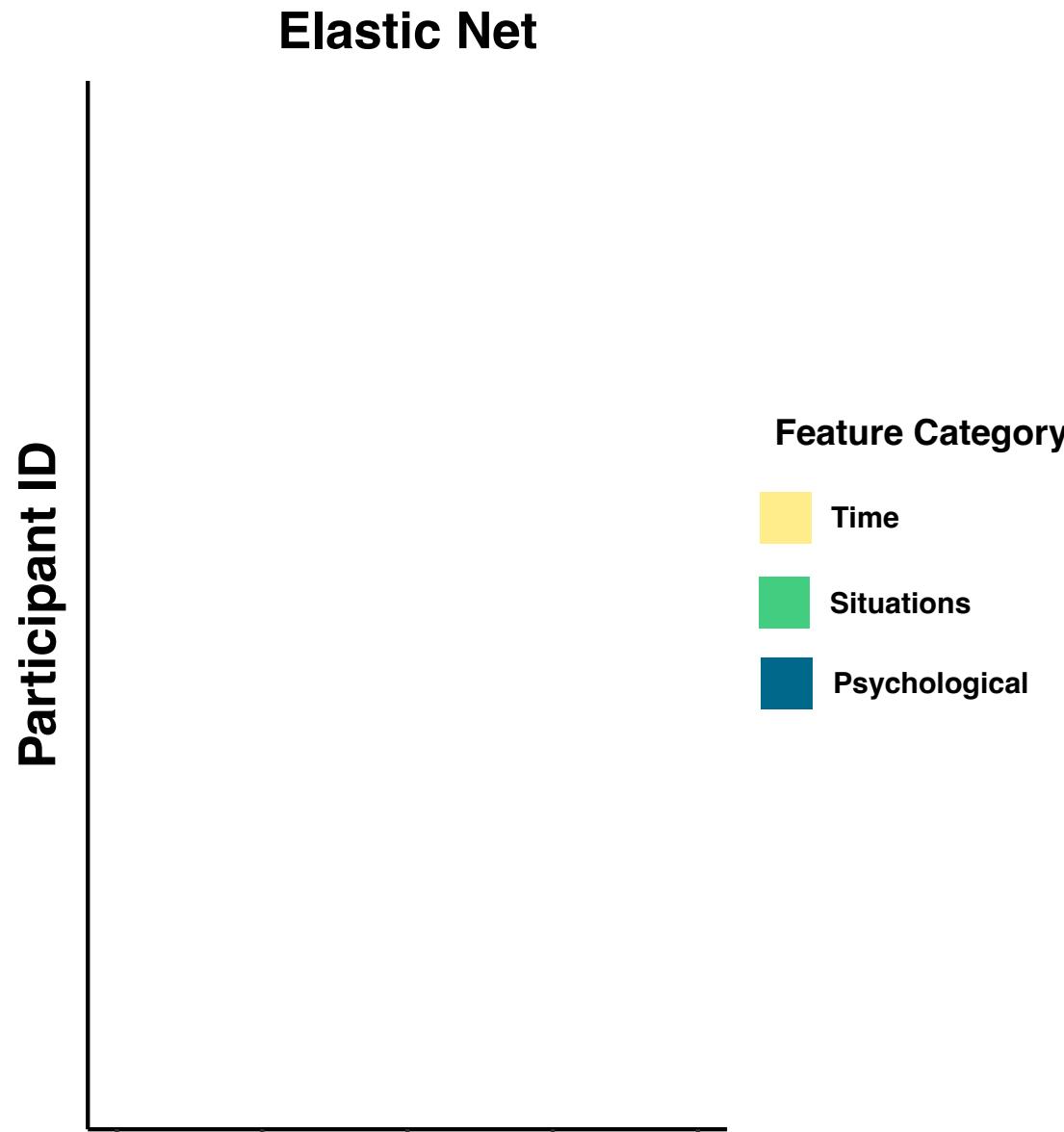
Sick

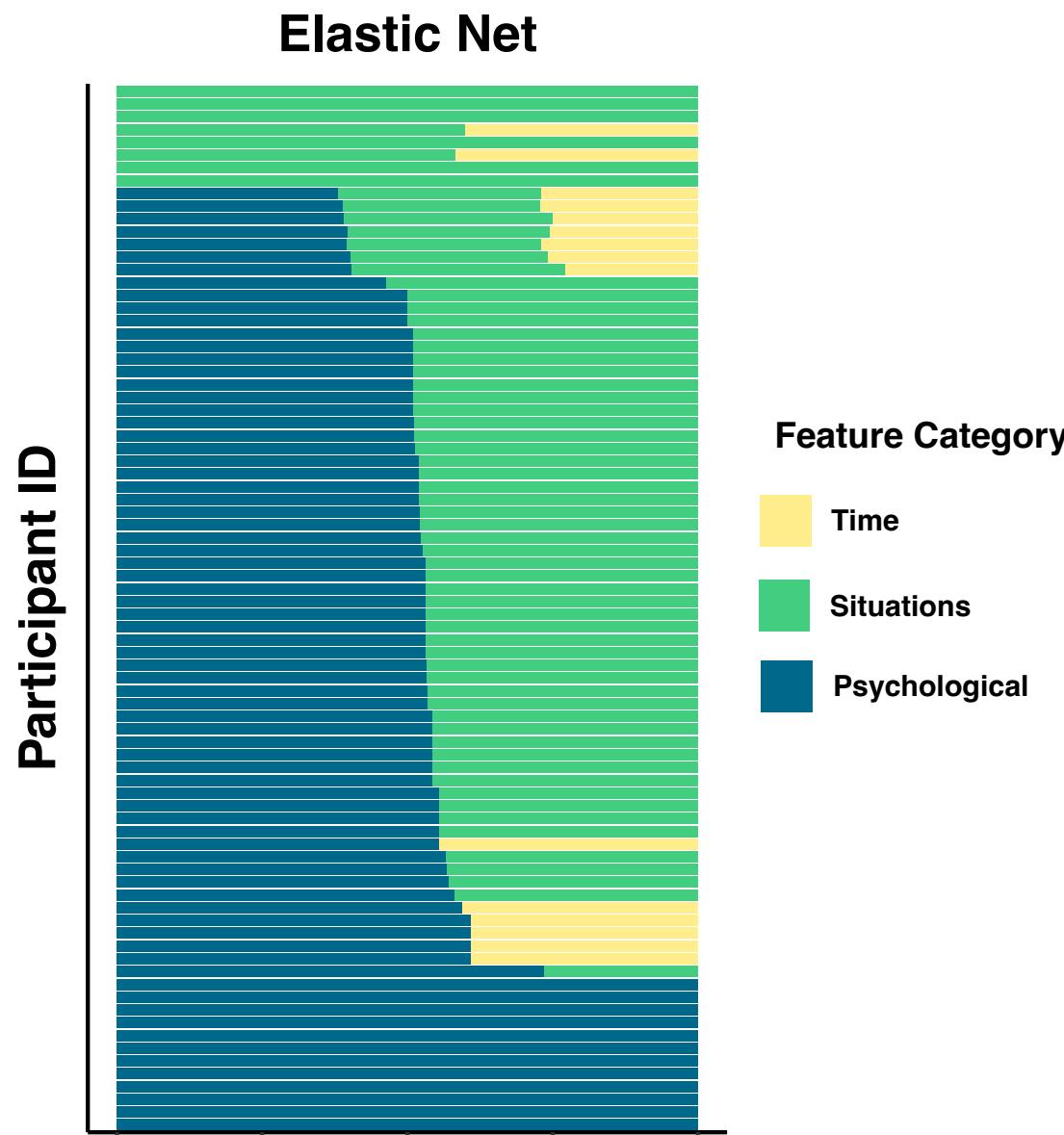
Tired



# Do certain categories