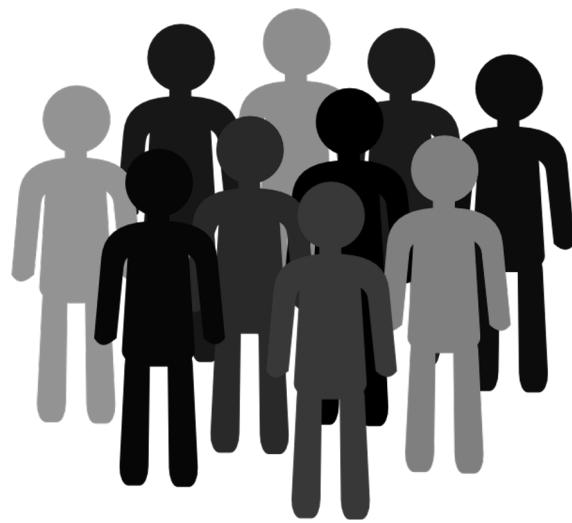
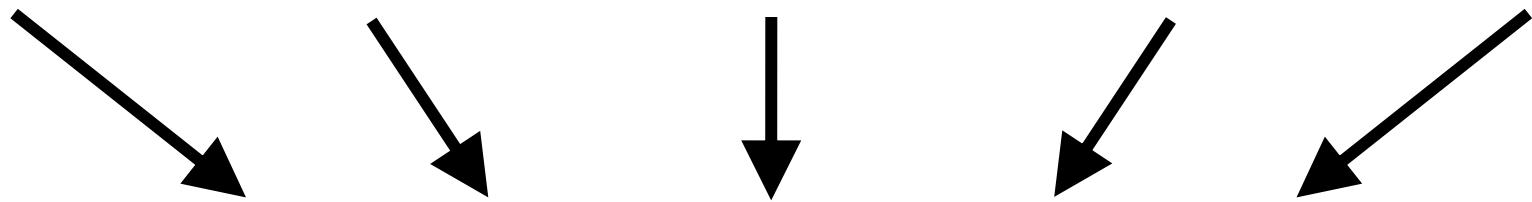


Network Approaches to Representing and Understanding Psychological Dynamics

Emorie D Beck and Joshua J Jackson

Washington University in St. Louis





Nomothetic

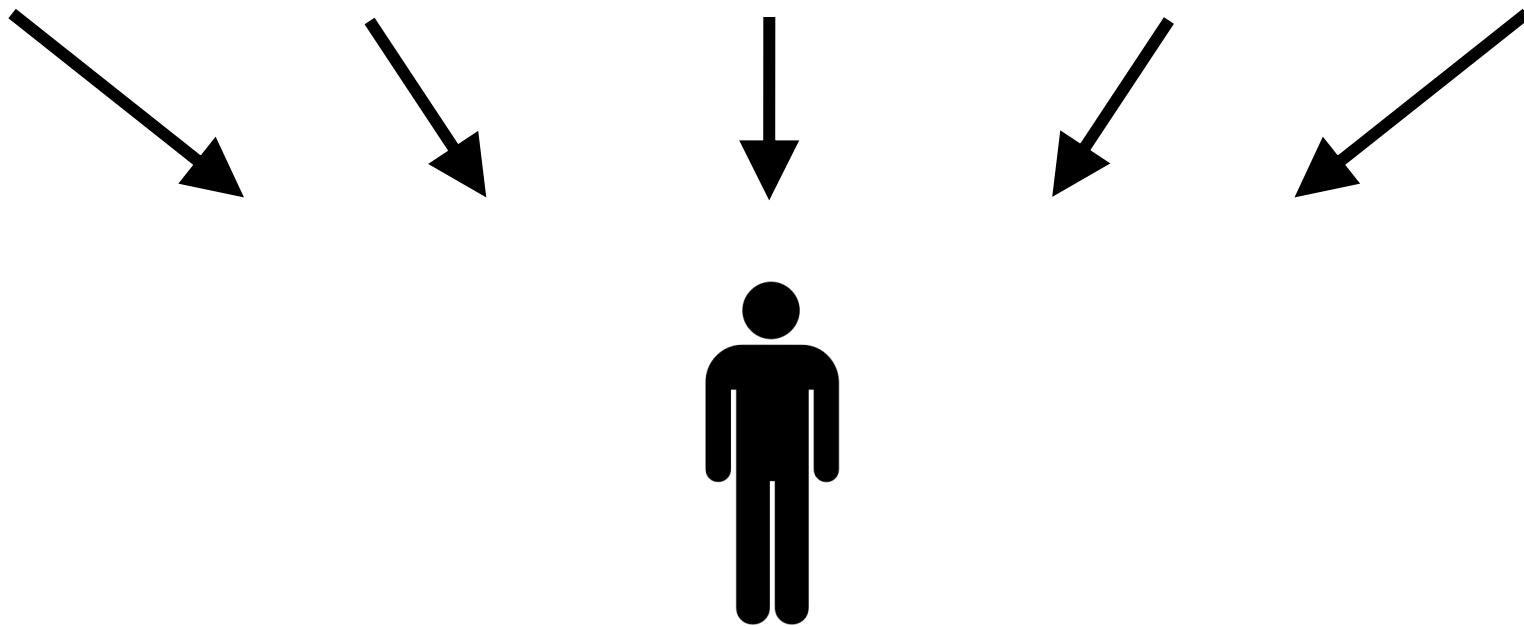
Extraversion

Agreeableness

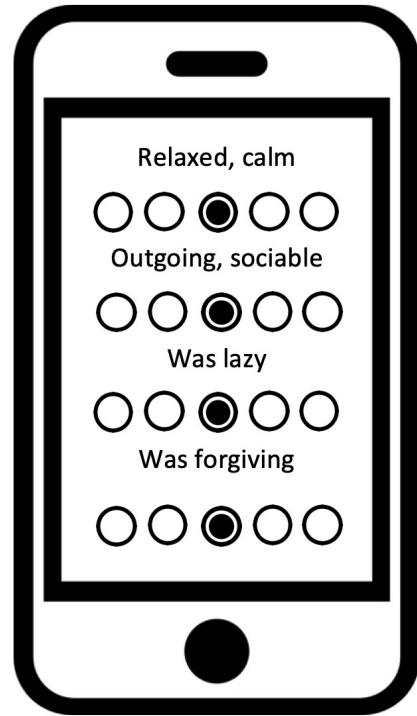
Conscientiousness

Neuroticism

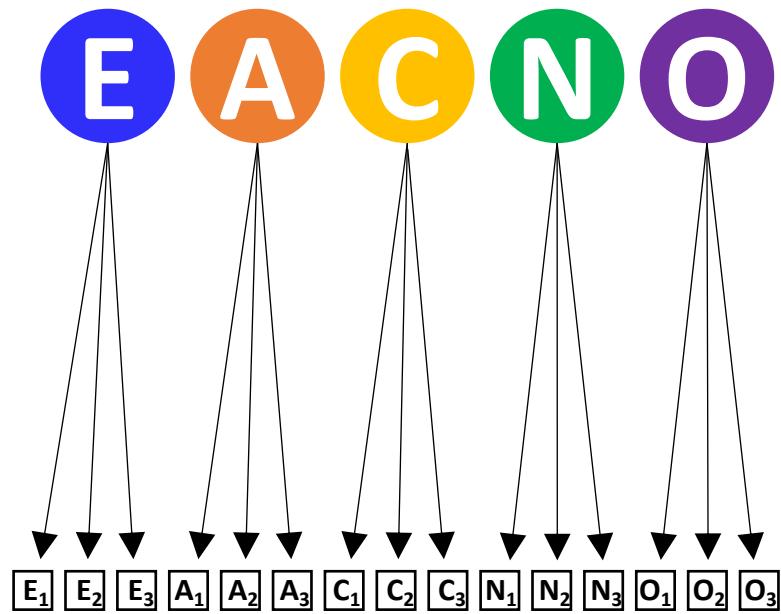
Openness



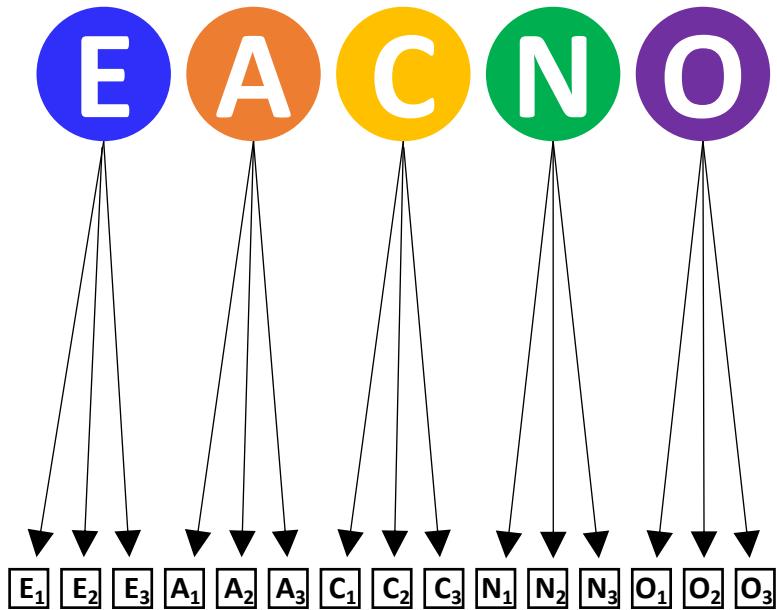
Idiographic



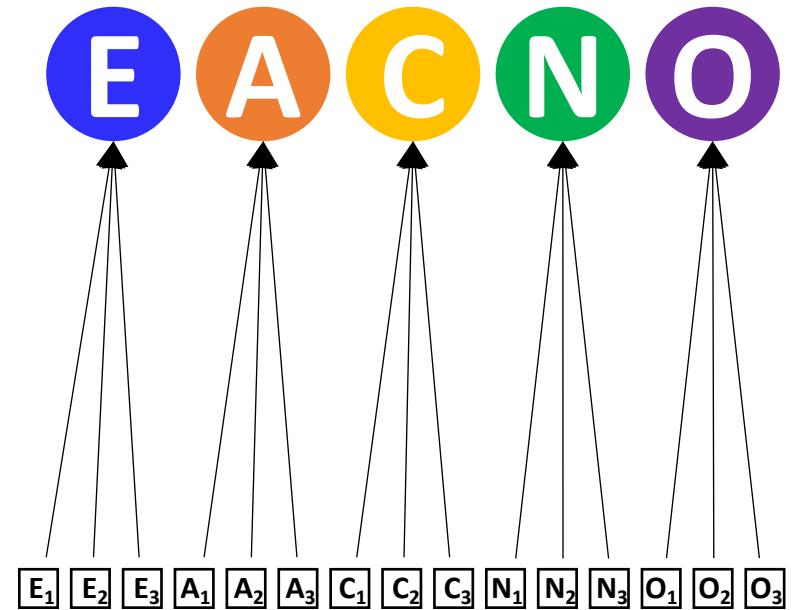
Reflective



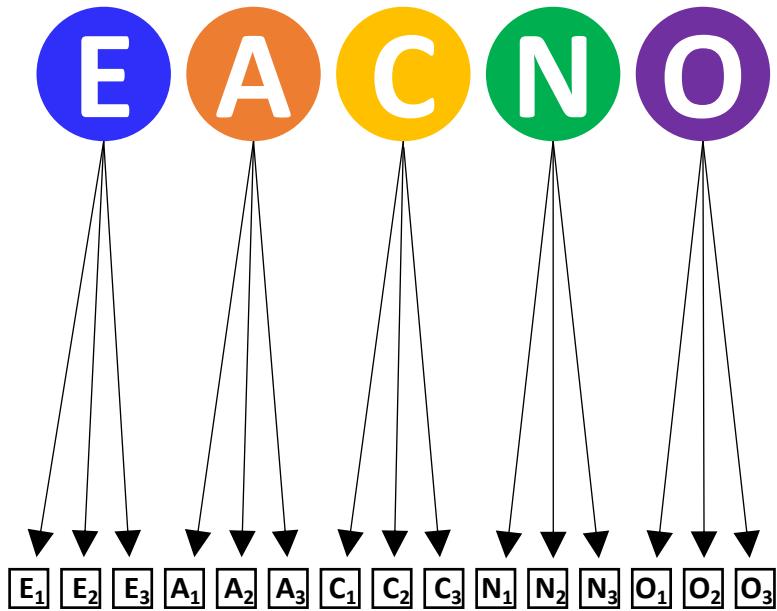
Reflective



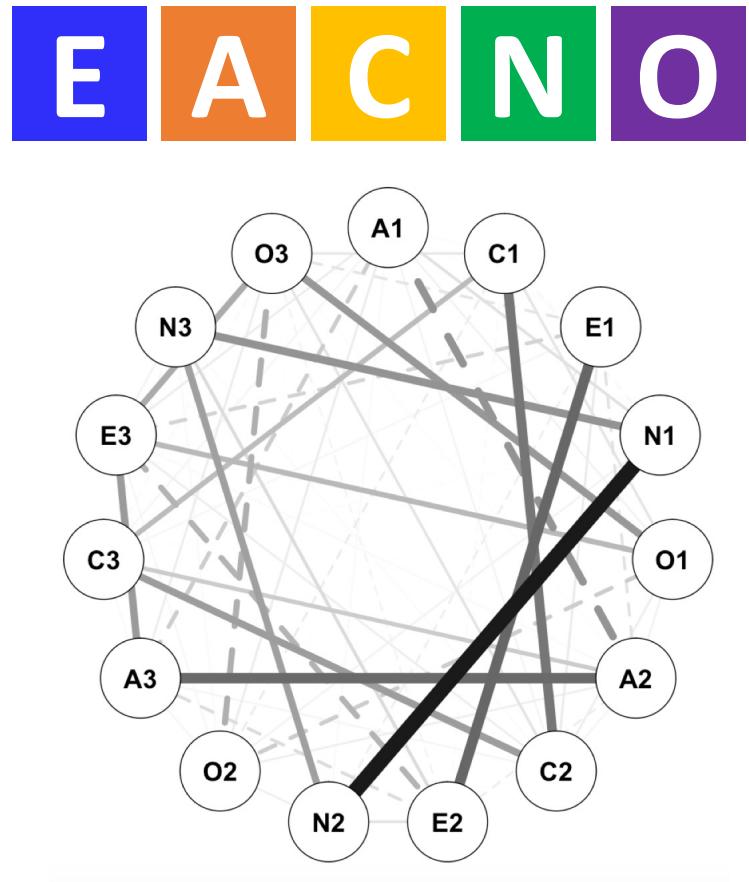
Formative



Reflective



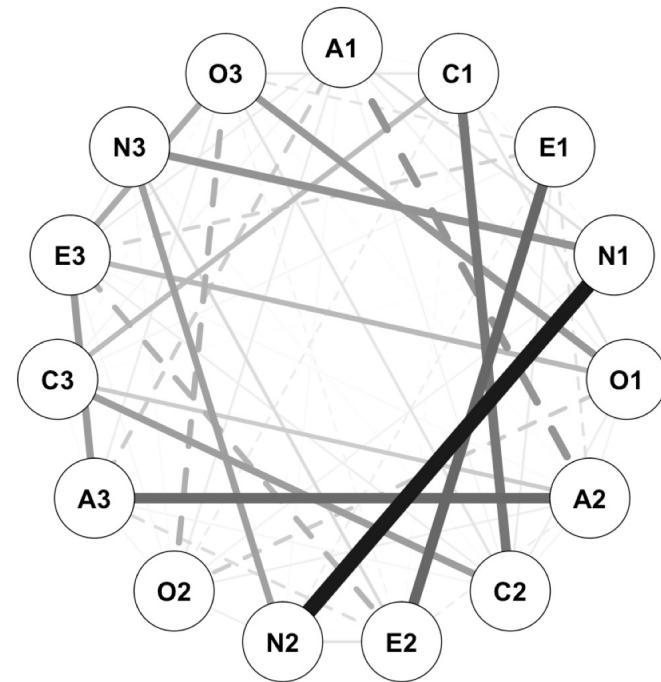
Formative



Borsboom, Melenberg, & Van Heerden, 2003; Molenaar, 2004; Schmittman et al., 2013

Network

E A C N O

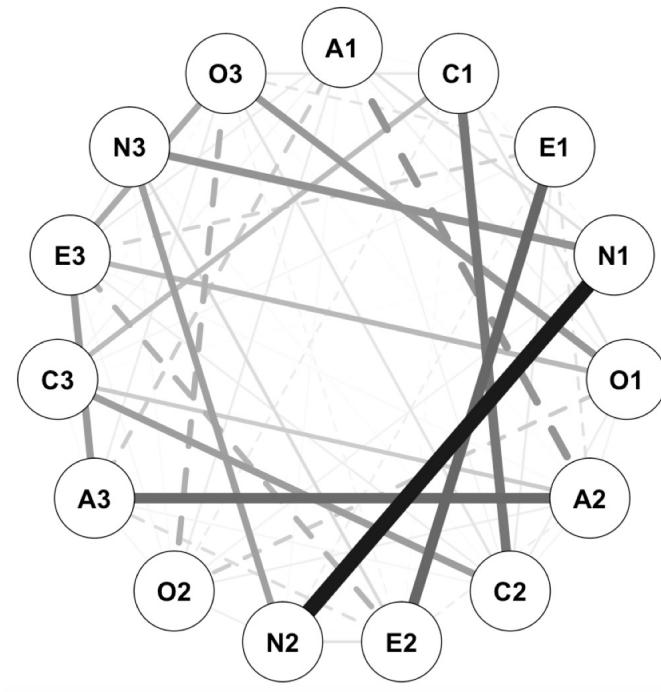


1

Networks are a useful frame for thinking of personality as a psychological system.

Formative

E A C N O



1

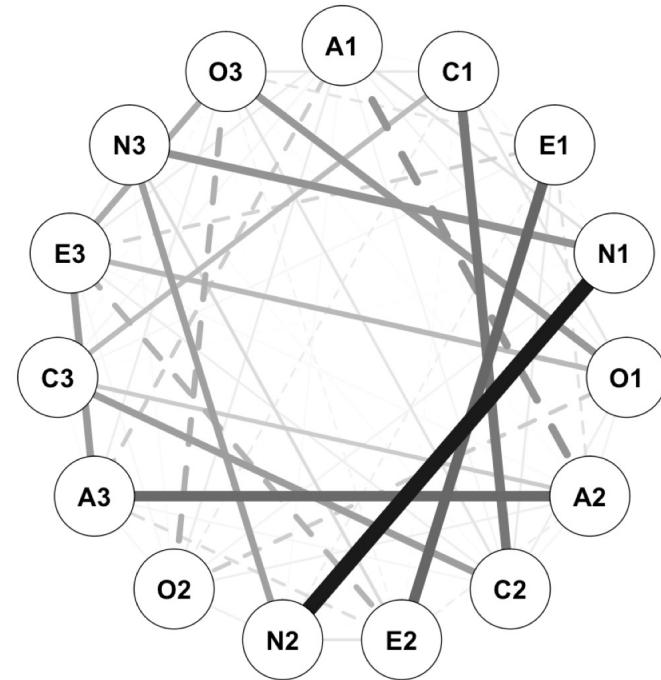
Networks are a useful frame for thinking of personality as a psychological system.

2

Causal frameworks of personality require an understanding of within-person dynamics (i.e. an idiographic approach).