of features out-predict others?

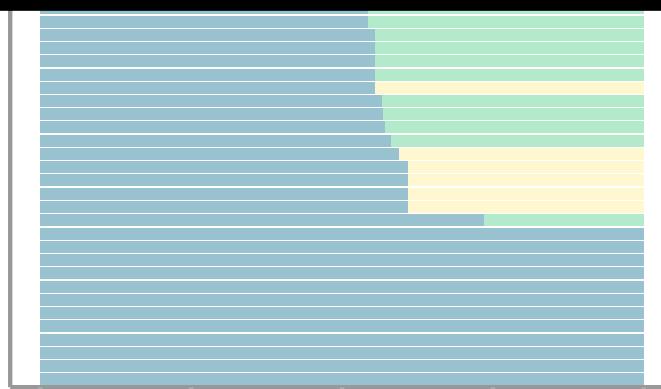






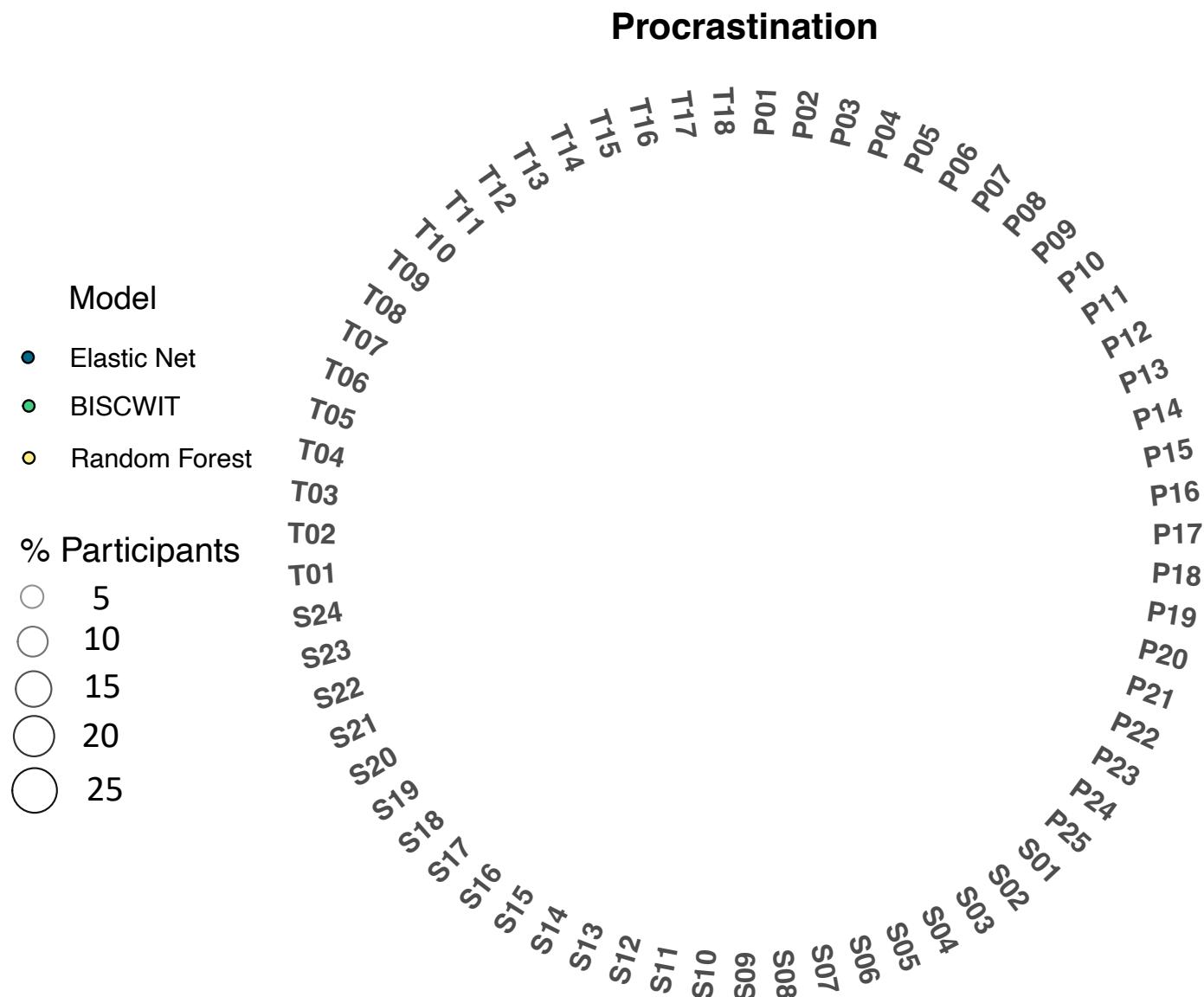
## Elastic Net

The relative contribution of person, situation, and timing features varies across people.