Formative

E A C N O



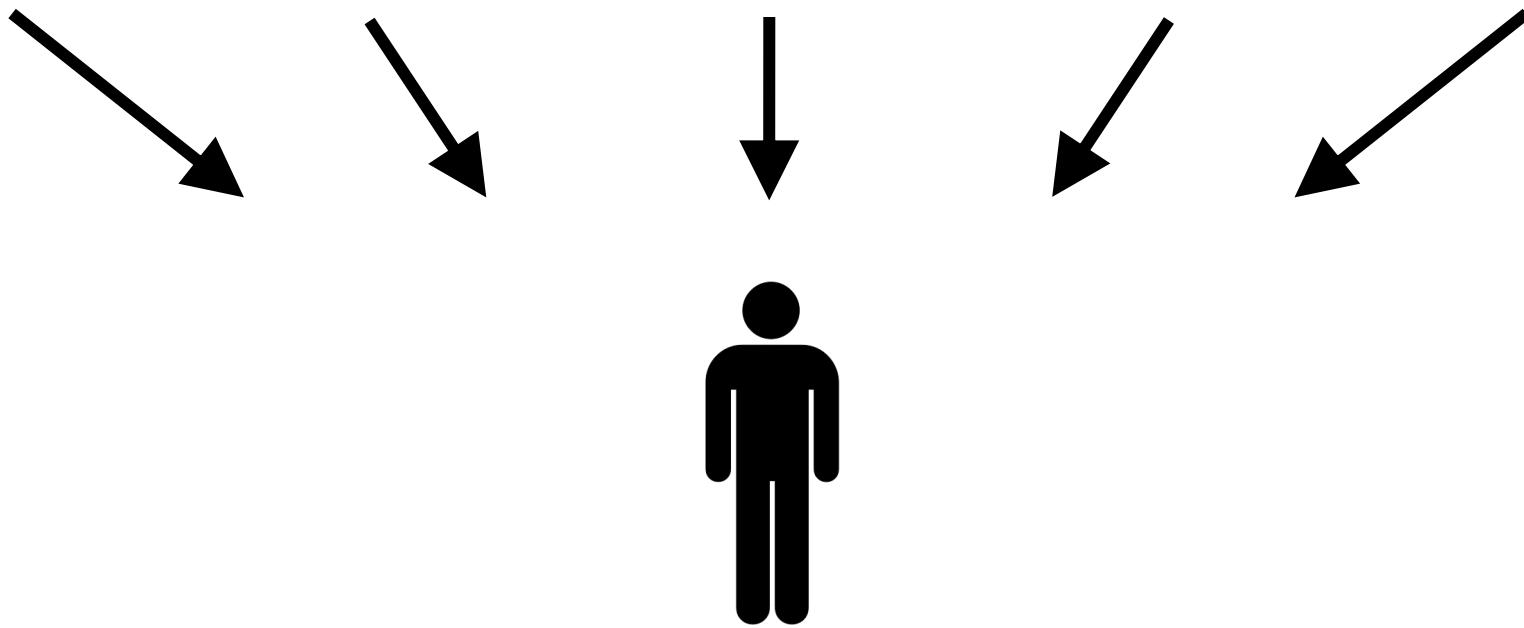
Extraversion

Agreeableness

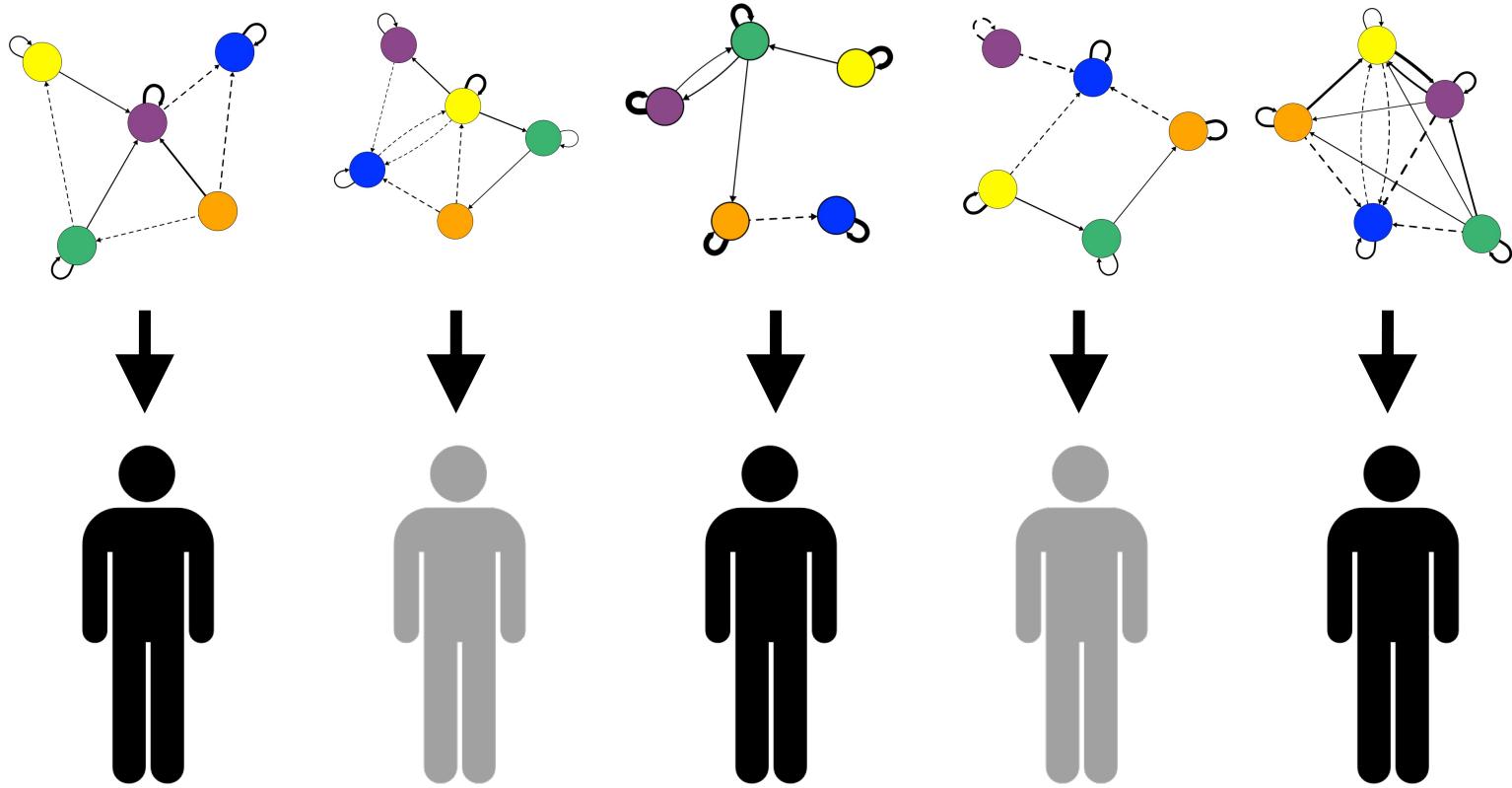
Conscientiousness

Neuroticism

Openness



Idiographic



Idiographic

BUT

What are the nodes and edges?

**Network techniques are a tool for
analyzing the structure and
dynamics of matrices.**

Personality

Rude
Quiet
Lazy
Relaxed
Depressed
Outgoing
Kind
Reliable
Worried

Cognitive Affective

Academic Motivation
Around Others
Connected
Positive Emotion
Negative Emotion
Authenticity
Self-Esteem
Happiness
Loneliness

Idiographic Assessment: Graphical Autoregressive Models

$$X_{i,k}(t) = \sum_{j=1}^n \beta_{ij} X_{j,k}(t-1) + \varepsilon_{i,k}(t)$$

k = subjects
 i = item
 j = item
 t = assessment point

Personality

Rude
Quiet
Lazy
Relaxed
Depressed
Outgoing
Kind
Reliable
Worried

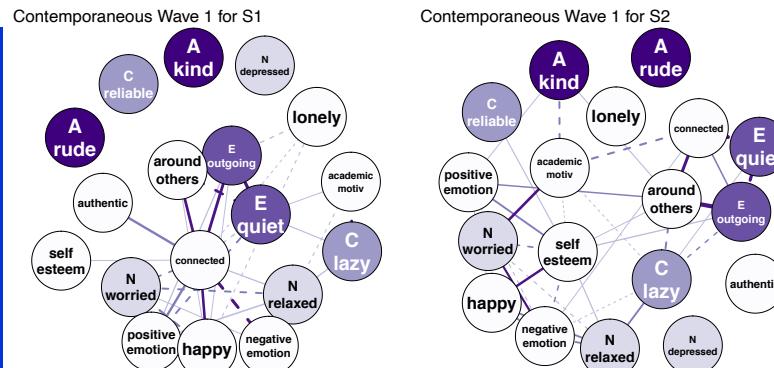
Cognitive Affective

Academic Motivation
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Happiness
Loneliness

Promises

Challenges

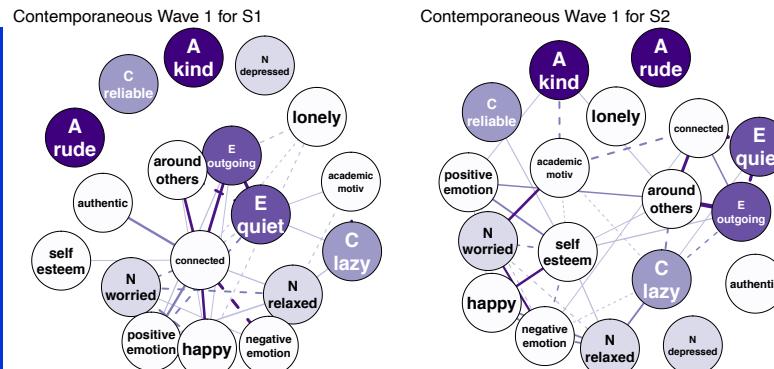
Structure



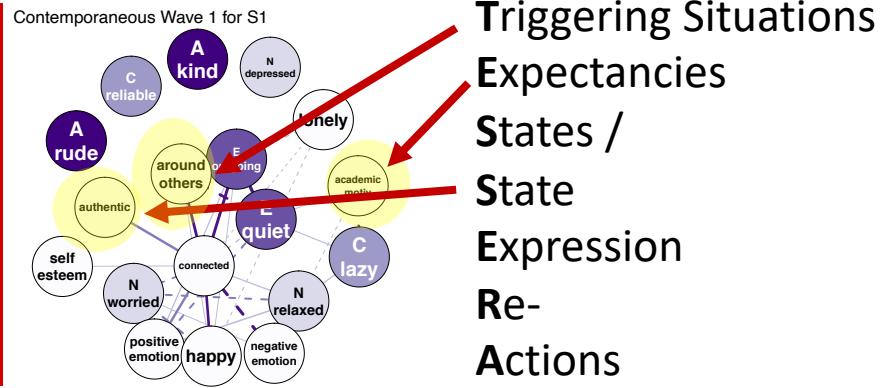
Promises

Challenges

Structure



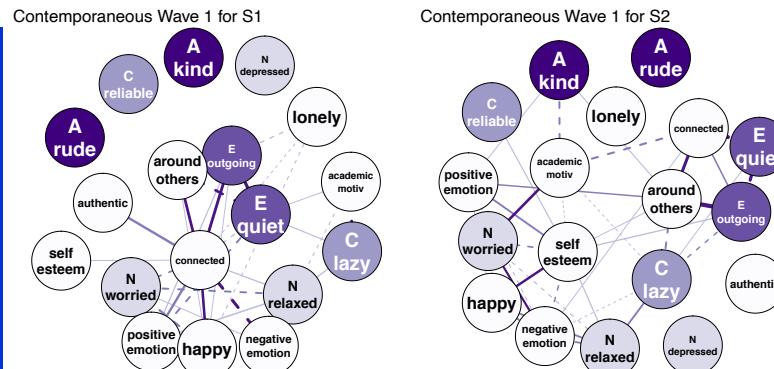
Process



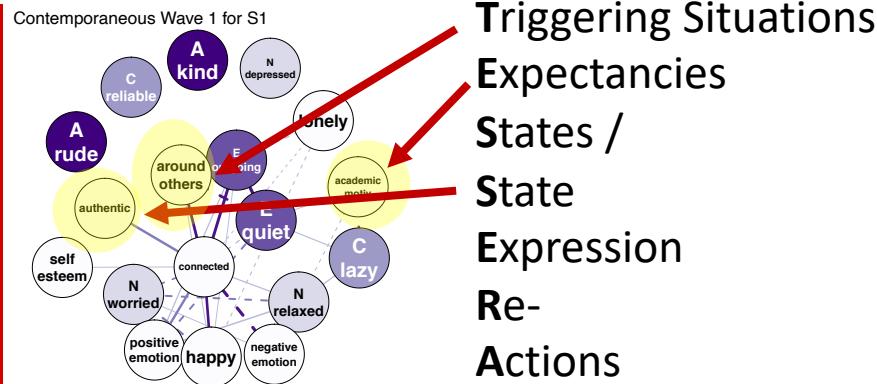
Promises

Challenges

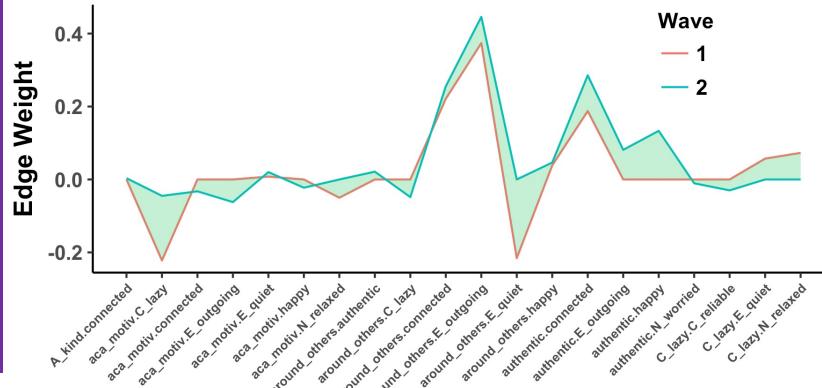
Structure



Process



Change



Structure

Rude

Quiet

Lazy

Relaxed

Depressed

Outgoing

Kind

Reliable

Worried

Academic Motivation

Around Others

Connected

Positive Emotion

Negative Emotion

Authenticity

Self-Esteem

Happiness

Loneliness

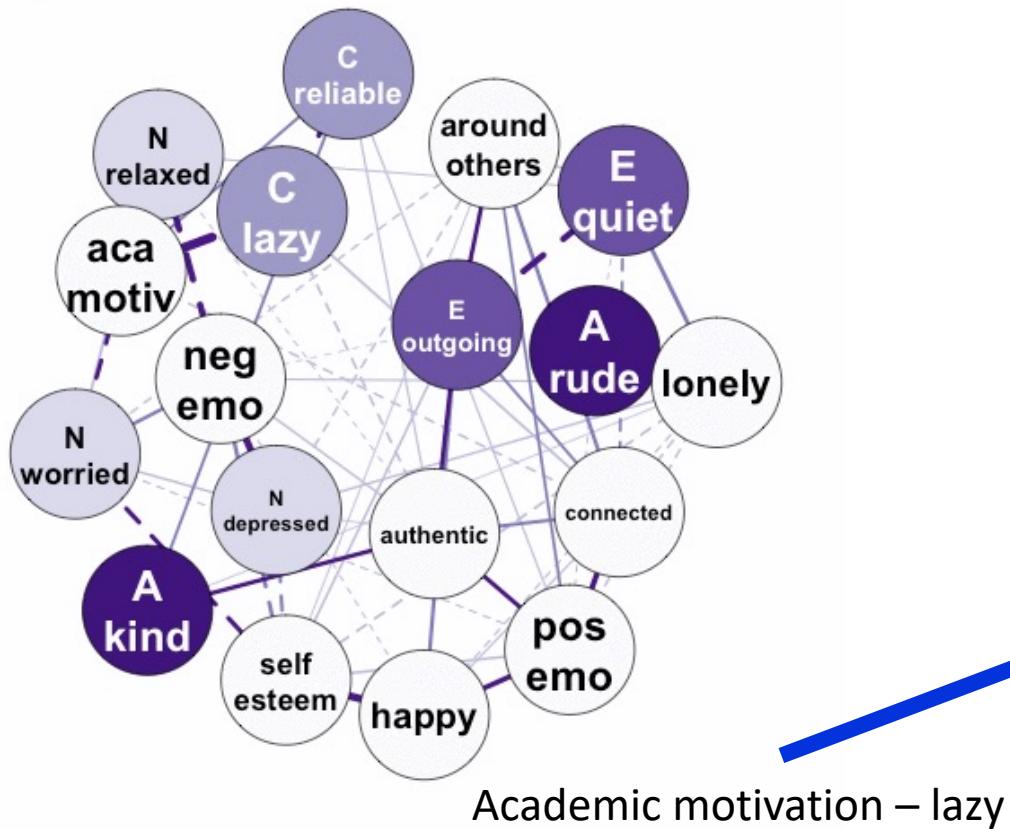
Promises

Challenges

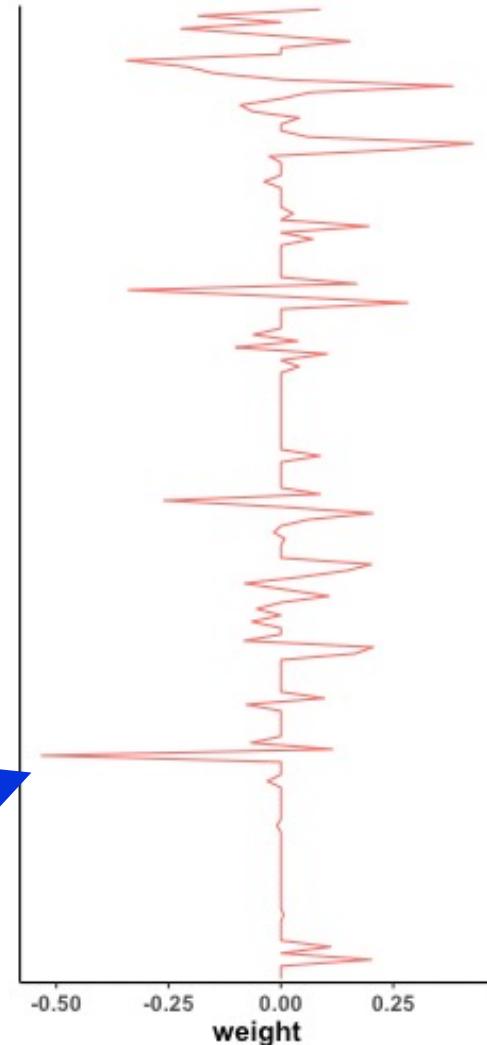
Structure

Structure

Contemporaneous Wave 1 for S882



Academic motivation – lazy

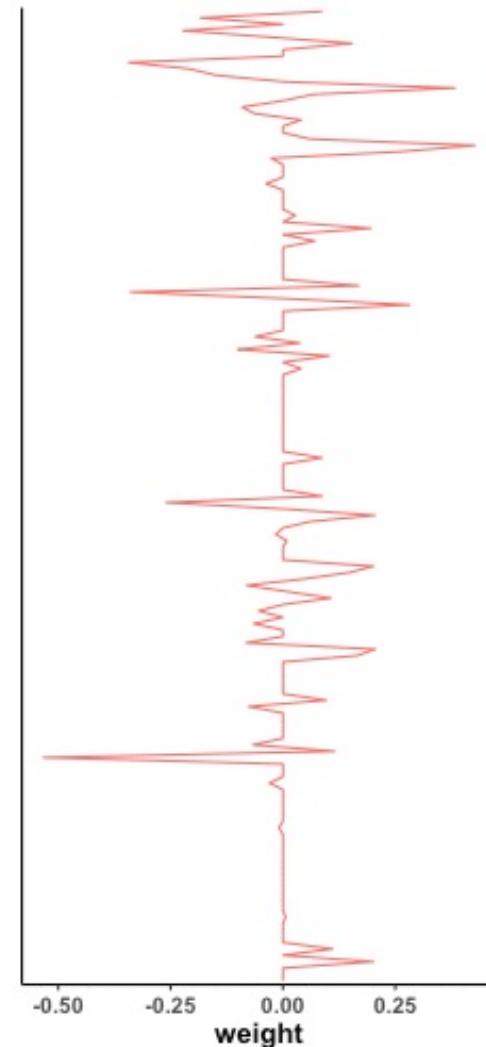
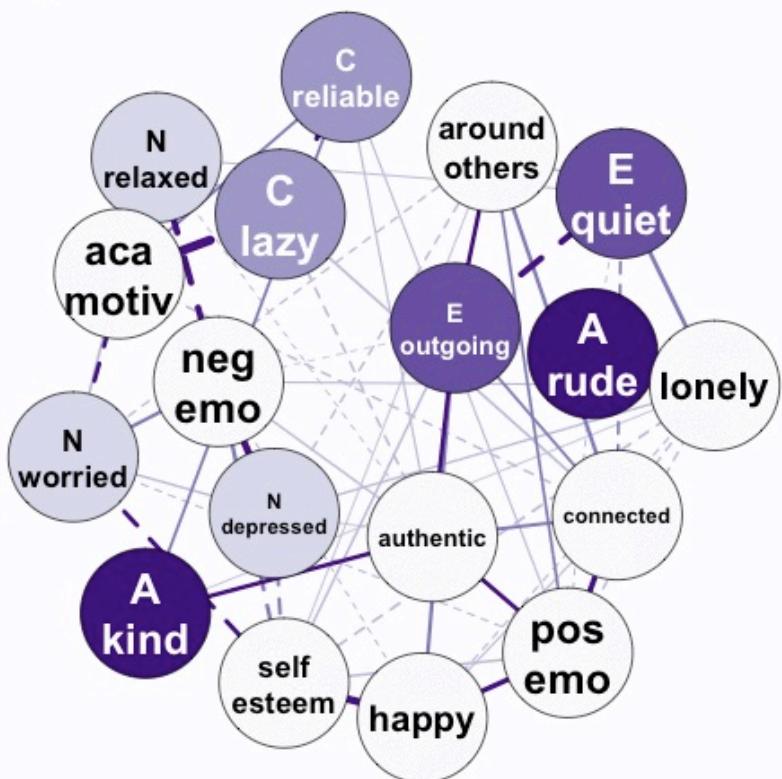


Promises

Challenges

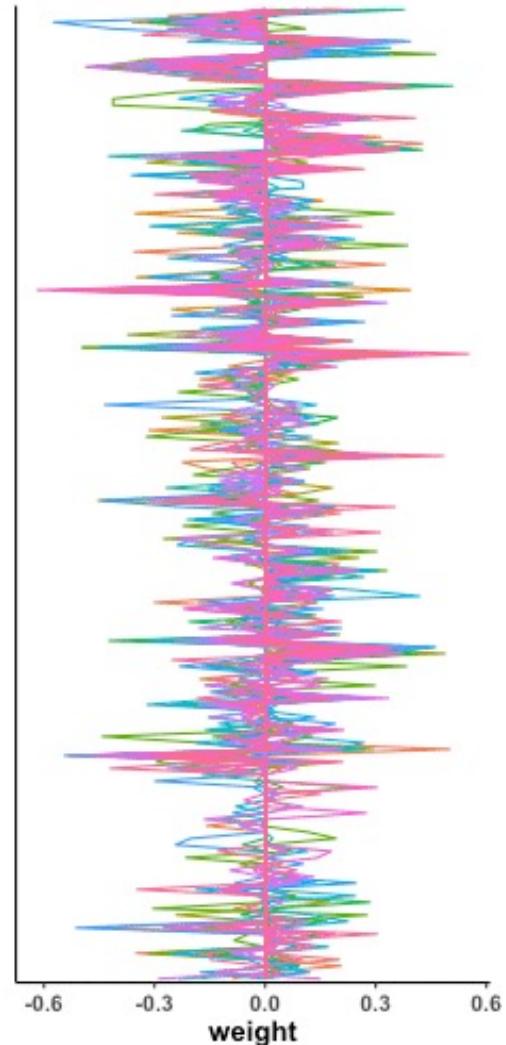
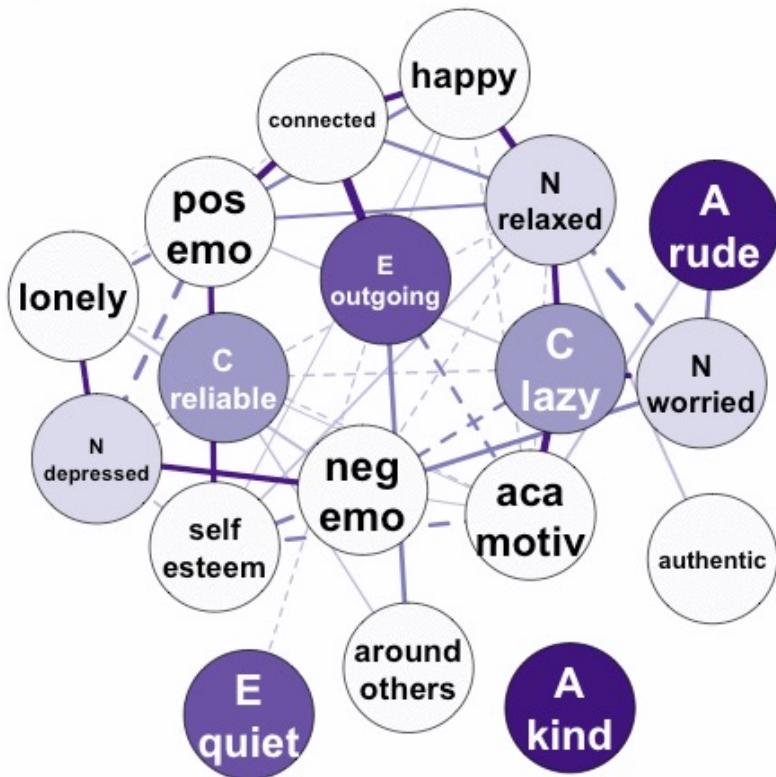
Structure

Contemporaneous Wave 1 for S882



Structure

Contemporaneous Wave 1 for S59665



Personality Processes

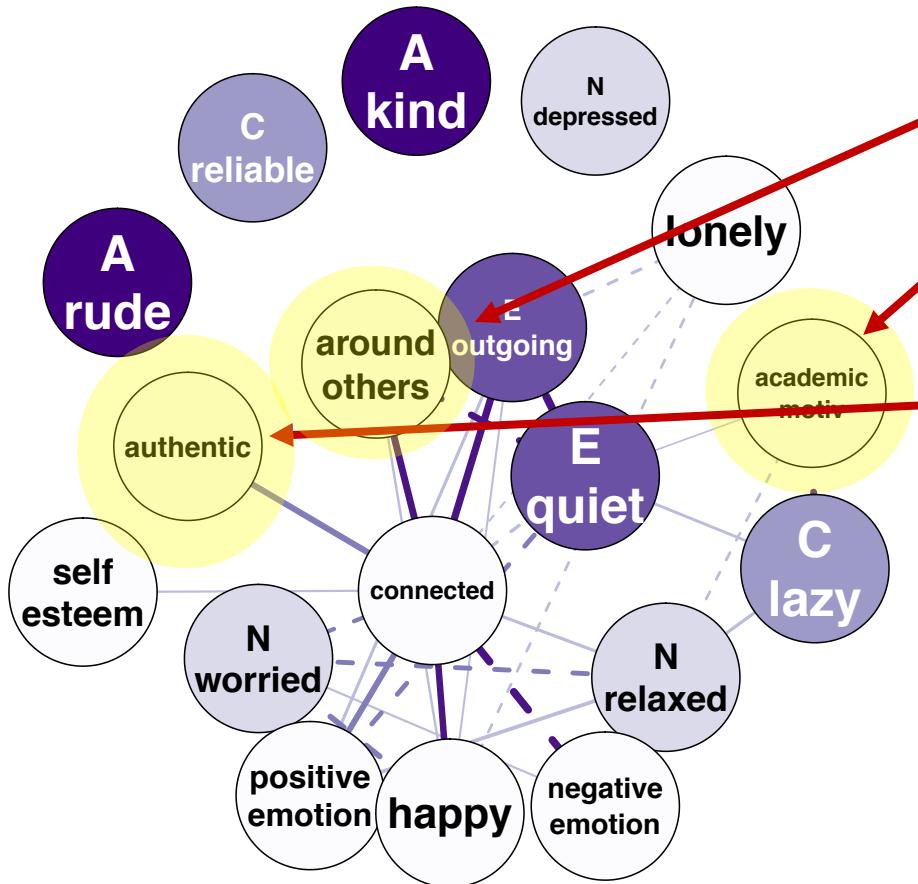
T
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A