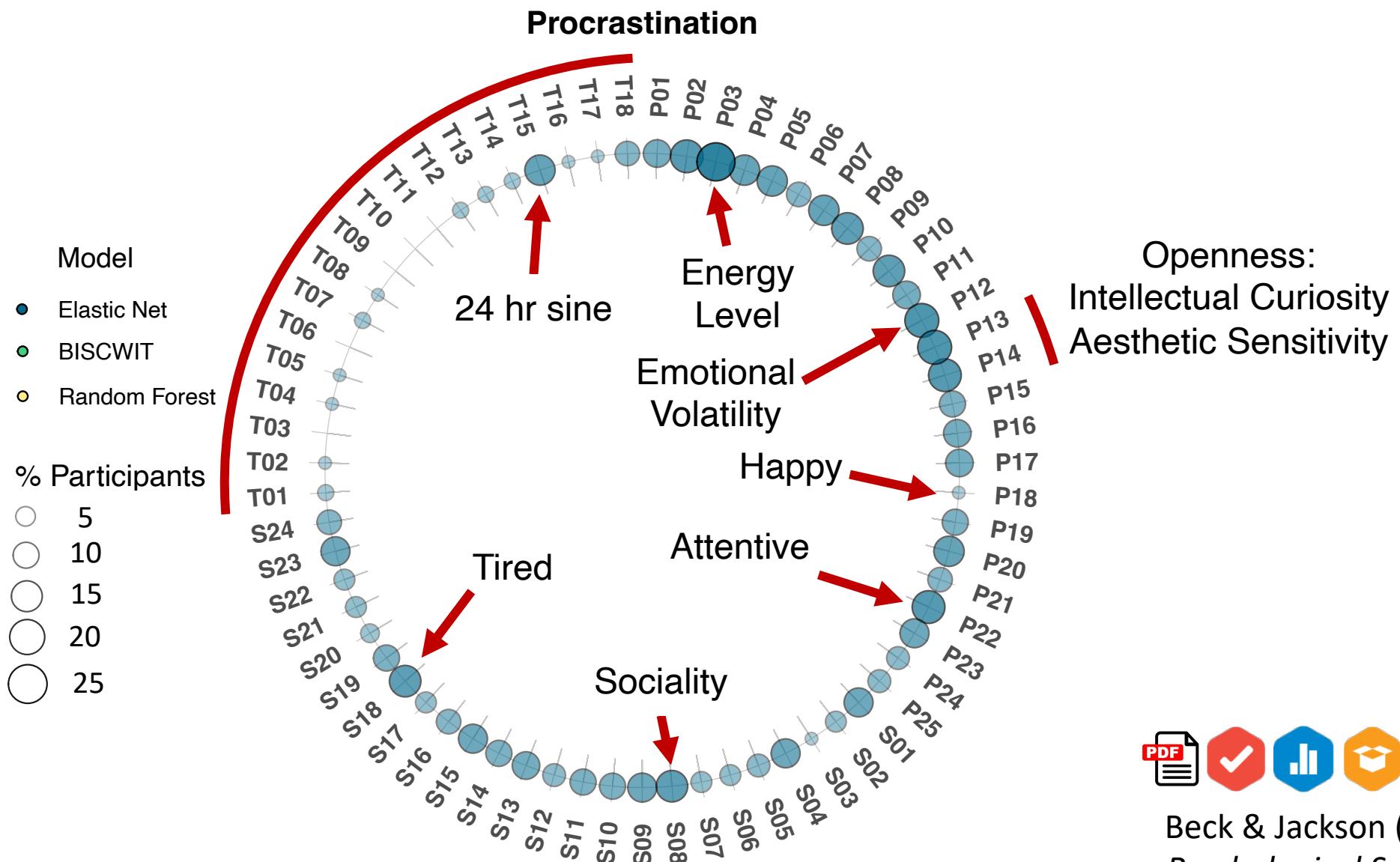


# Which features play the strongest roles?

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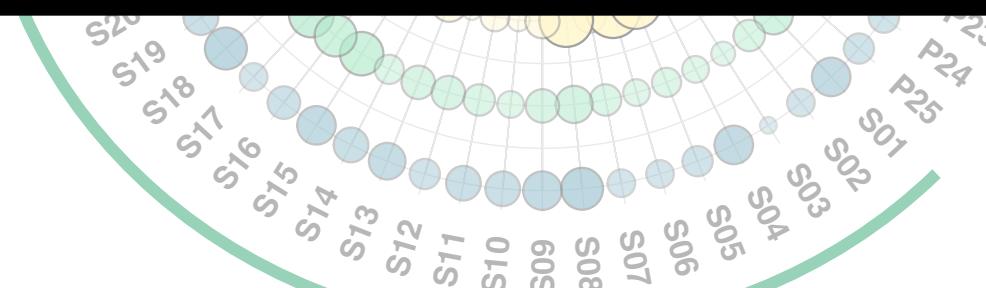