Personality Processes

T riggering Situations
E xpectancies
S tates /
S tate
E xpression
R e-
A ctions

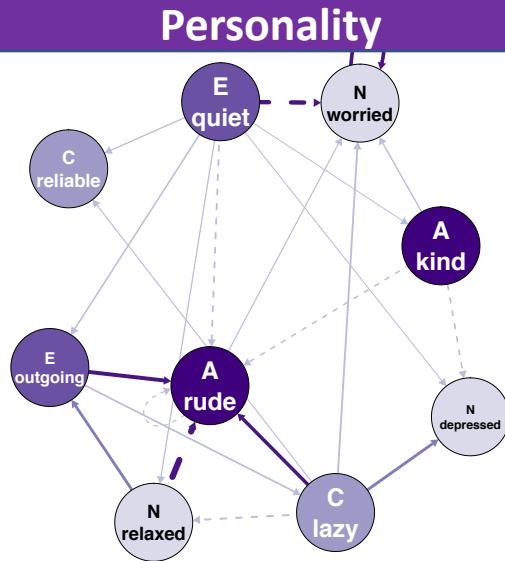
Personality Processes

Contemporaneous Wave 1 for S1



Triggering Situations
Expectancies
States /
State
Expression
Re-
Actions

Personality Processes

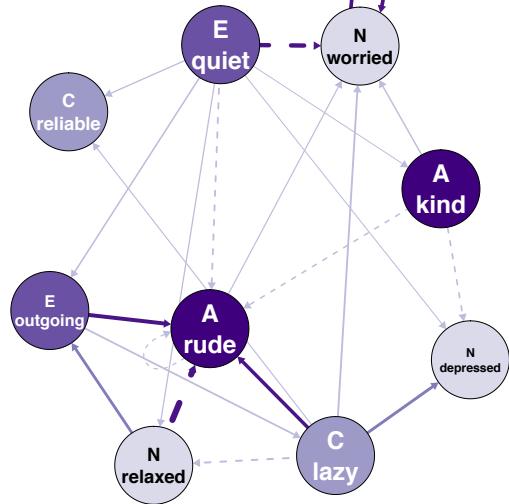


Promises

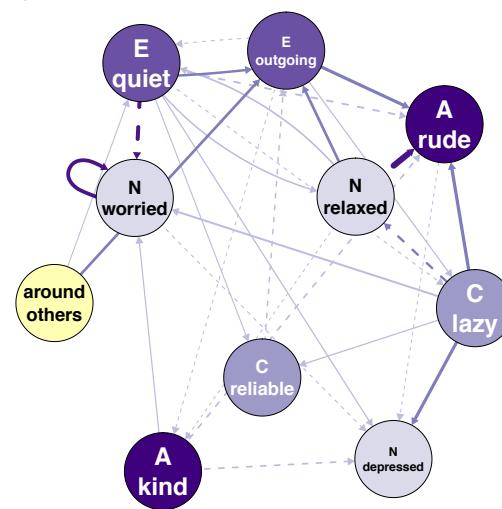
Challenges

Personality Processes

Personality



Personality + Triggering Situations

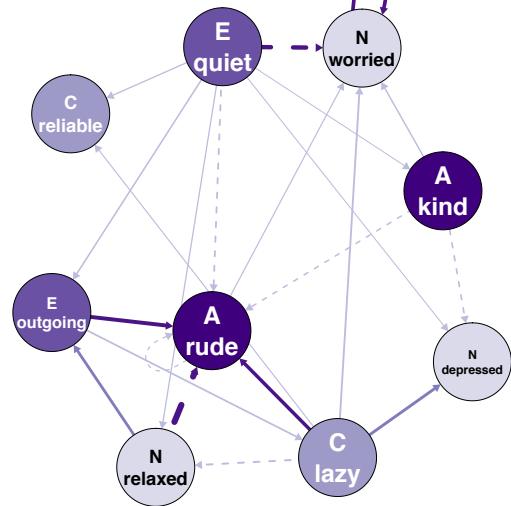


Promises

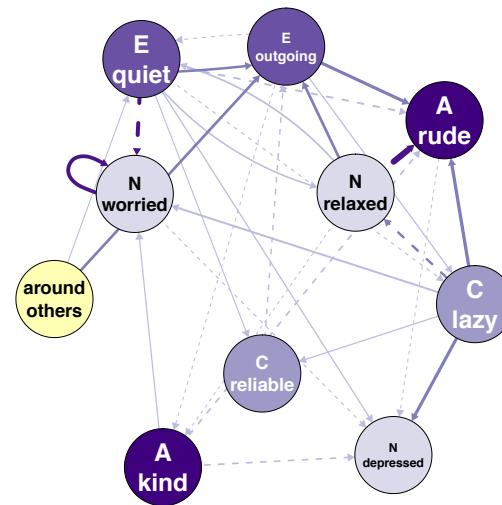
Challenges

Personality Processes

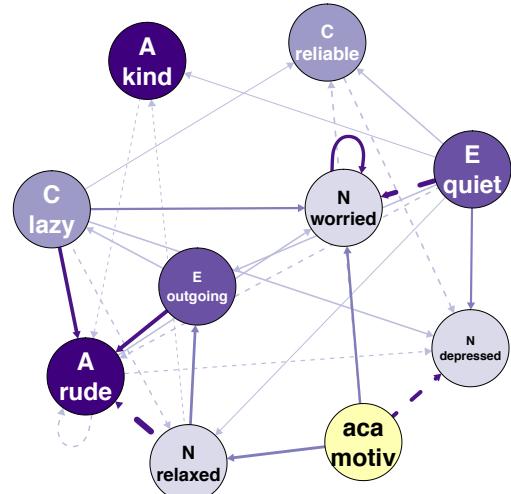
Personality



Personality + Triggering Situations



Personality + Expectancies

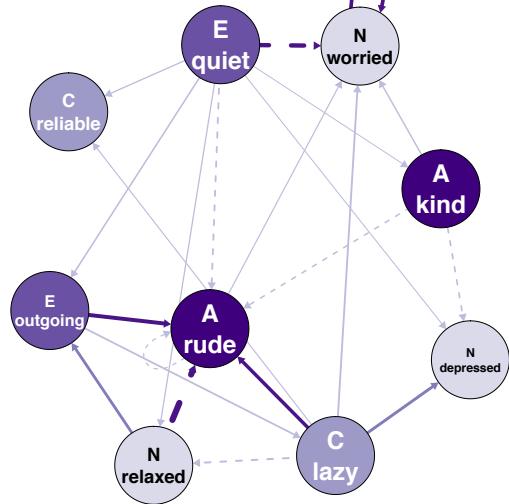


Promises

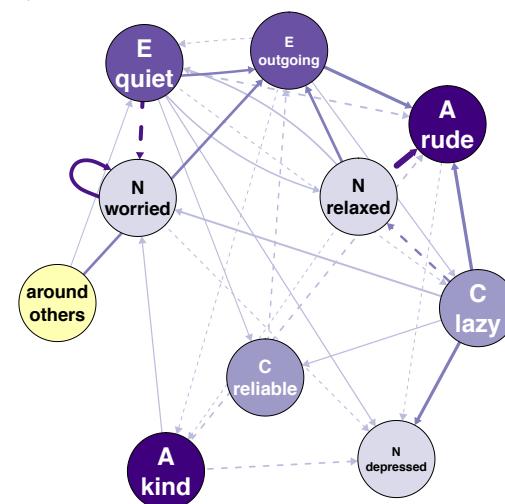
Challenges

Personality Processes

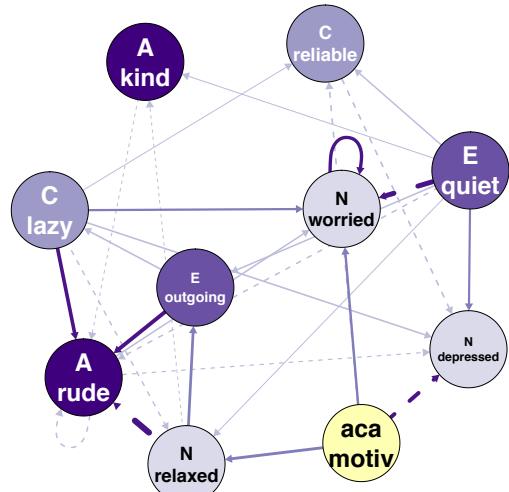
Personality



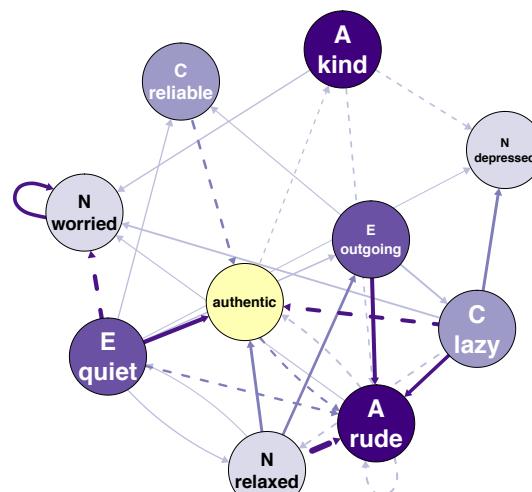
Personality + Triggering Situations



Personality + Expectancies



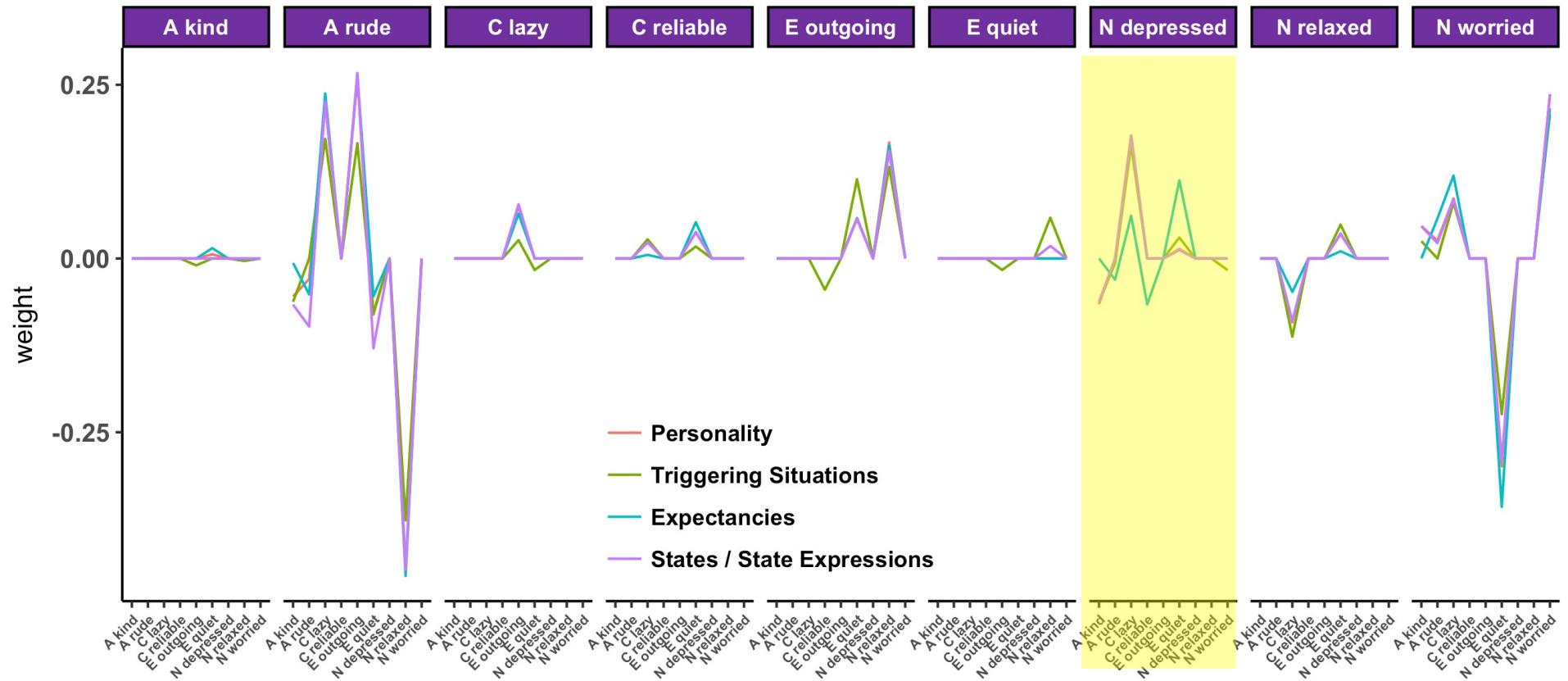
Personality + State Expression



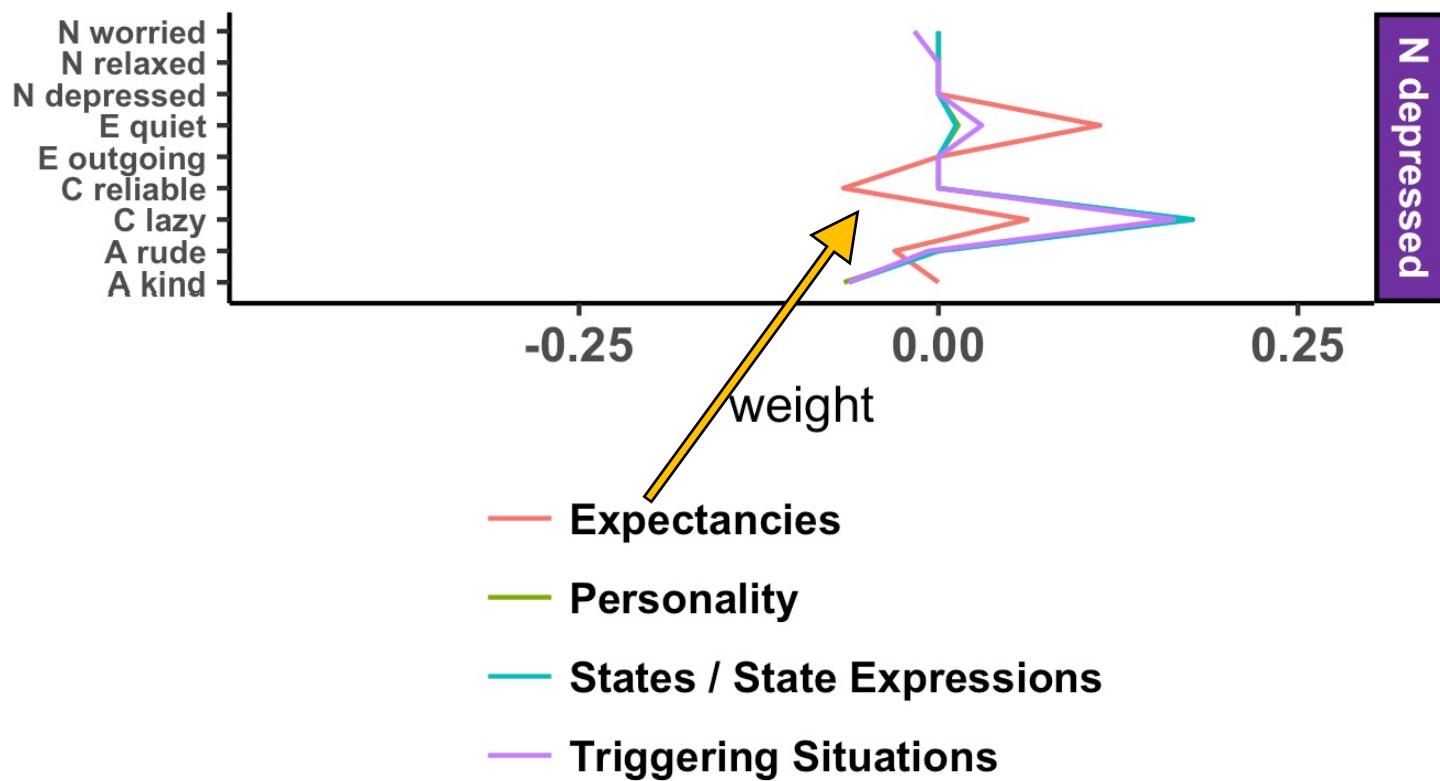
Promises

Challenges

Personality Processes



Personality Processes

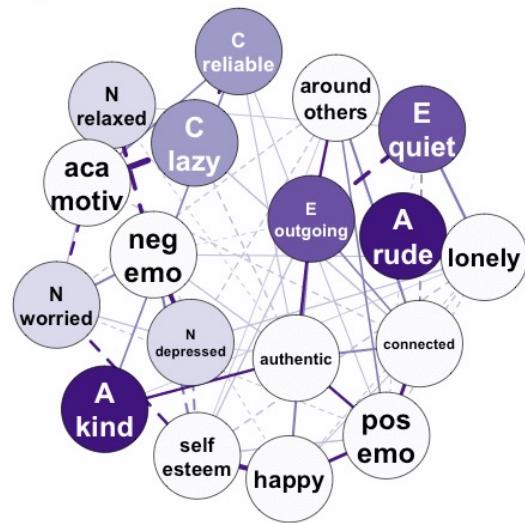


Promises

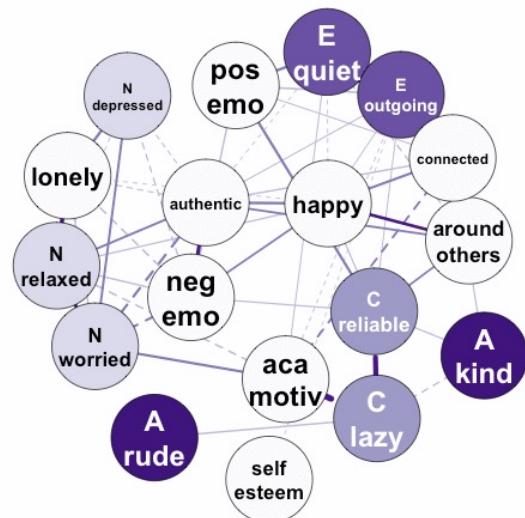
Challenges

Development

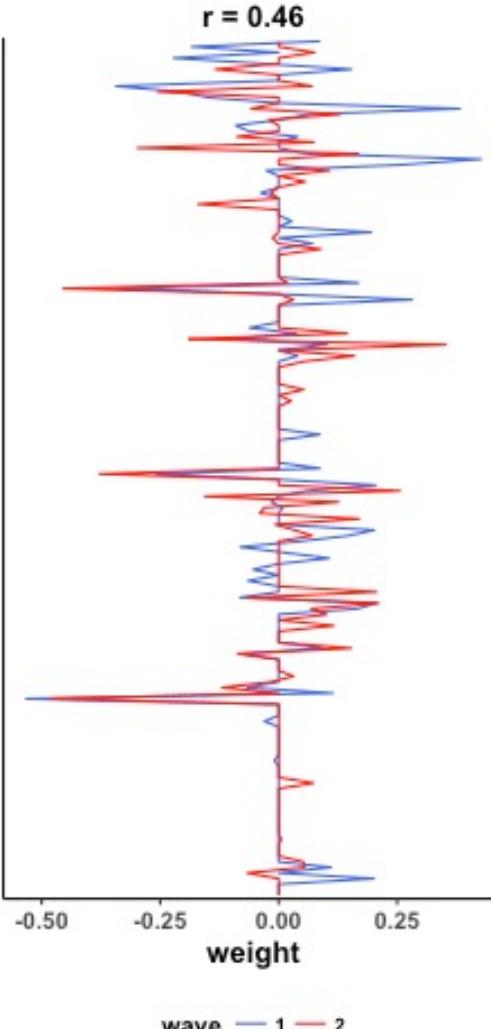
Contemporaneous Wave 1 for S882



Contemporaneous Wave 2 for S882



Subject 882

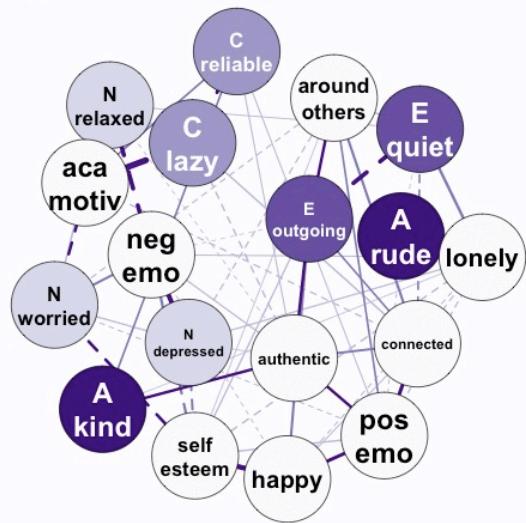


Promises

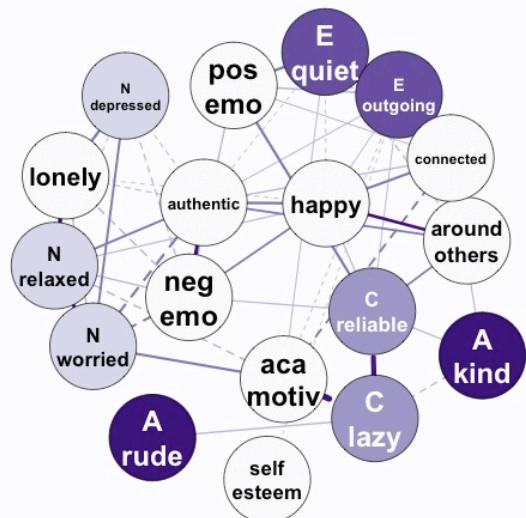
Challenges

Development

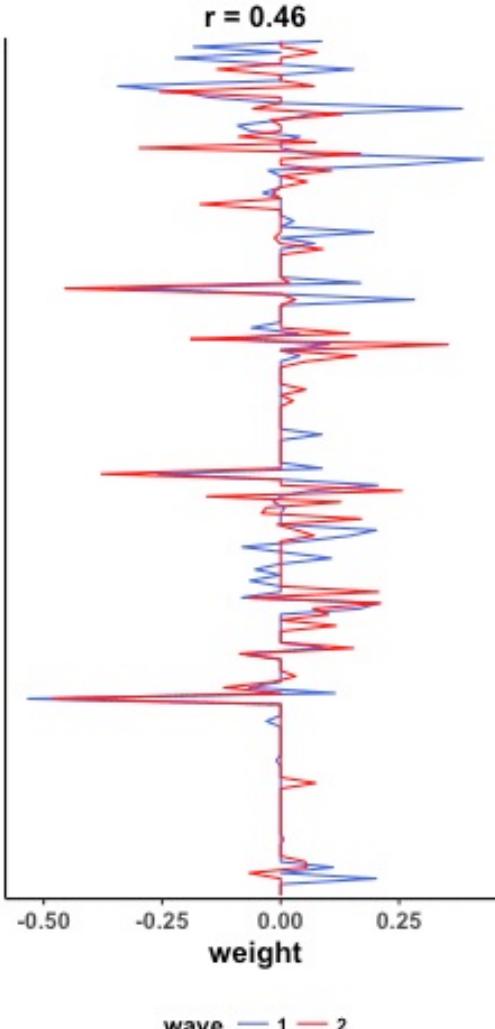
Contemporaneous Wave 1 for S882



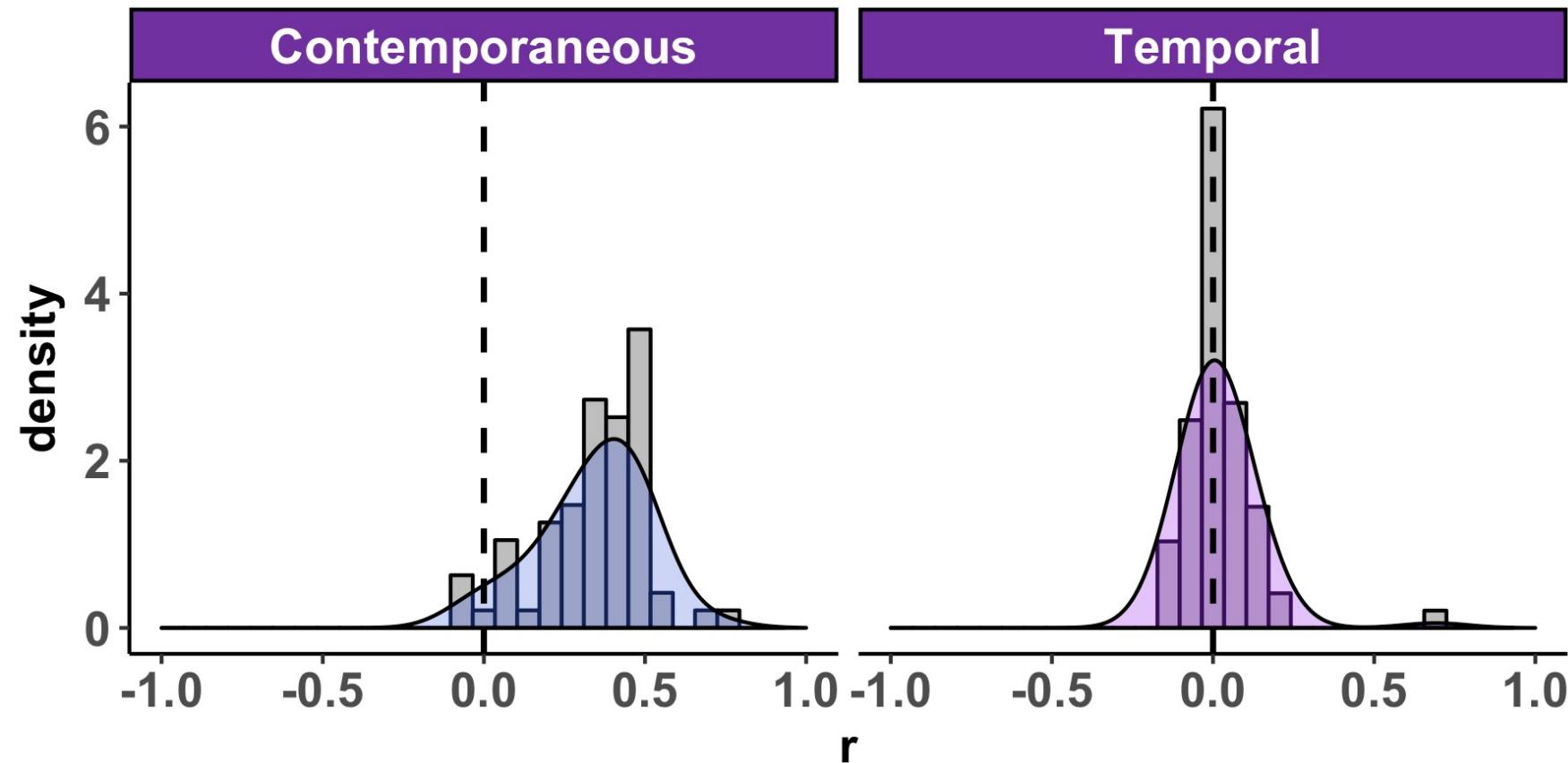
Contemporaneous Wave 2 for S882



Subject 882



Development



Promises

Challenges

Development

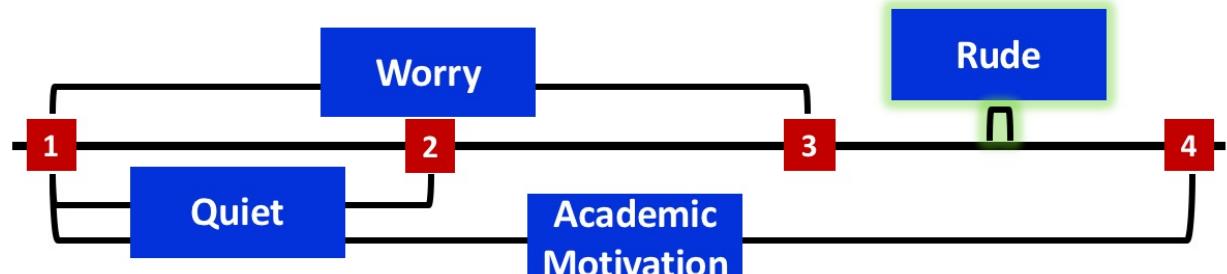
Promises

Challenges

Promises

Challenges

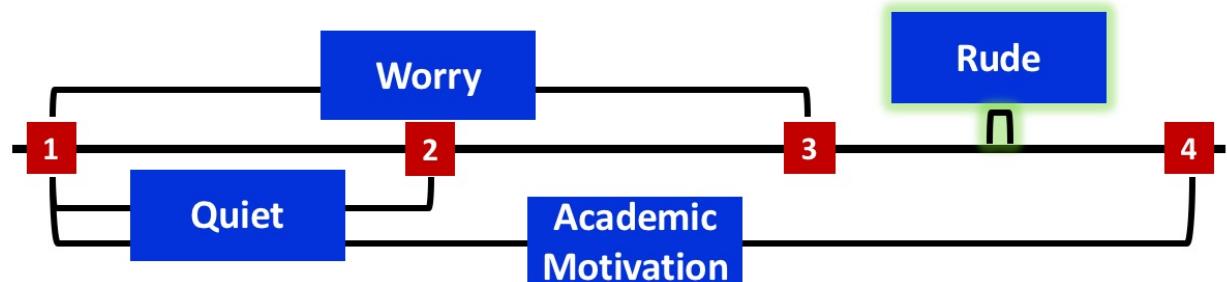
Velocity



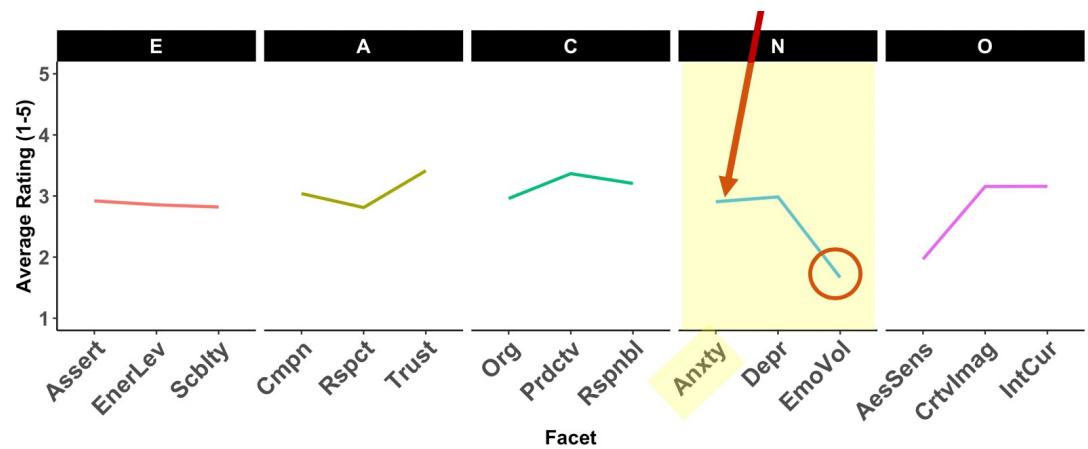
Promises

Velocity

Challenges



Psychometrics



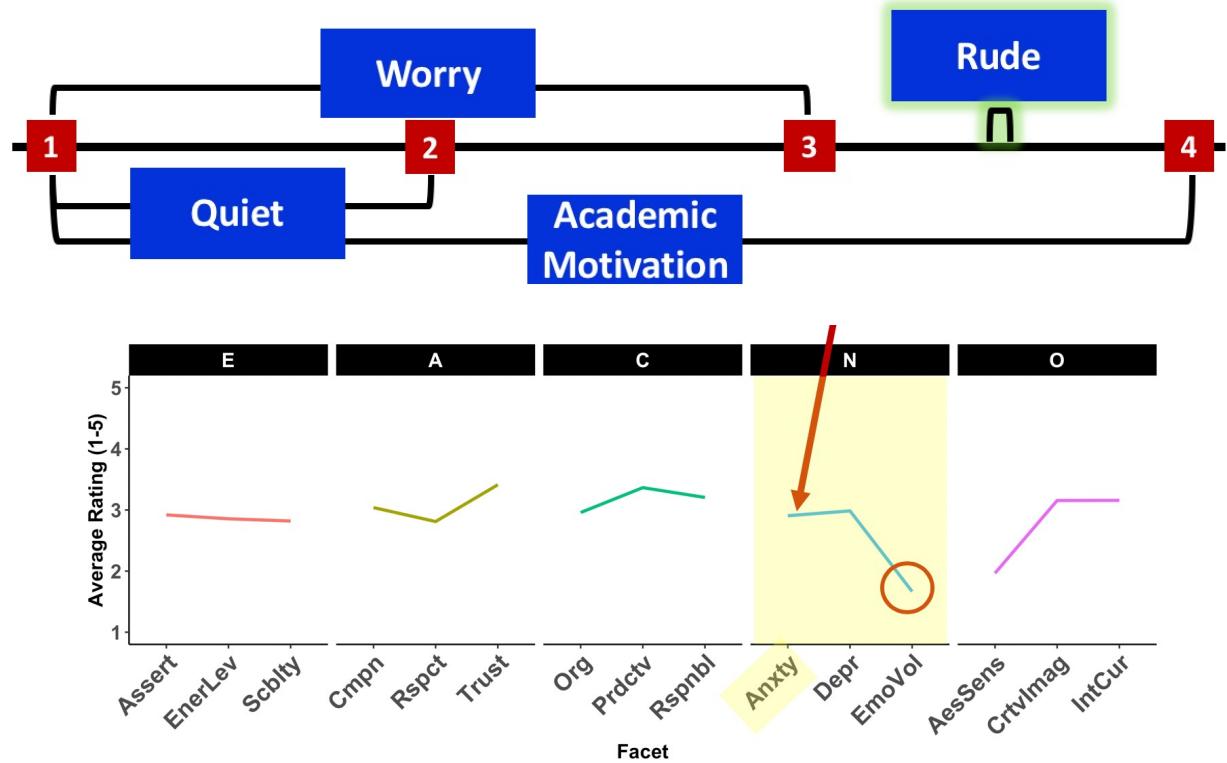
Promises

Challenges

The Time Interval Problem

Psychometrics

Aggregation



Centrality

Clustering

Density

Communities

Promises

Challenges

The Time Interval Problem



Worry

Academic
Motivation

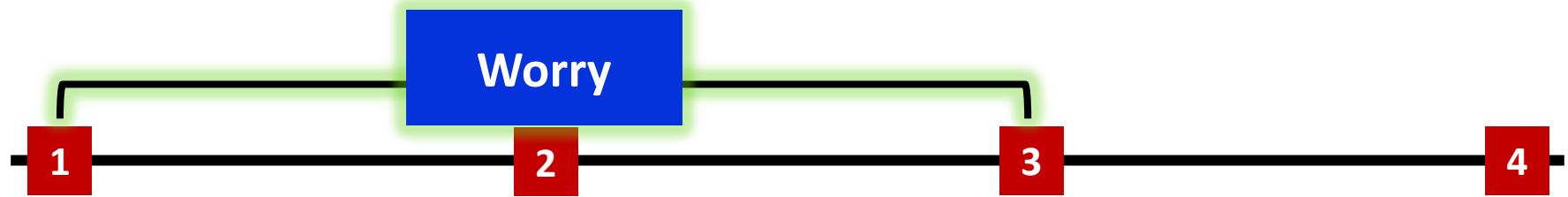
Quiet

Rude

Promises

Challenges

The Time Interval Problem



Academic
Motivation

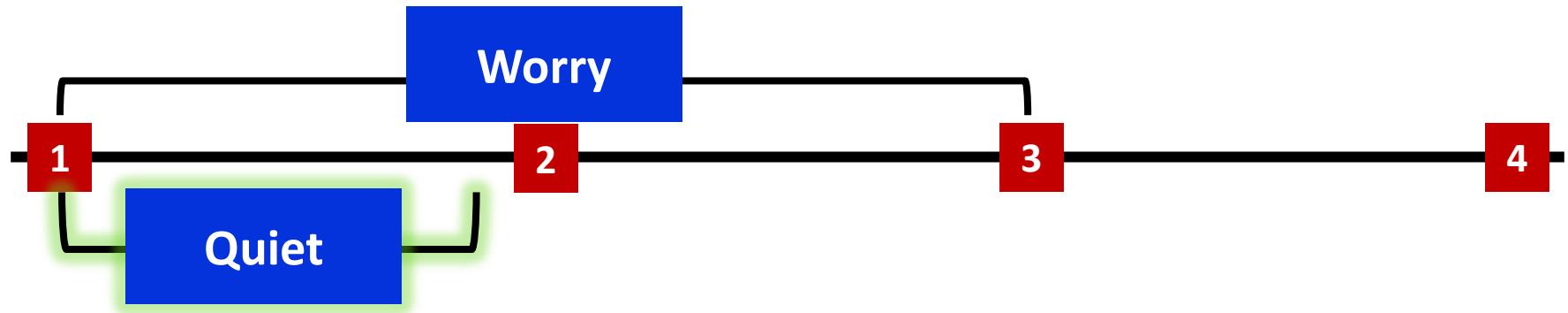
Quiet

Rude

Promises

Challenges

The Time Interval Problem



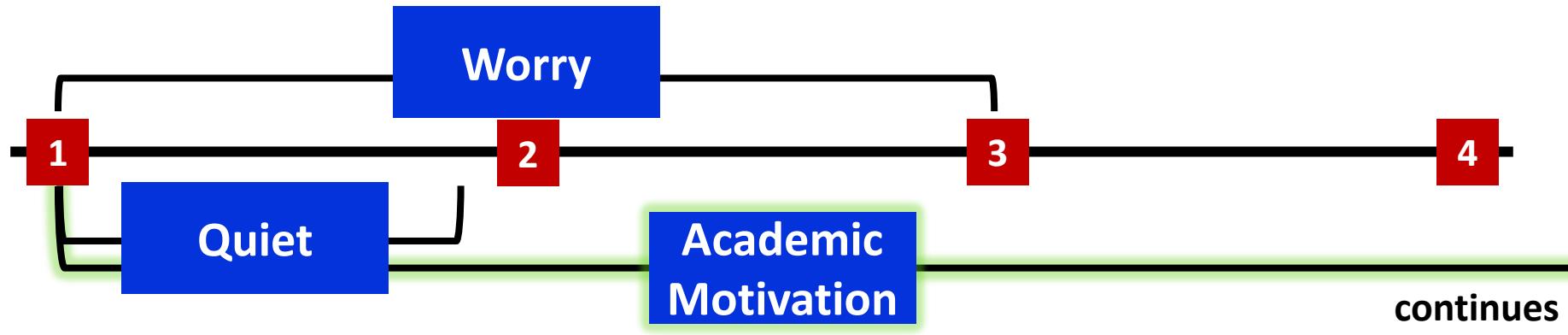
Academic
Motivation

Rude

Promises

Challenges

The Time Interval Problem

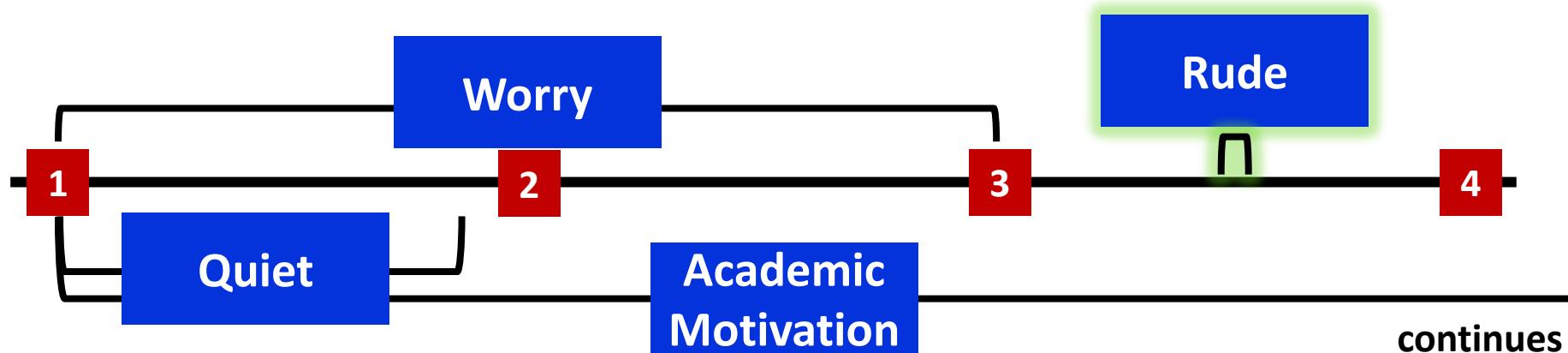


Rude

Promises

Challenges

The Time Interval Problem

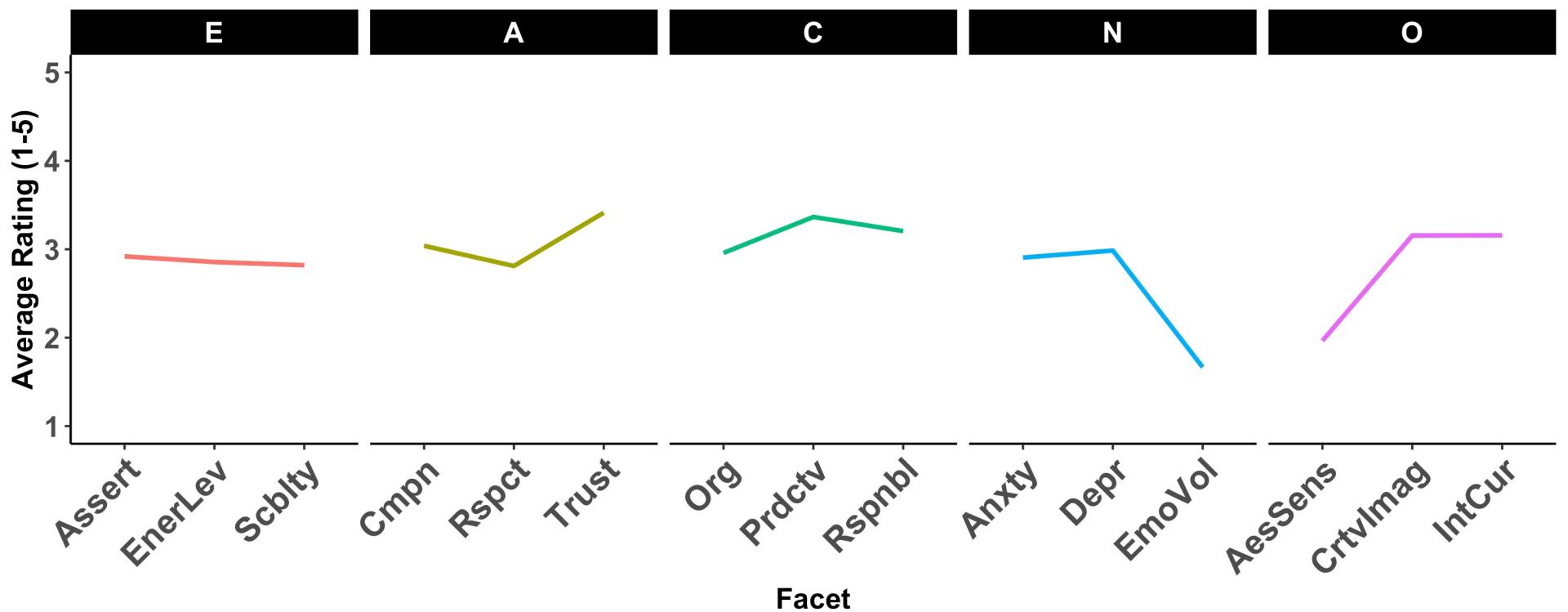


Promises

Challenges

Psychometrics

Extraversion	Agreeableness	Conscientiousness	Neuroticism	Openness
Was outgoing, sociable.	Was compassionate, had a soft heart.	Tended to be lazy.	Was relaxed, handled stress well.	Had little interest in abstract ideas.
Was talkative.	Was polite, courteous to others.	Was reliable, could always be counted on.	Worried a lot.	Was complex, a deep thinker.
Sociability	Compassion	Responsibility	Anxiety	Intellectual Curiosity

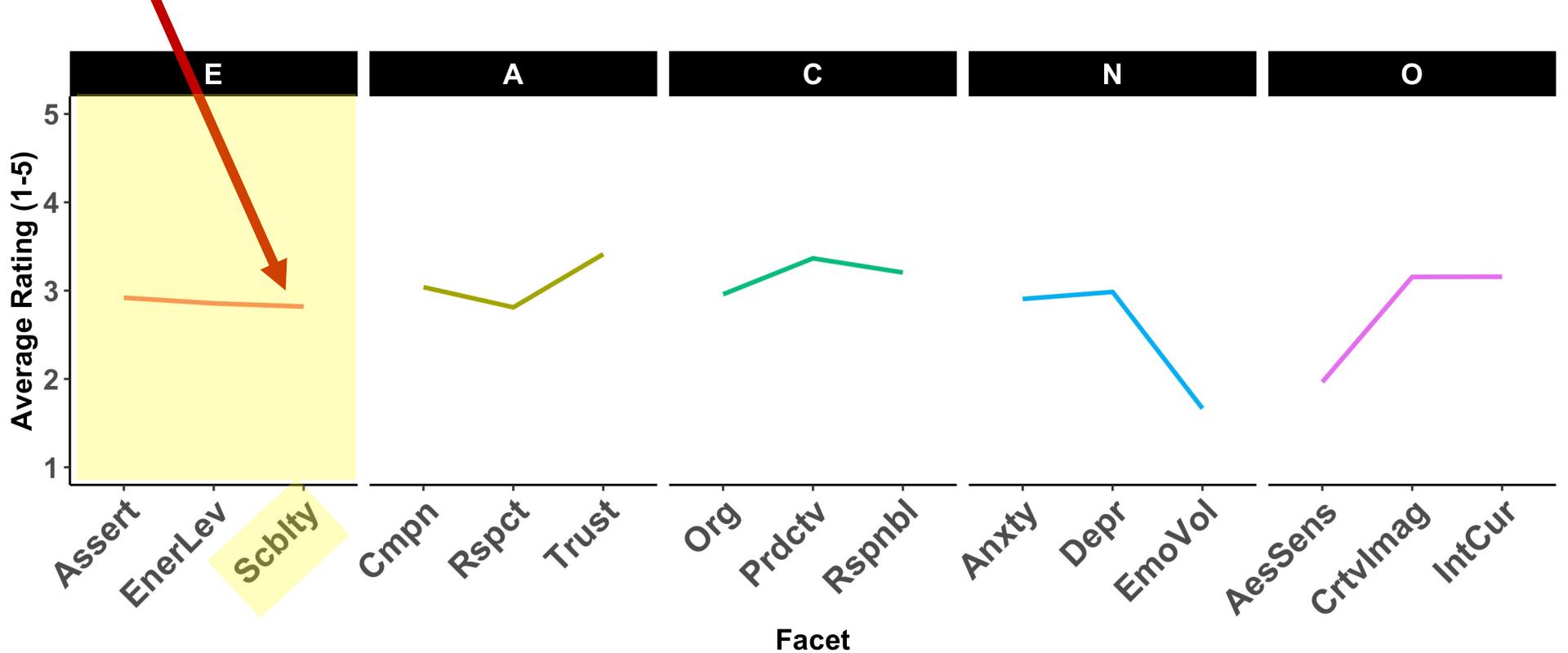


Promises

Challenges

Psychometrics

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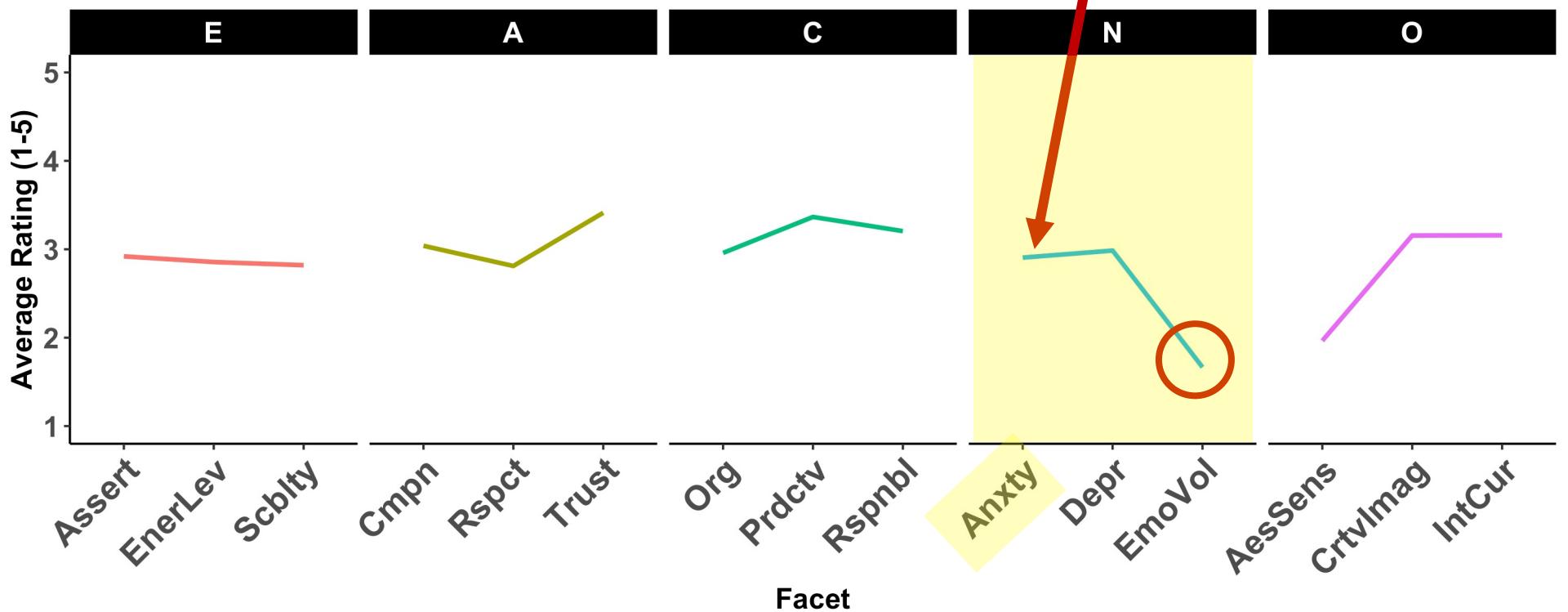


Promises

Challenges

Psychometrics

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Sociability	Compassion	Responsibility	Anxiety	Intellectual Curiosity



Promises

Challenges

Psychometrics

Extraversion	Agreeableness	Conscientiousness	Neuroticism	Openness
Was outgoing, sociable.	Was compassionate, had a soft heart.	Was systematic, liked to keep things in order.	Was tense.	Was curious about many different things.
Was talkative.	Was helpful and unselfish with others.	Kept things neat and tidy.	Worried a lot.	Was complex, a deep thinker.
Tended to be quiet.	Felt little sympathy for others.	Tended to be disorganized.	Was relaxed, handled stress well.	Avoided intellectual, philosophical discussions.
Was sometimes shy, introverted.	Was cold and uncaring.	Left a mess, didn't clean up.	Rarely felt anxious or afraid.	Had little interest in abstract ideas.
Had an assertive personality.	Was respectful, treated others with respect.	Was efficient, got things done.	Often felt sad.	Was fascinated by art, music, or literature.
Was dominant, acted as a leader.	Was polite, courteous to others.	Was persistent, worked until the task was finished.	Tended to feel depressed, blue.	Valued art and beauty.
Found it hard to influence people.	Started arguments with others.	Tended to be lazy.	Stayed optimistic after experiencing a setback.	Had few artistic interests.
Preferred to have others take charge.	Was sometimes rude to others.	Had difficulty getting started on tasks.	Felt secure, comfortable with self.	Thought poetry and plays were boring.
Was full of energy.	Had a forgiving nature.	Was dependable, steady.	Was moody, had up and down mood swings.	Was inventive, found clever ways to do things.
Showed a lot of enthusiasm.	Assumed the best about people.	Was reliable, could always be counted on.	Was temperamental, got emotional easily.	Was original, came up with new ideas.
Rarely felt excited or eager.	Tended to find fault with others.	Was somewhat careless.	Was emotionally stable, not easily upset.	Had little creativity.
Was less active than other people.	Was suspicious of others' intentions.	Sometimes behaved irresponsibly.	Kept their emotions under control.	Had difficulty imagining things.

Promises

Challenges

Summary

Structure

The Time Interval
Problem

Process

Psychometrics

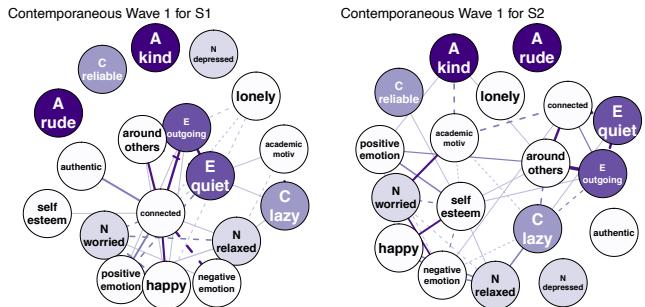
Development

Aggregation

Promises

Challenges

Summary



The Time Interval Problem

Process

Psychometrics

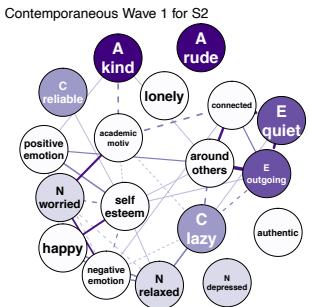
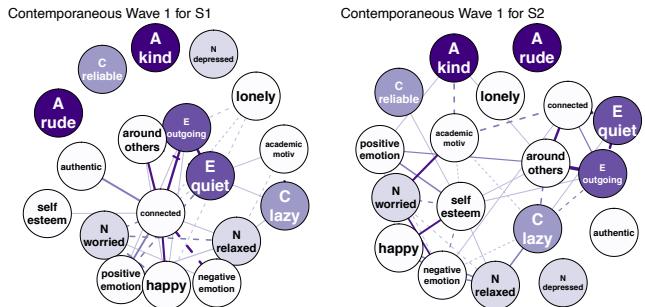
Development

Aggregation

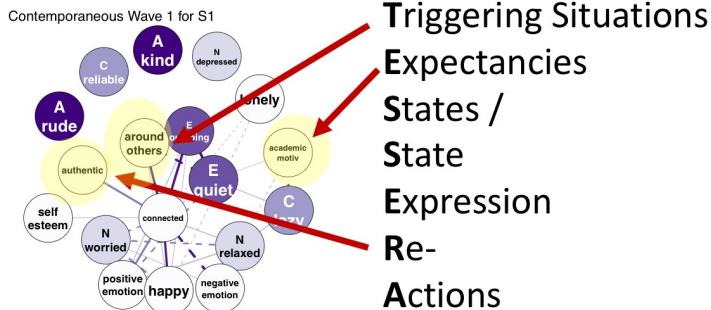
Promises

Challenges

Summary



The Time Interval Problem



**States /
State
Expression
Re-
Actions**

Psychometrics

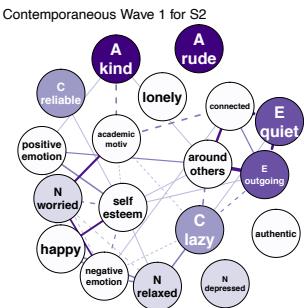
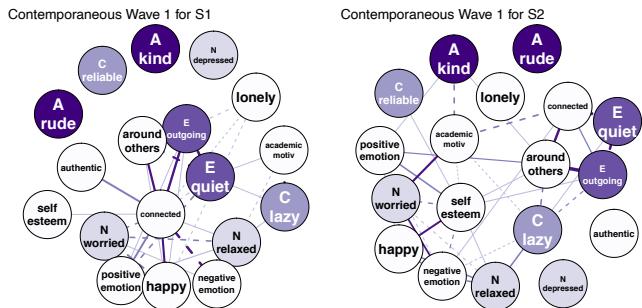
Development

Aggregation

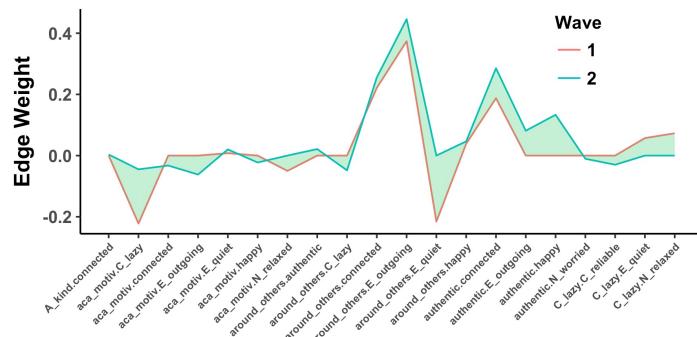
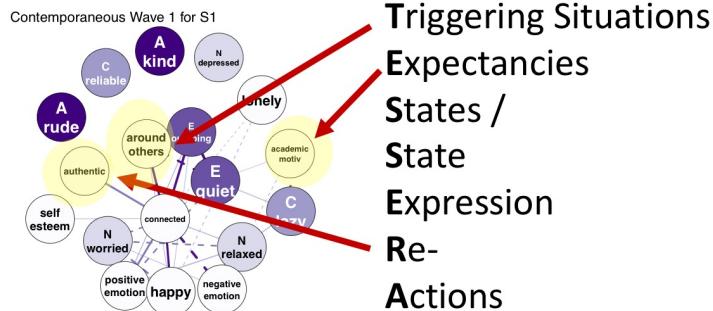
Promises

Challenges

Summary



The Time Interval Problem



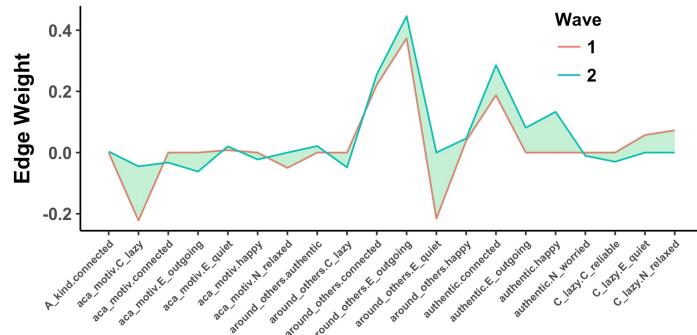
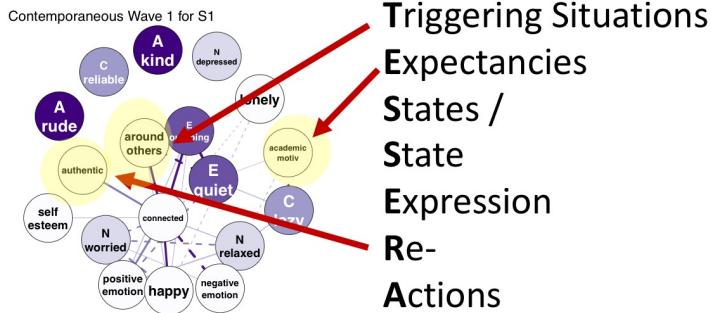
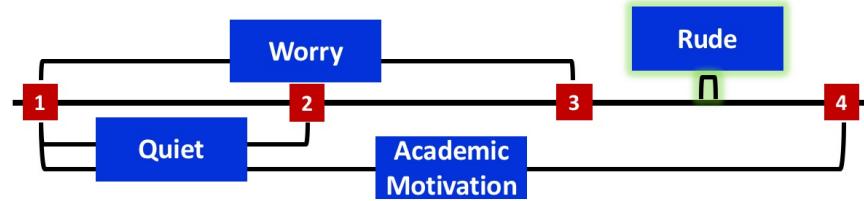
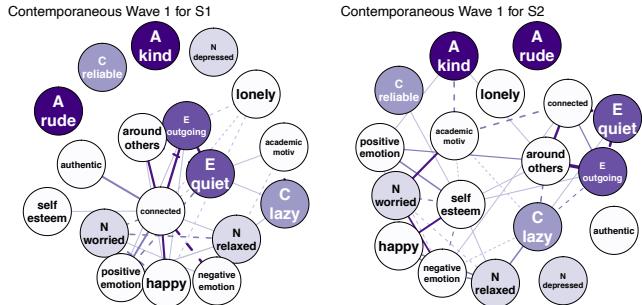
Psychometrics

Aggregation

Promises

Challenges

Summary



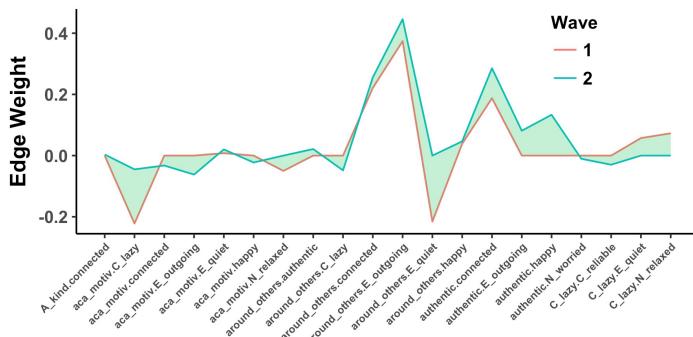
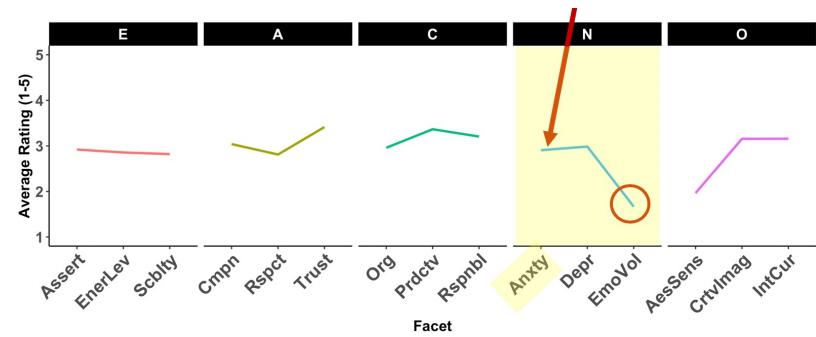
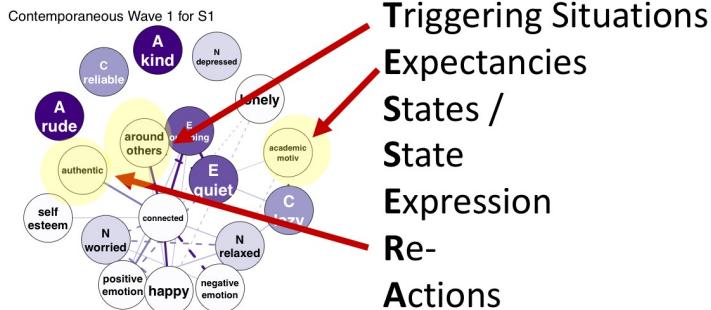
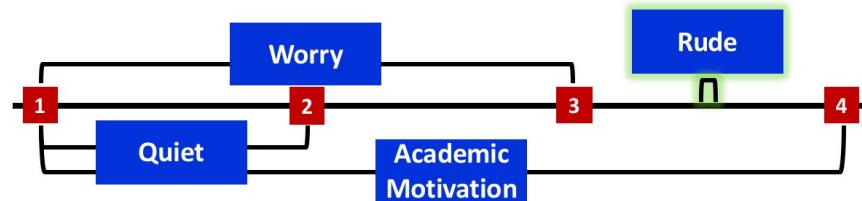
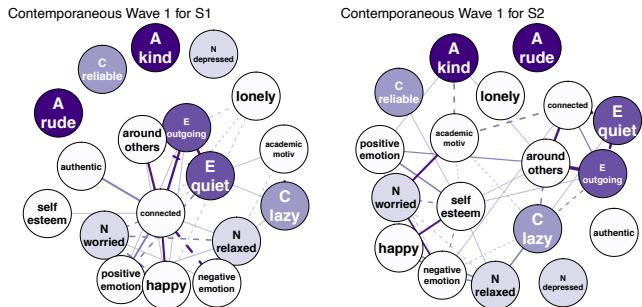
Psychometrics

Aggregation

Promises

Challenges

Summary



Aggregation

Questions?