Procrastination

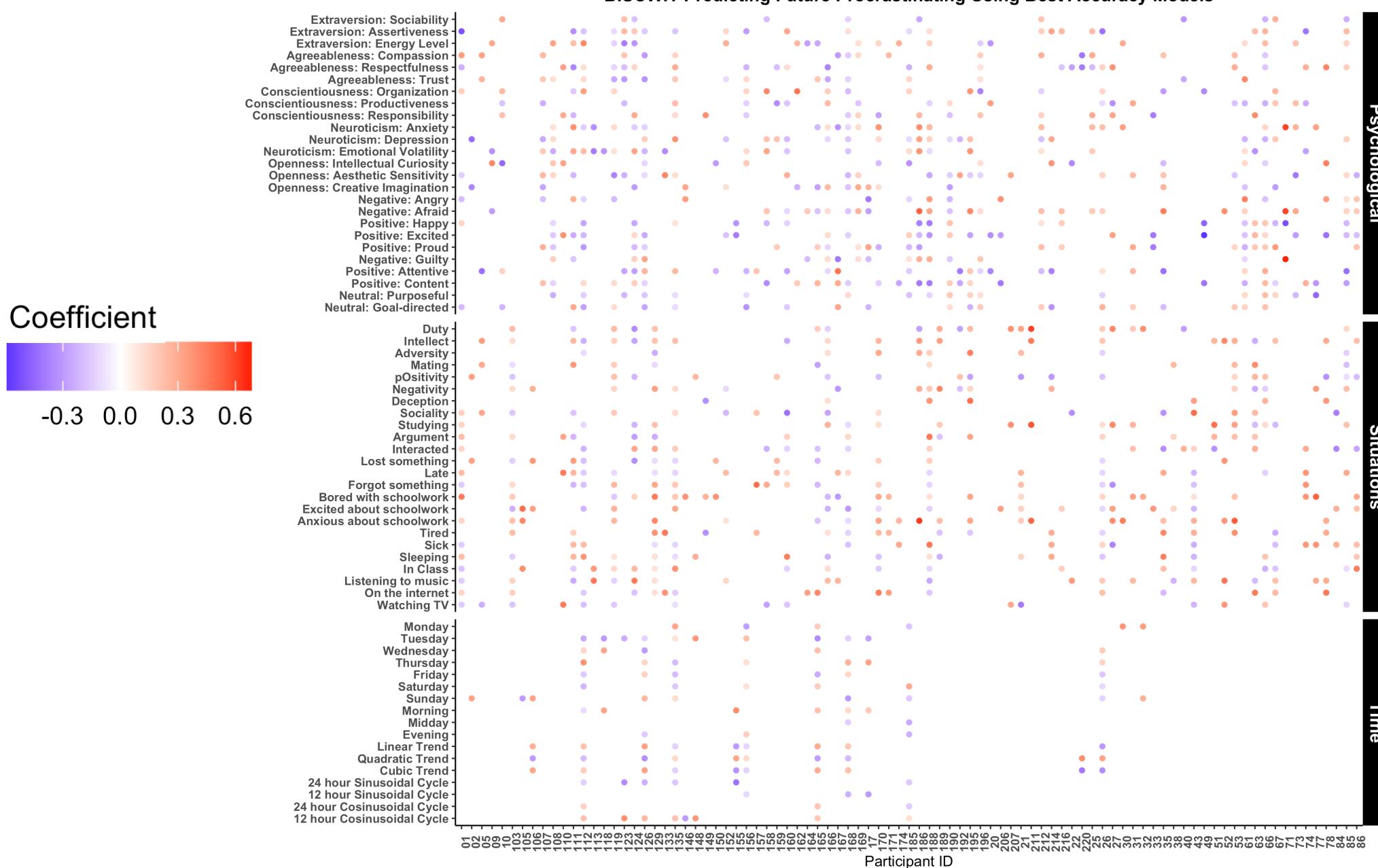
No one feature dominated the prediction of any outcome (max ~35%).

Behaviors & experiences have unique antecedents.