Special Thanks to:

Josh Jackson

The PMaD Lab

(And the people who
brought us PAIRS data)



Results:

[https://pmdlab.wustl.edu/
Beck_2019.html](https://pmdlab.wustl.edu/Beck_2019.html)



Data and Code:

https://github.com/emorybeck/APS_2018

The Big 5

Extraversion

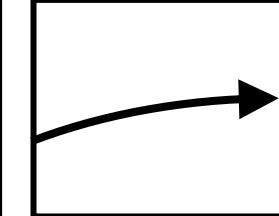
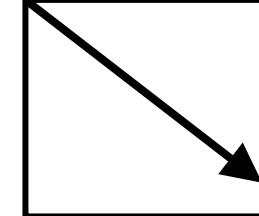
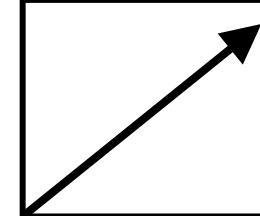
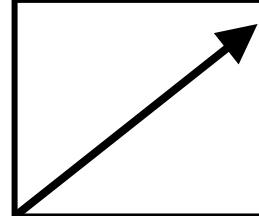
Agreeableness

Conscientiousness

Neuroticism

Openness

Direction



Magnitude

--

.6 SD

1 SD

-.8 SD

.4 SD

Timing

--

Lifespan

Lifespan

10-35

10-20

Roberts, Walton, & Viechtbauer, 2006

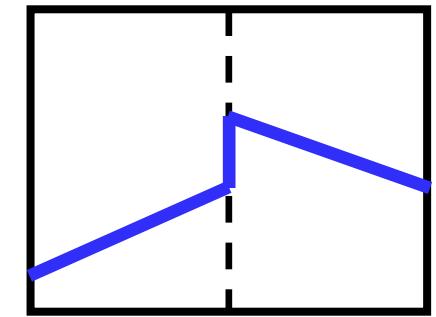
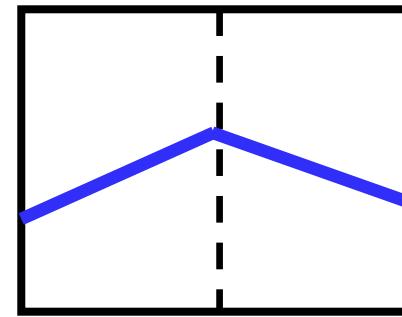
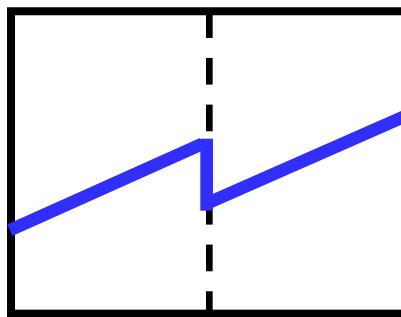
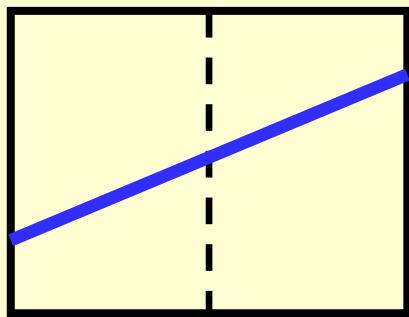
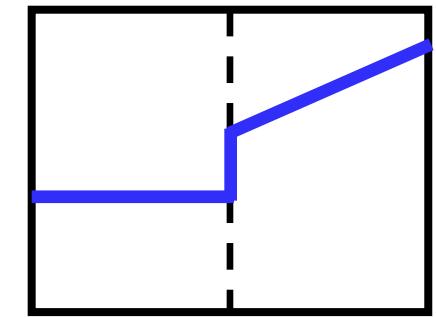
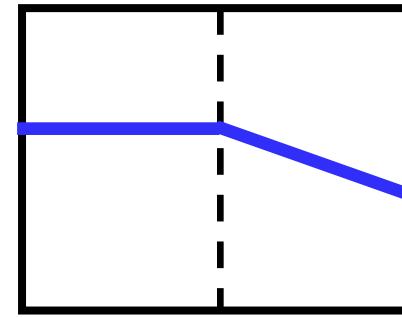
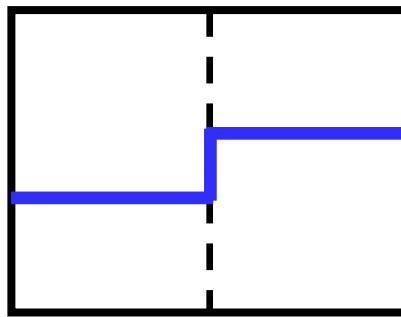
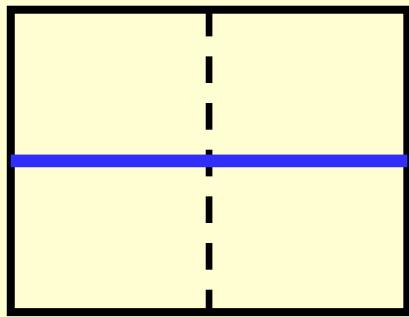
	Marriage	Moved in with Partner	Divorced	Separated from Partner	Death of Partner/Spouse	Leaving Parental Home	Child Leaves Home	Birth of Child	Death of Parent	Unemployment	Retirement	First Job
E	X	X	X	X	X	X	✓	X	X	X	X	X
A	X	X	X	✓	X	X	X	X	X	X	X	X
C	X	X	X	X	X	X	X	X	X	X	X	X
Z	X	X	X	X	X	X	X	X	X	X	X	X
O	X	X	X	X	X	X	X	X	X	X	X	X

Problems with Mean-Level Change

Timing

Independence
of Traits

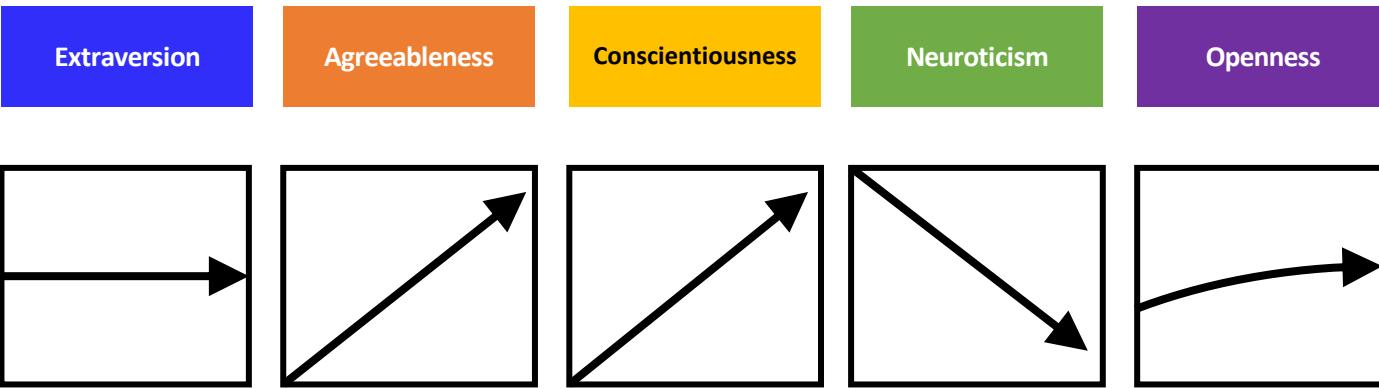
Timing of Change



Schwaba & Bleidorn, 2017; Doss et al., 2009 ; Bleidorn et al., 2016

“No trait operates alone”

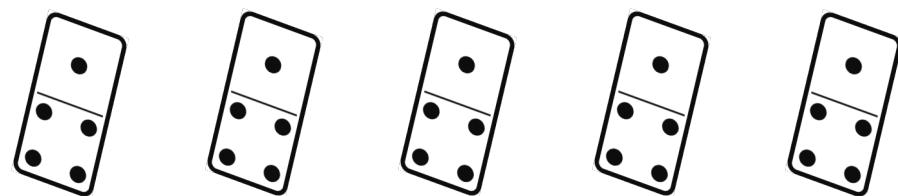
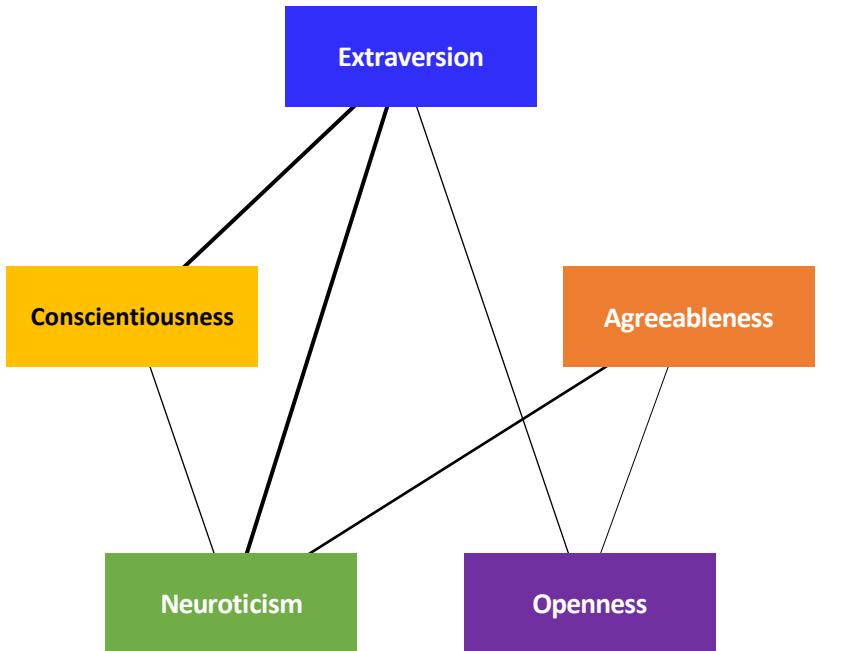
Allport, 1937, p. 330



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

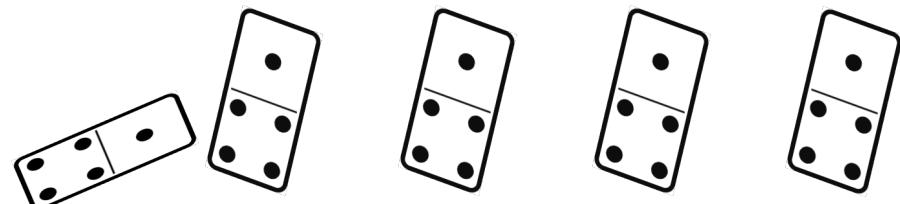
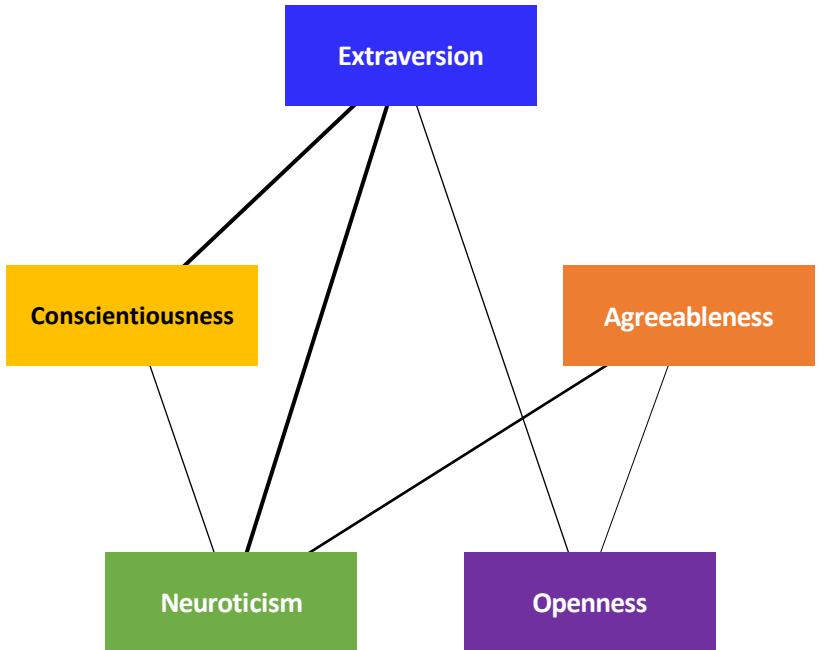
“No trait operates alone”

Allport, 1937, p. 330



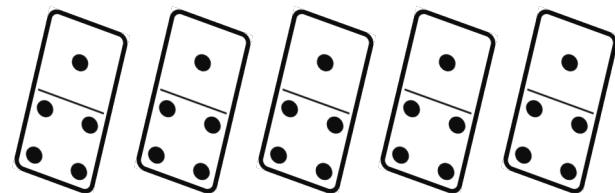
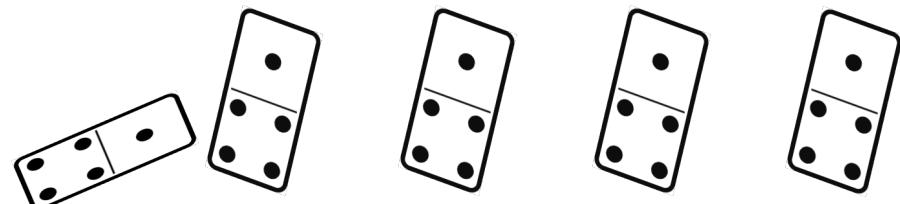
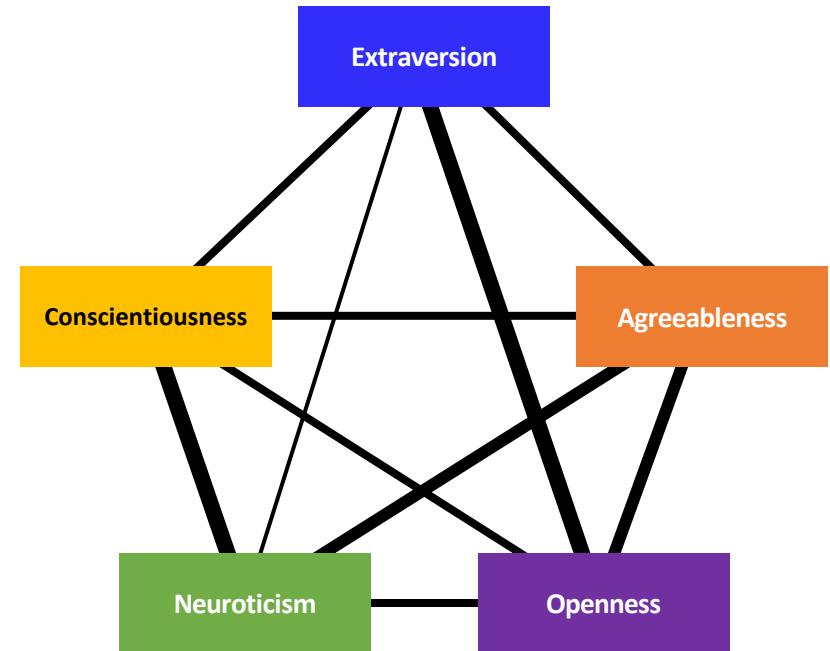
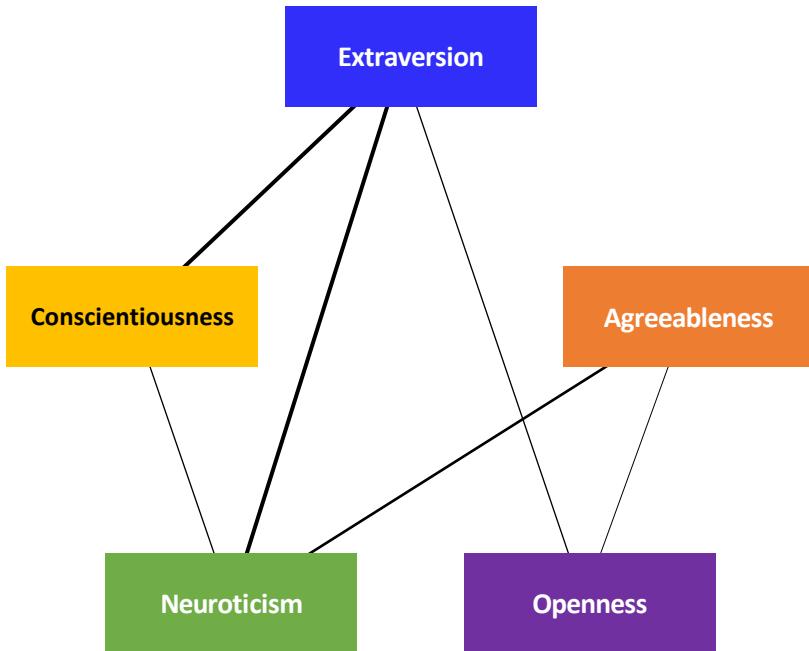
“No trait operates alone”

Allport, 1937, p. 330



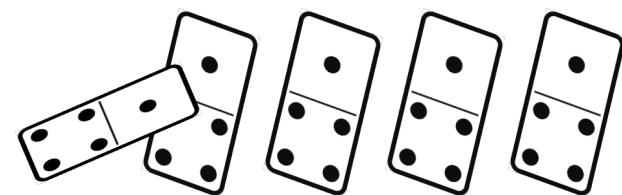
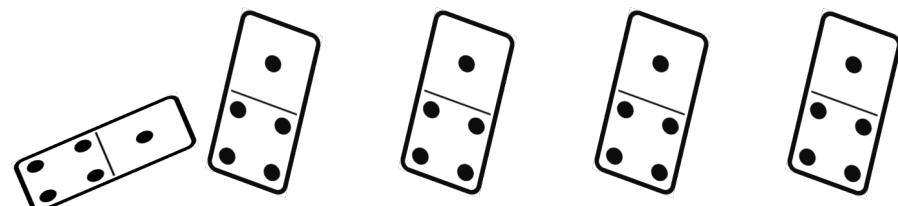
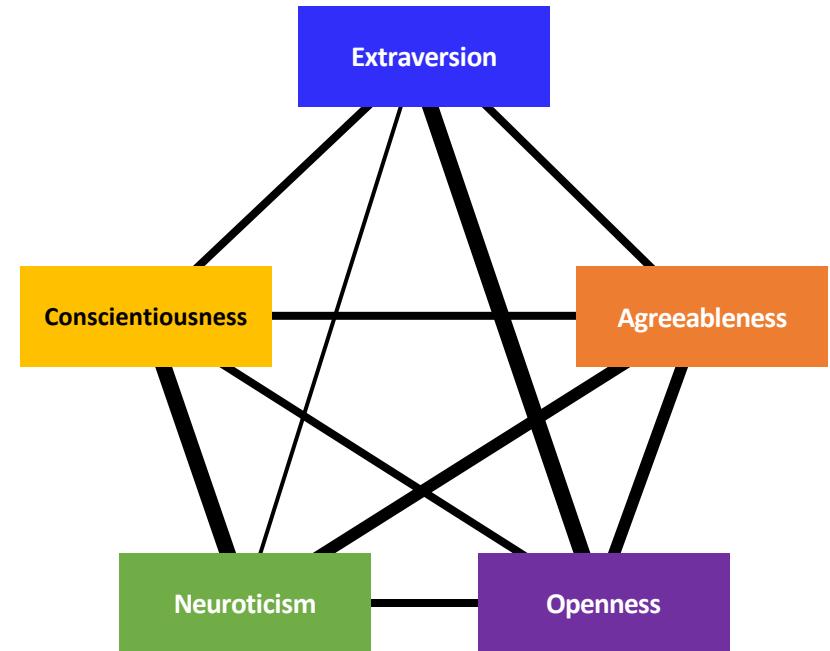
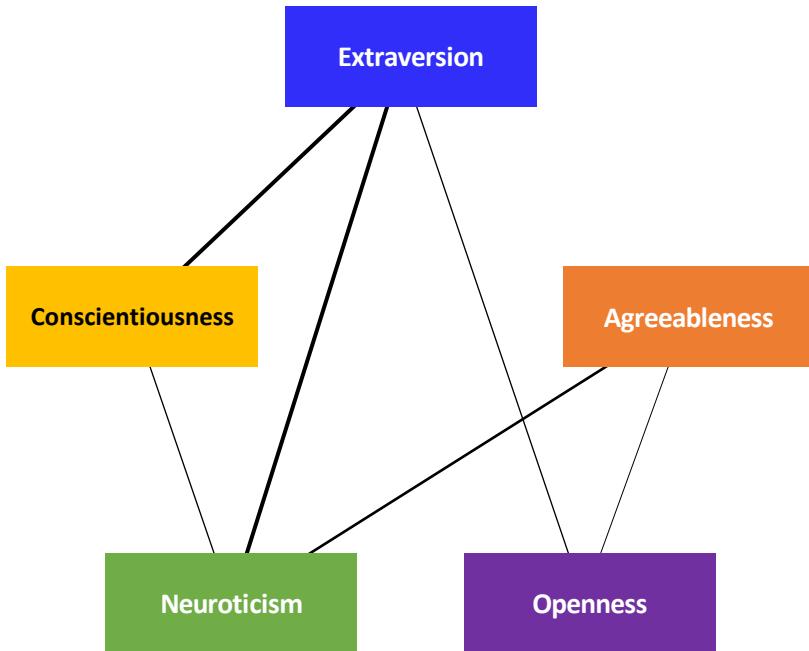
“No trait operates alone”

Allport, 1937, p. 330



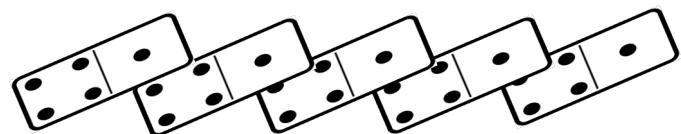
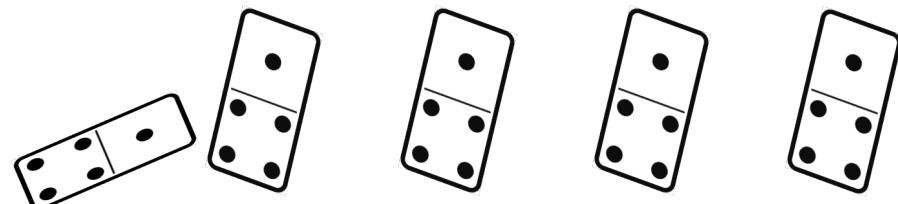
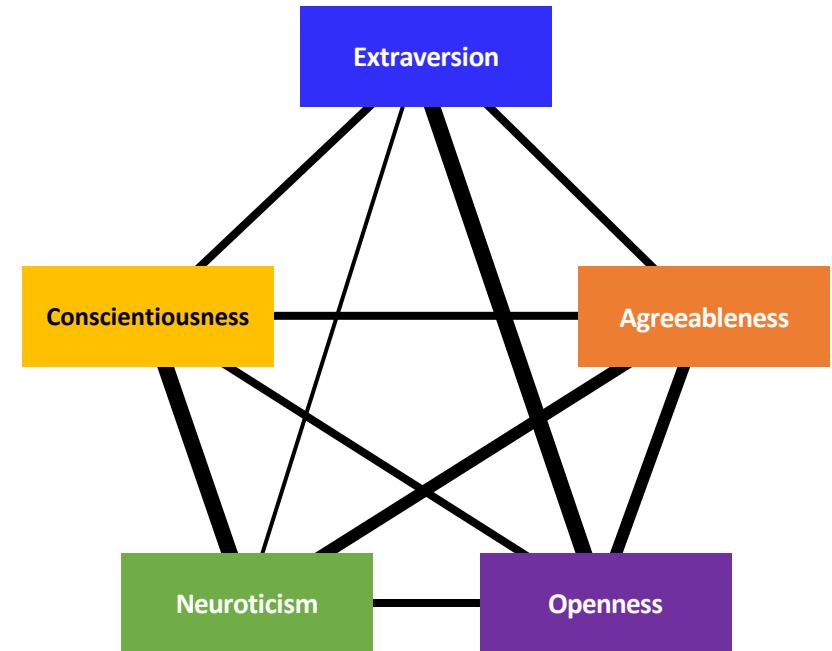
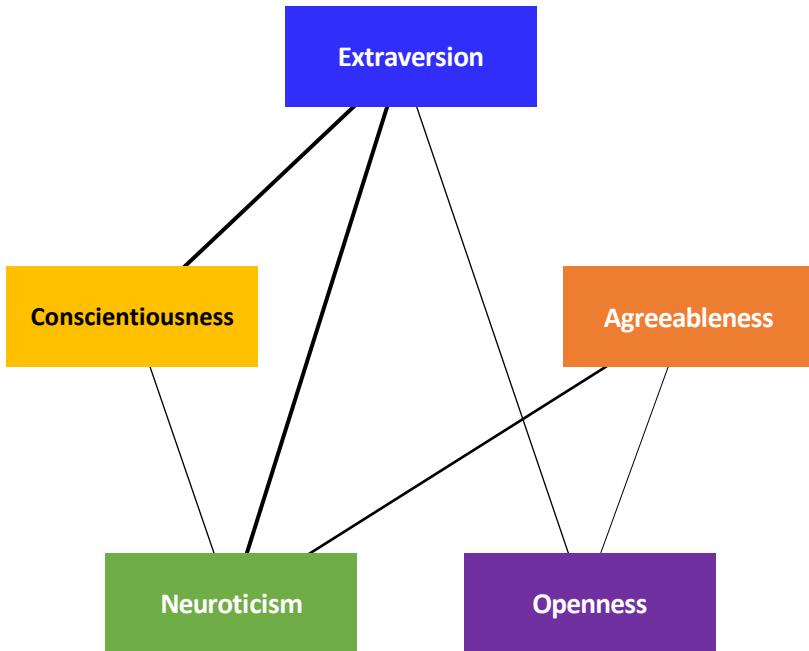
“No trait operates alone”

Allport, 1937, p. 330



“No trait operates alone”

Allport, 1937, p. 330



Promises

Challenges

Development

SCIENTIFIC REPORTS



OPEN

Testing for the Presence of Correlation Changes in a Multivariate Time Series: A Permutation Based Approach

Jedelyn Cabrieto¹, Francis Tuerlinckx¹, Peter Kuppens¹, Borbála Hunyadi^{2,3} & Eva Ceulemans¹

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Published online: 15 January 2018

1

Moving Window Correlations

2

Gaussian Similarity between all possible phases for different k

$$Gk(\mathbf{R}_i, \mathbf{R}_j) = \exp\left(\frac{-\|\mathbf{R}_i - \mathbf{R}_j\|^2}{2h_R^2}\right)$$

$$\mathbf{R}_i = \begin{bmatrix} w_{i,1} \\ w_{i,2} \\ \vdots \\ w_{i,\frac{V(V-1)}{2}} \end{bmatrix}$$

3

Calculate average within-phase Variance of Gaussian Similarity

$$\hat{R}(\tau_1, \tau_2, \dots, \tau_K) = \frac{1}{n} \sum_{p=1}^{K+1} \hat{V}_p, \tau_1, \tau_2, \dots, \tau_K$$

$$\hat{V}_{p,\tau_1,\tau_2,\dots,\tau_K} = (\tau_p - \tau_{p-1}) - \frac{1}{\tau_p - \tau_{p-1}} \sum_{i=\tau_{p-1}+1}^{\tau_p} \sum_{j=\tau_{p-1}+1}^{\tau_p} Gk(\mathbf{R}_i, \mathbf{R}_j)$$

4

Repeat steps 1 and 2 for 1000 permuted data sets

$$p_{variancetest} = \frac{\#(\hat{R}_{min,K=0,perm} > \hat{R}_{min,K=0})}{B}$$

5

Perform the variance test

$$p_{variancedropertest} = \frac{\#(\max variance drop_{perm} > \max variance drop)}{B}$$

6

Perform the variance drop test

7

Declare significance if either the variance or variance drop tests passes

$$pen_K = C \frac{V_{max}}{n} \frac{(K+1)}{n} [1 + \log(\frac{n}{K+1})]$$

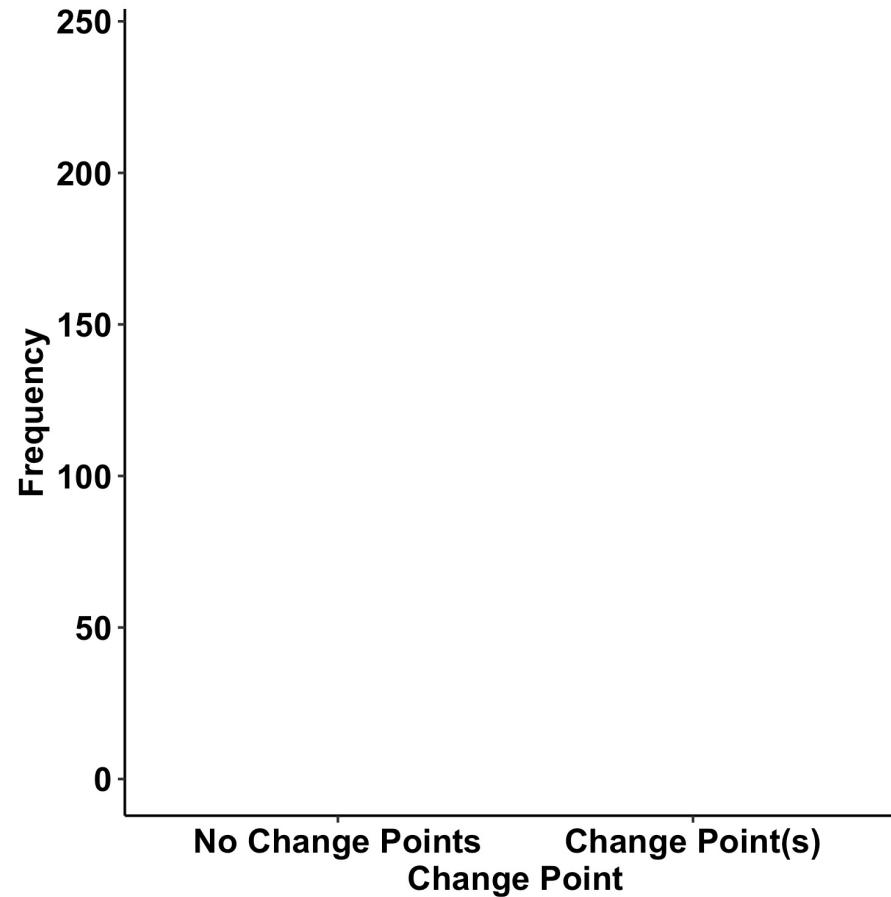
$$\hat{K} = \arg \min \hat{R}_{min,K} + pen_K,$$

8

Keep k of minimum penalized average within-phase variance

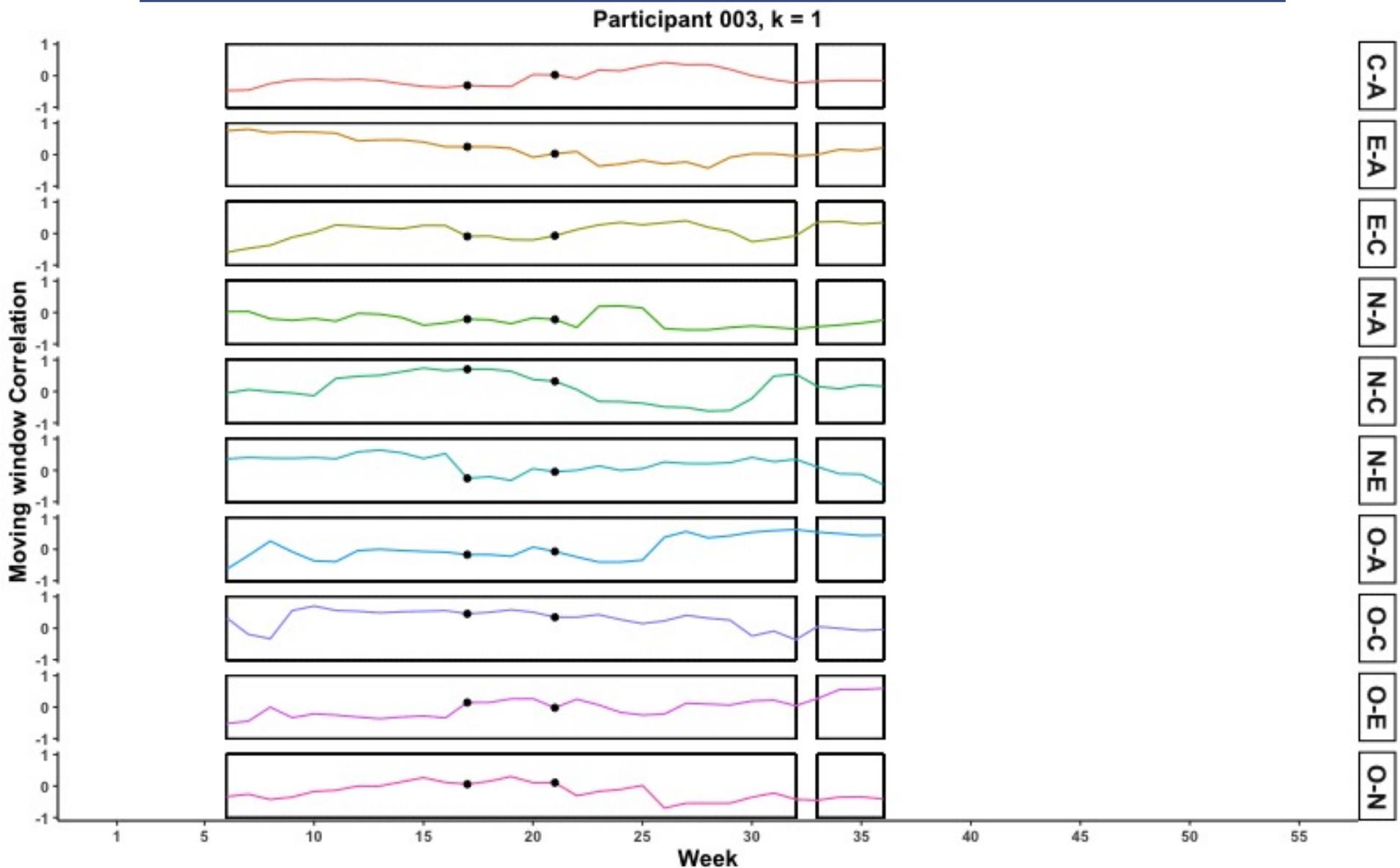
Preregistration: <https://osf.io/mfn8w/>

Did people show correlational changes?

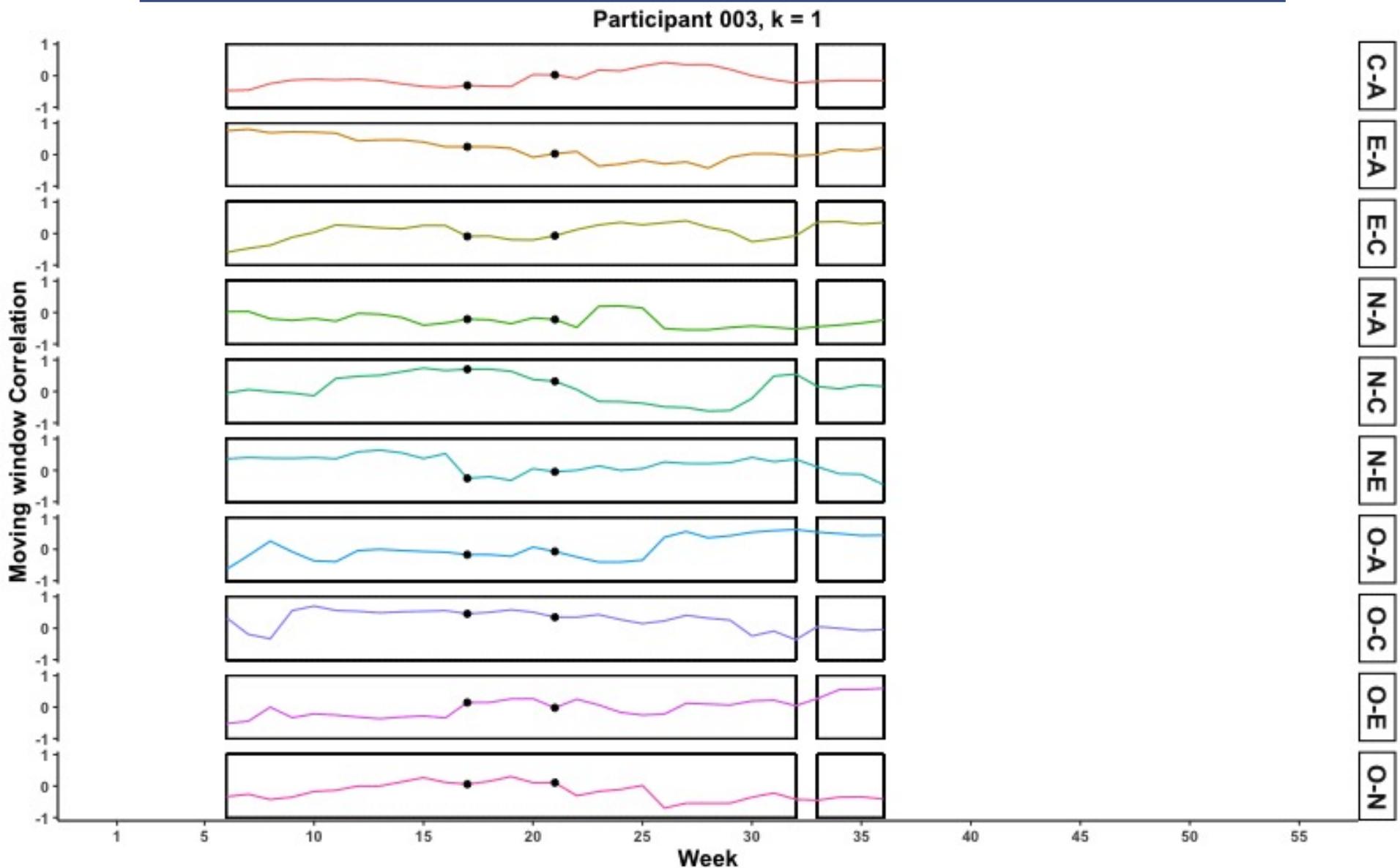


Where were there correlational changes?

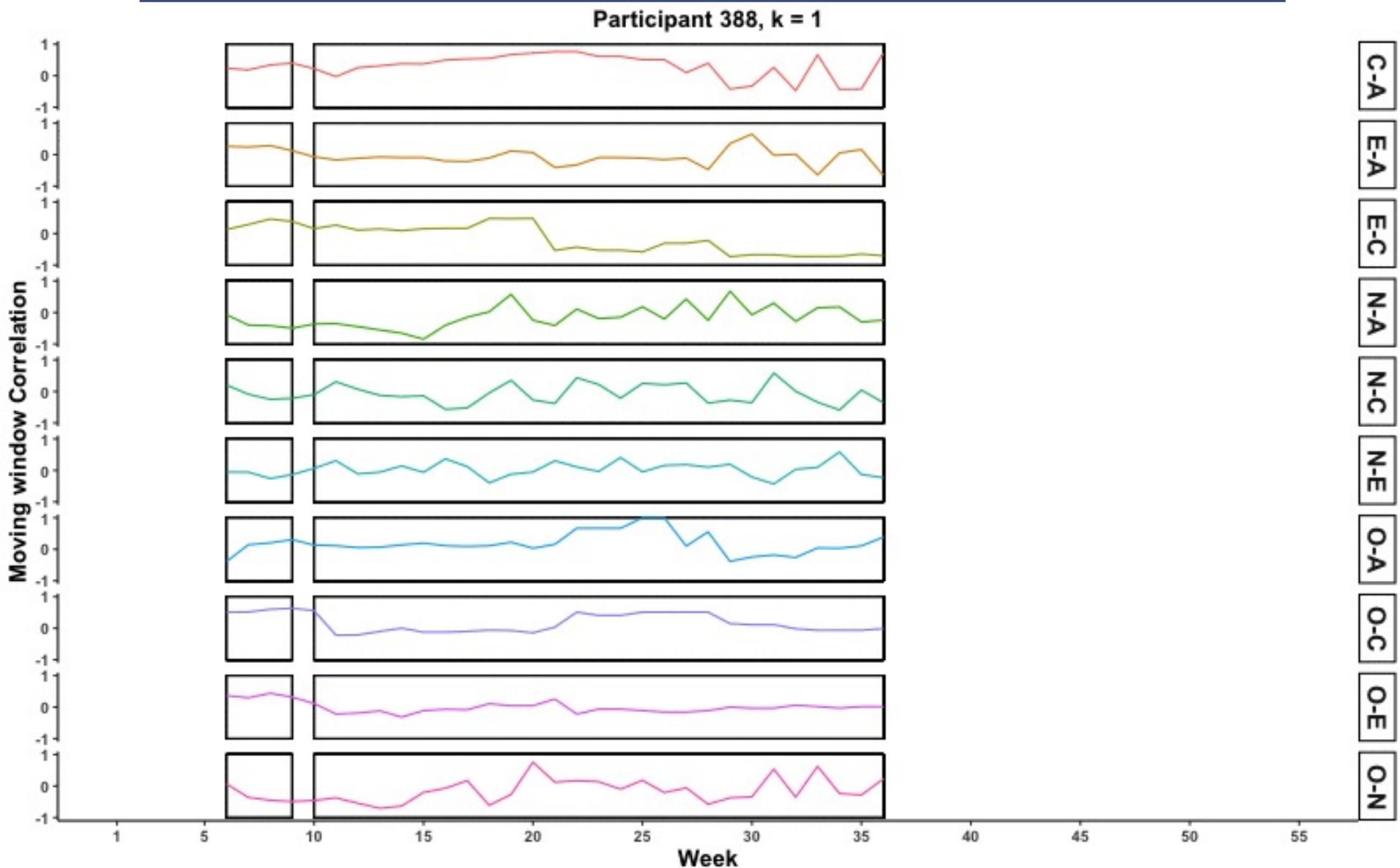
Where were there correlational changes?