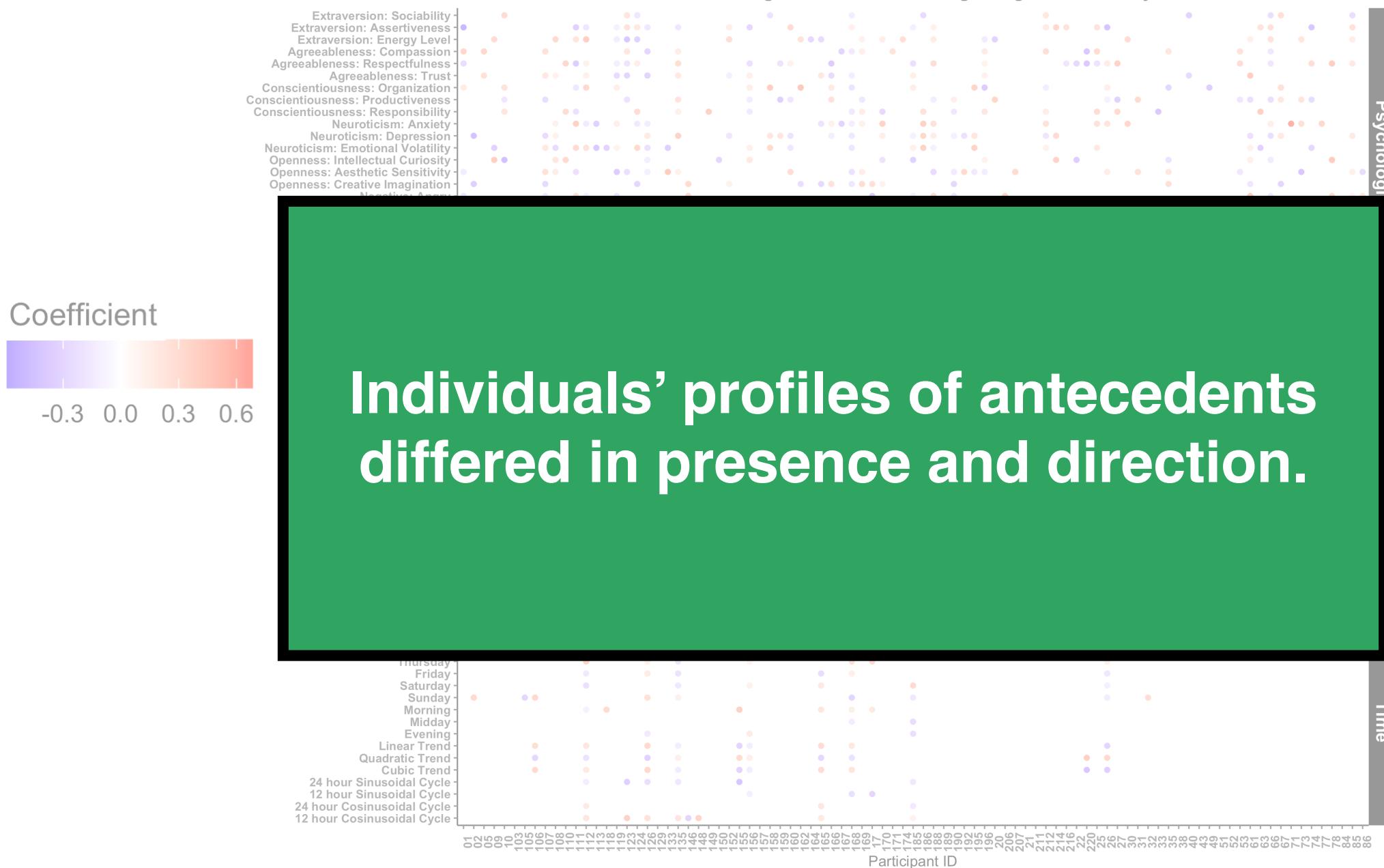
○ 25



# Which features play the strongest roles?



# Which features play the strongest roles?



# OUTLINE

- 1** **What is personality and how can it inform behavioral forecasting**
- 2** **Precision Medicine and Personality Forecasting: Targeting and Tailoring**
- 3** **Empirical Example: Behavioral Forecasting in Everyday Life Using Personalized Machine Learning Prediction Models**
- 4** **Lingering Challenges and Ongoing Directions**

# **What are we missing when we use the same measures for everyone?**

We have no idea. That's an empirical question!

# What are we missing when we use the same measures for everyone?

## Content

**Hypothesis:** People will generate content that doesn't overlap with the Big Five or other typical shared indicators we measure.

## Variability

**Hypothesis:** People will show more variability and use the full scale more for unique items than shared items, on average.

## Predictive Utility

**Hypothesis:** Unique items will improve predictive utility and play important roles in personalized prediction models.

# The Personalizing Personality Pilot Study

## Study Design

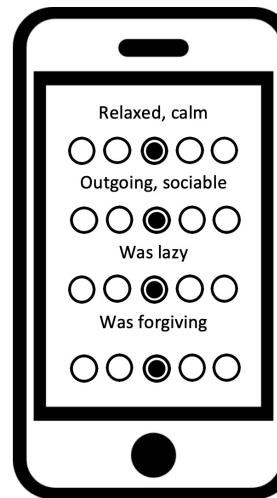
**UCDAVIS**

 N = 200



### Baseline Surveys

- Big Five Personality
- Cardinal Traits
- Demographics
- **Unique Item Generation**
- ...
- etc.



### Experience Sampling Method (ESM)

5 x / day for 3 weeks (*max n = 105*)

- Big Five Personality States
- Unique, participant generated “Cardinal States”
- DIAMONDS Situation Characteristics
- Binary Behavior Indicators
- Passive Sensing

## Tell us about you and your life:

We want to understand your daily psychological, social, and emotional experiences; your behaviors; the contexts you inhabit; and your daily life overall. To do so, we want to give you the opportunity to tell us what questions we should ask you related to your emotions, thoughts, behaviors, contexts, goals, identities, challenges, and more in everyday life.

Please describe your typical daily thoughts, experiences, behaviors, contexts, beliefs, desires, and/or anything else you think is important below. You may say, for example, that "I'm usually very energetic, but I get tired after lunch;" "Most days, I feel excited about what I need to do, but on Wednesdays I have a lab course that ruins my mood;" or "When I'm around peers, I often feel out of place because I am a first gen student." Also think about your reasons for experiences/behaviors/etc. Is there another reason you get tired after lunch other than the time of day? What about that lab course ruins your mood? Do specific peers trigger your first gen identity more than others? There are no right or wrong answers. The goal is simply to help you think about yourself and everyday experiences as well as what you think drives those.

Write as much as you think is necessary to understand your daily life. There are no length limits, but please write at least two paragraphs. Richer descriptions will provide us more information to help you understand whether your perception of your daily life mirrors your actual experiences, while less rich descriptions may limit our ability to answer these questions. It might be helpful to think about the people you might be with, the places you might go, and the things you might do in the next few weeks.

(The submit button will appear after five minutes.)

What are we missing when we use the same measures for everyone?

# Content: Capturing Cardinal States

## Structure and Mood

- good mood
- keep school life balance
- scheduled time
- focus
- stay on track
- consistent routine
- unstructured time
- skipped breakfast impacts mood
- burnt out
- sleep later

## Context and Time

- Chemistry Lab
- Craft Center
- Thursdays
- Ceramics
- Sculpture
- Glassblowing
- Chinese
- American
- Creative
- After Learning
- 6:30
- energy
- after three

## Identity, Time, Context, and Behaviors

- Japanese
- Stressful
- Free time
- Library
- Studying
- Distracted
- Gym
- Fun topic
- Anime
- Friends

What are we missing when we use the same measures for everyone?

# Content: Capturing Cardinal States

## Structure and Time

- good mood
- keep school life
- scheduled time
- focus
- stay on track
- consistent routine
- unstructured time
- skipped breakfast
- mood
- burnt out
- sleep later

**People generate unique content in their Cardinal States that does not overlap with many of our common measures**

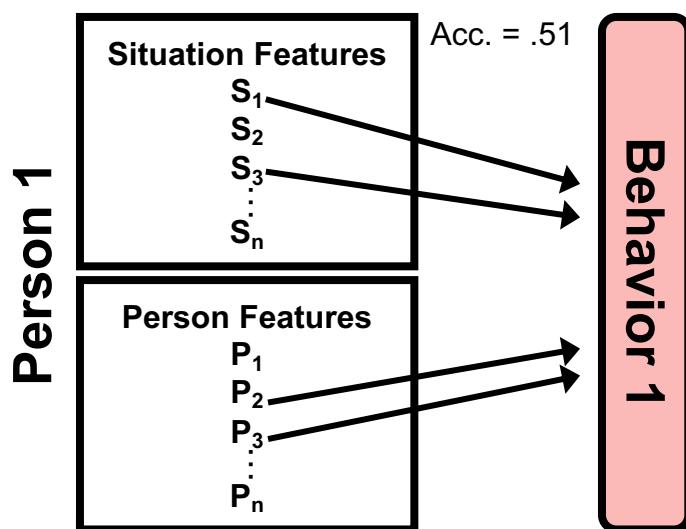
- Creative
- After Learning
- 6:30
- energy
- after three

- Anime
- Friends

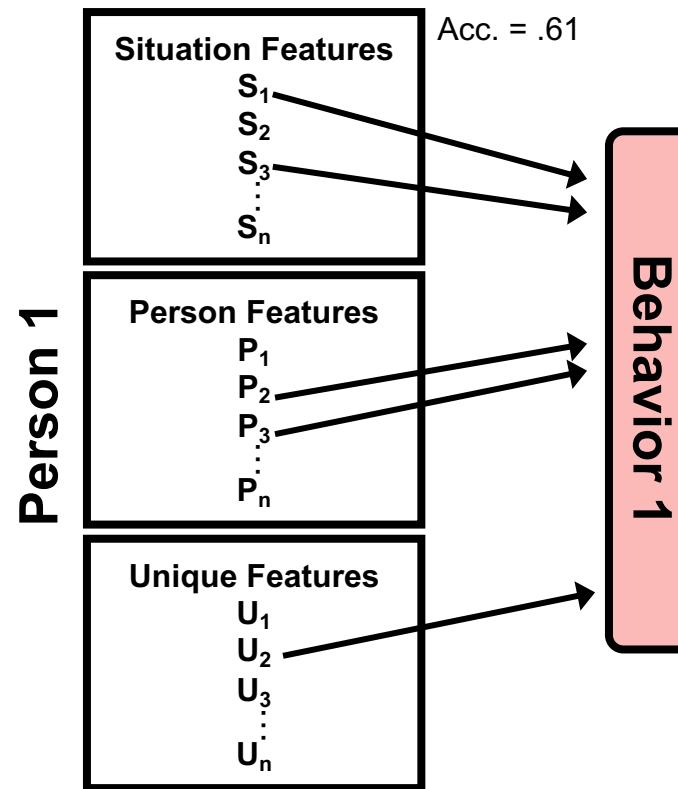
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# Predictive Utility

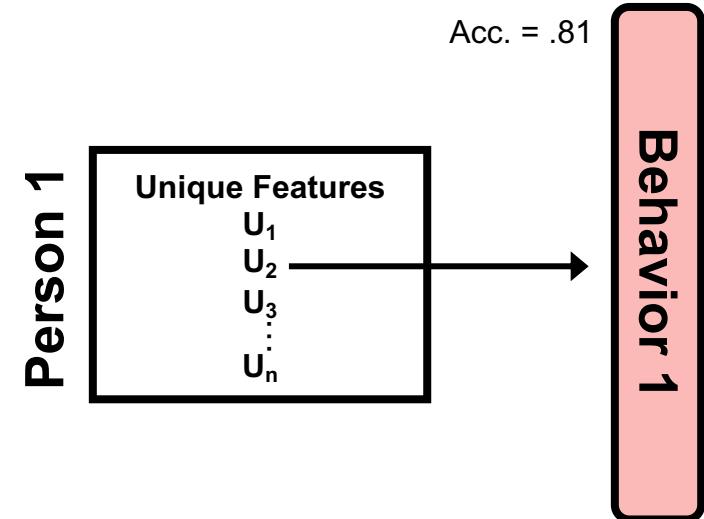
**SHARED:**  
PERSON + SITUATION



**COMBINED:**  
PERSON + SITUATION +  
UNIQUE



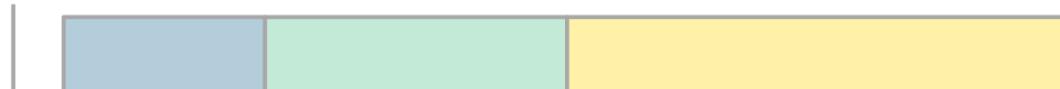
**UNIQUE:**  
CARDINAL STATES



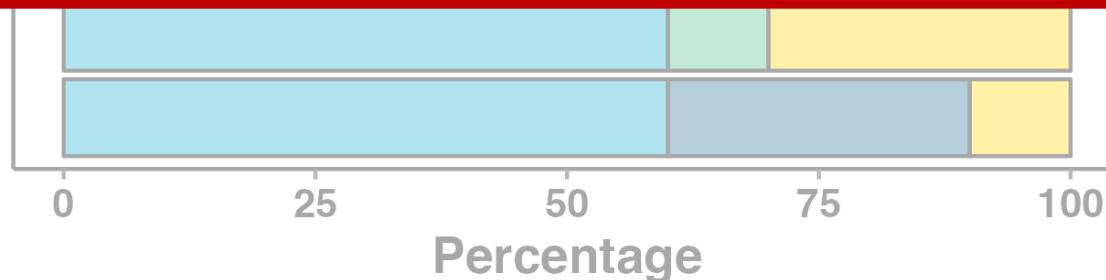
What are we missing when we use the same measures for everyone?

# Predictive Utility

Procrastination



For ~50%, unique, cardinal states items had higher variable importance than shared person and situation features.



NSF Grant

# Precision Medicine

## Targeting

Identifying risk-factors of a disease or populations of people most likely to respond to a treatment

Build algorithms that can accurately predict who is at risk, so they can be targeted for treatment.

## Tailoring

Tailoring treatment of a person to their physical or digital biomarkers

Build algorithms that can actually predict momentary relevant health markers and tailor treatment to most predictive features.

# Thank you!

## Lingering Questions

1. Extension to coupled person *systems*: Couples, parent-child, friendships
2. Extension across levels of the system(s): From micro to macro
3. Connection to traits and long-term outcomes

## The What is Personality? Lab



 Washington  
University in St. Louis  
**UCDAVIS**  
UNIVERSITY OF CALIFORNIA



**My favorite coupled chaos system(s)**