Where were there correlational changes?

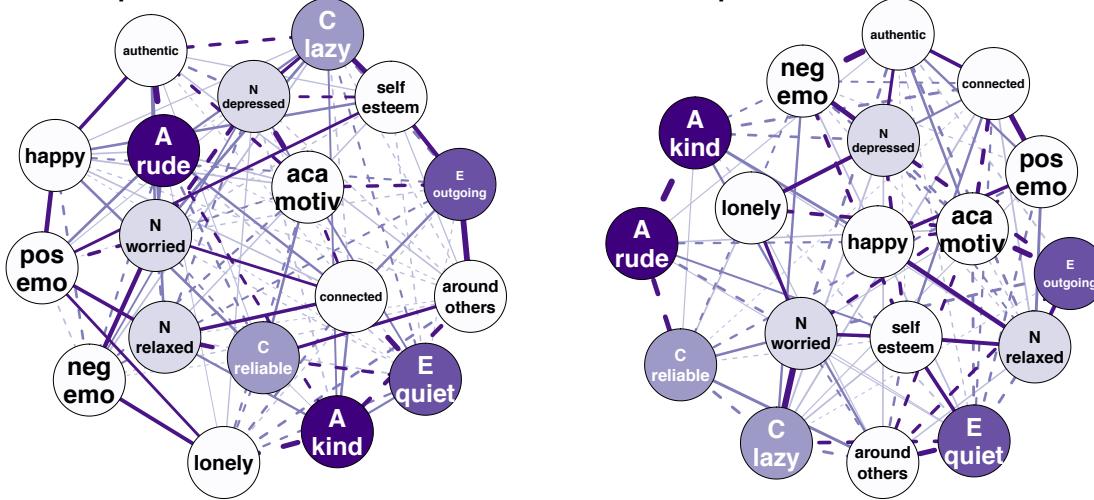


Where were there correlational changes?

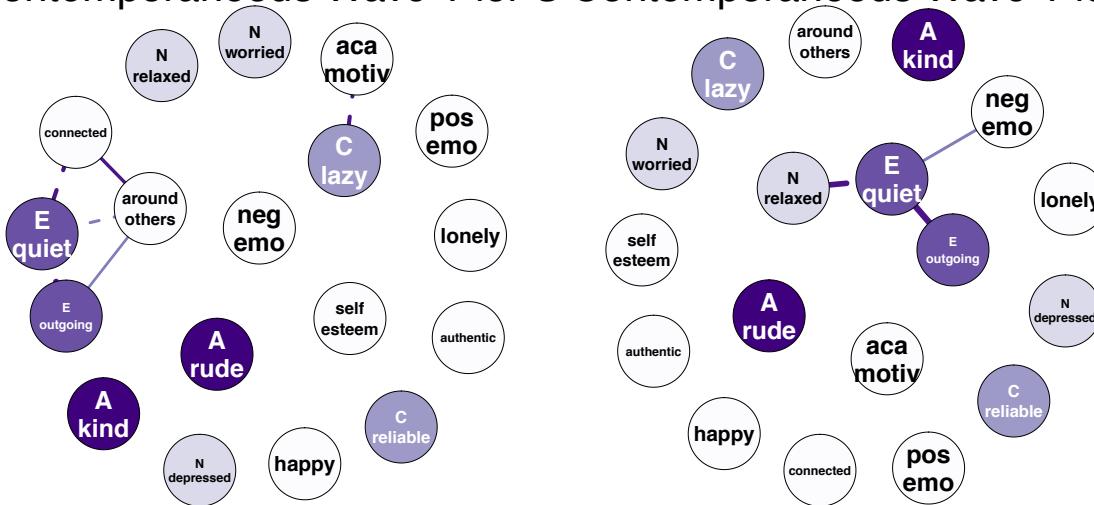


Aggregation

Contemporaneous Wave 1 for S Contemporaneous Wave 1 for S



Contemporaneous Wave 1 for S Contemporaneous Wave 1 for S

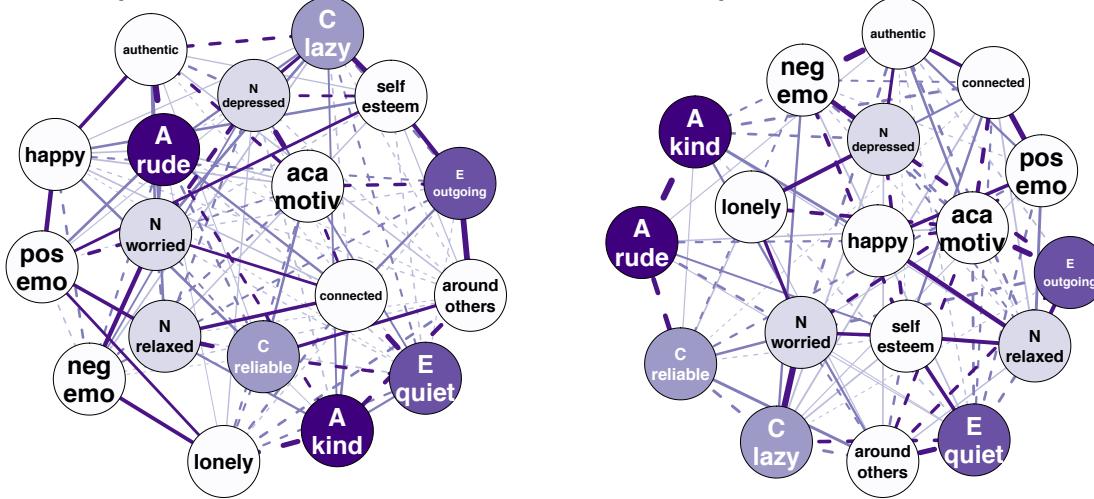


Promises

Challenges

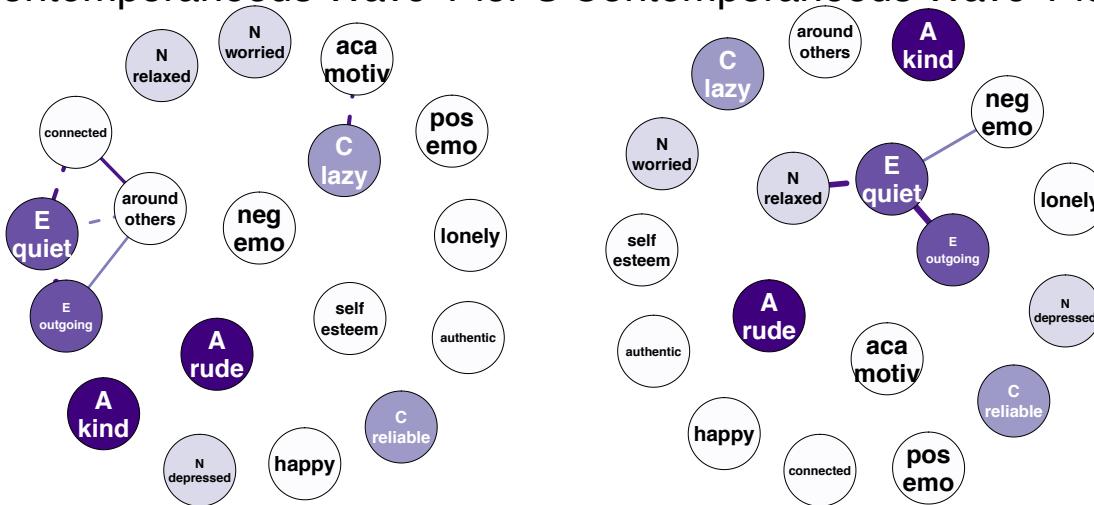
Aggregation

Contemporaneous Wave 1 for S Contemporaneous Wave 1 for S



Centrality

Contemporaneous Wave 1 for S Contemporaneous Wave 1 for S

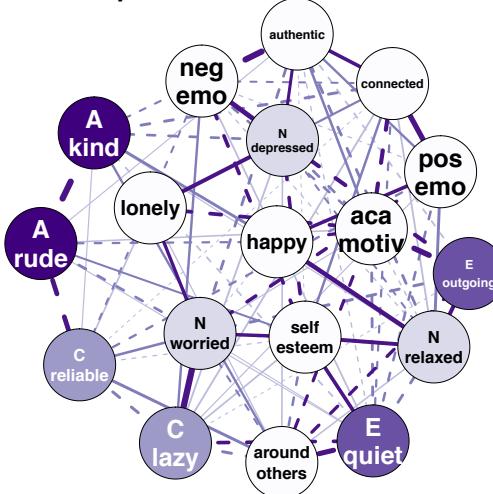
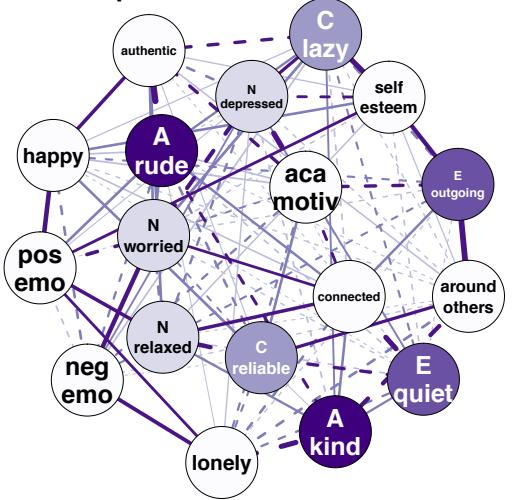


Promises

Challenges

Aggregation

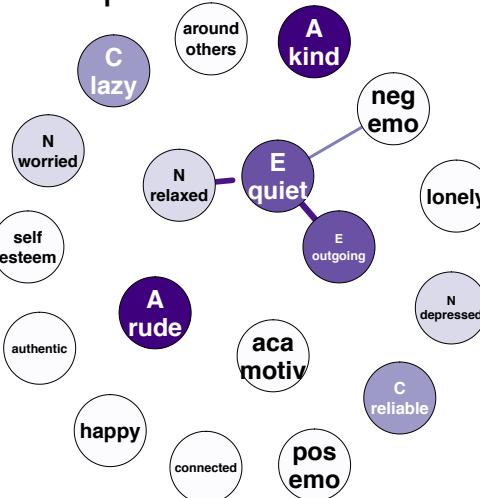
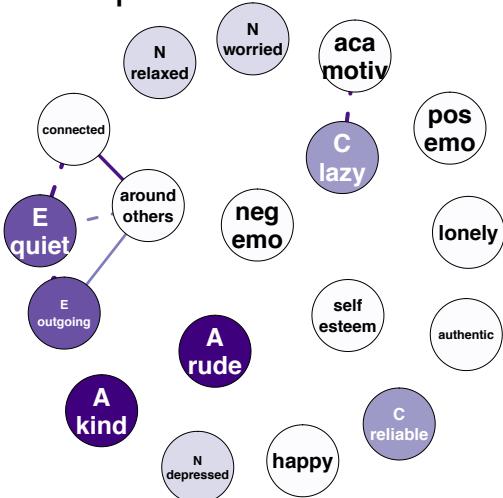
Contemporaneous Wave 1 for S Contemporaneous Wave 1 for S



Centrality

Density

Contemporaneous Wave 1 for S Contemporaneous Wave 1 for S

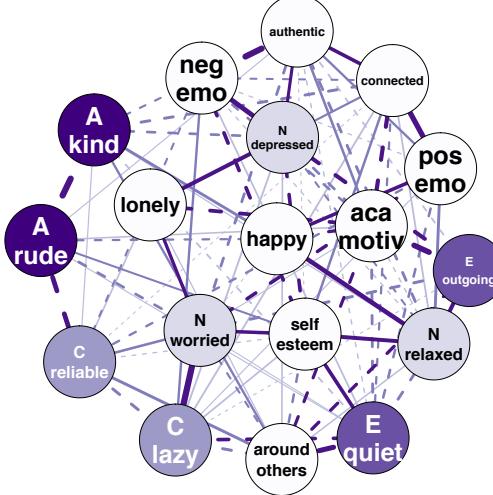
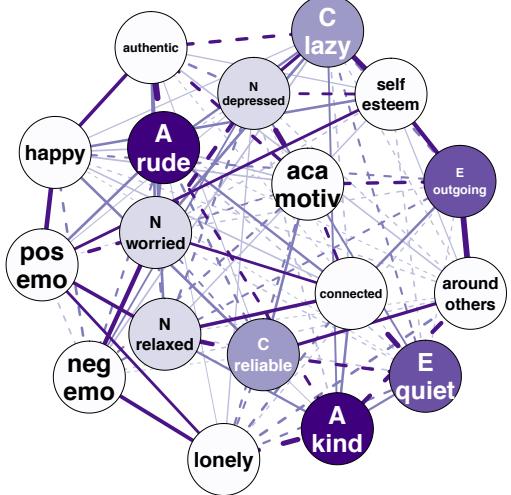


Promises

Challenges

Aggregation

Contemporaneous Wave 1 for S Contemporaneous Wave 1 for S



Centrality

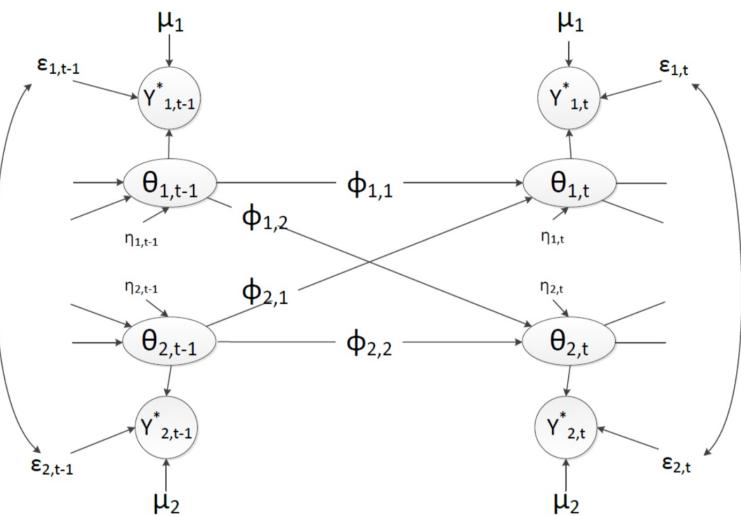
Density

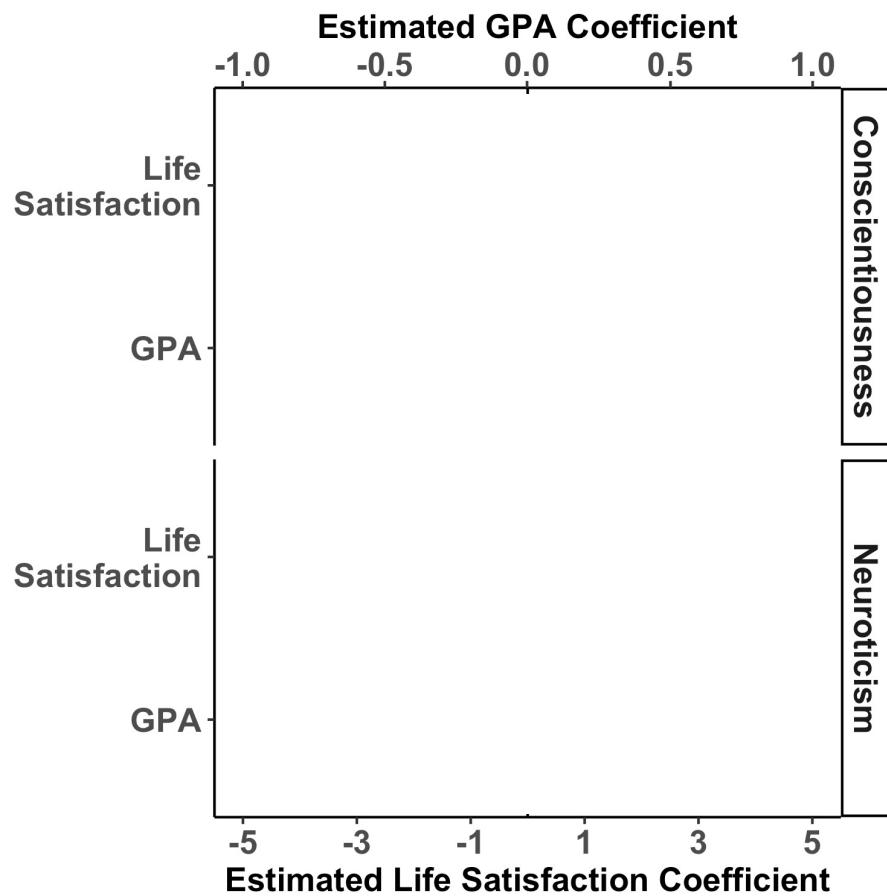
Clustering

Communities

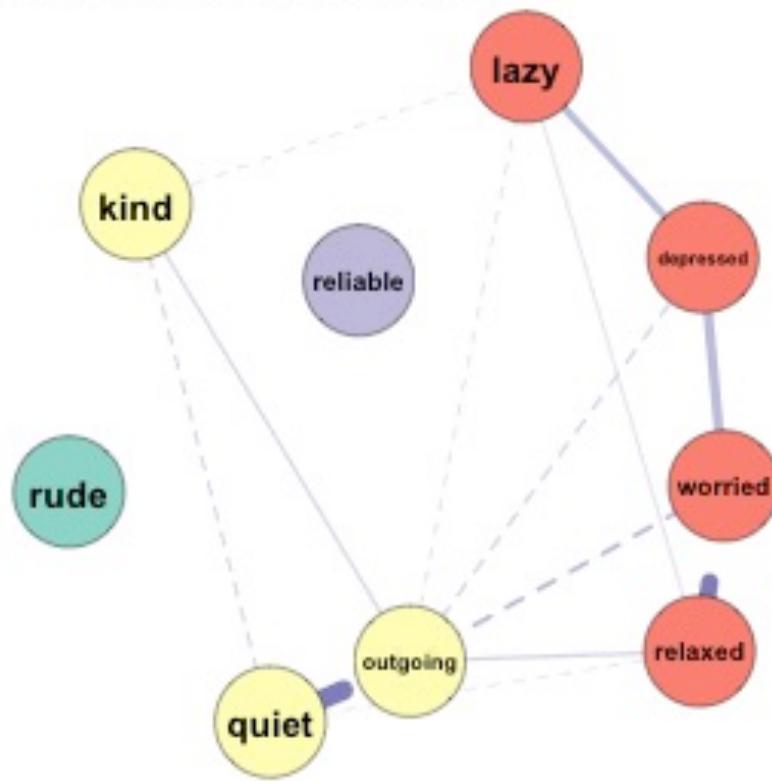
Innovation

Variability

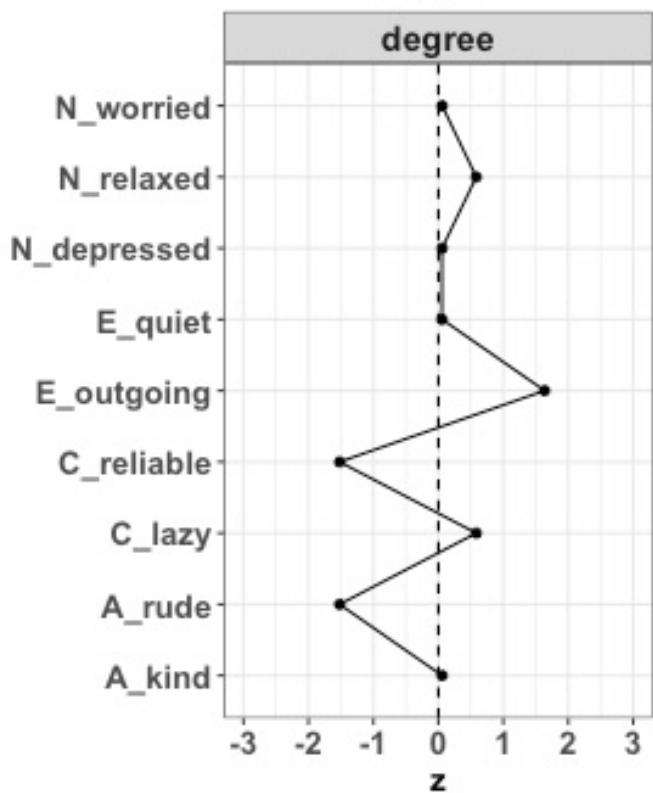




Contemporaneous Wave 1 for S1



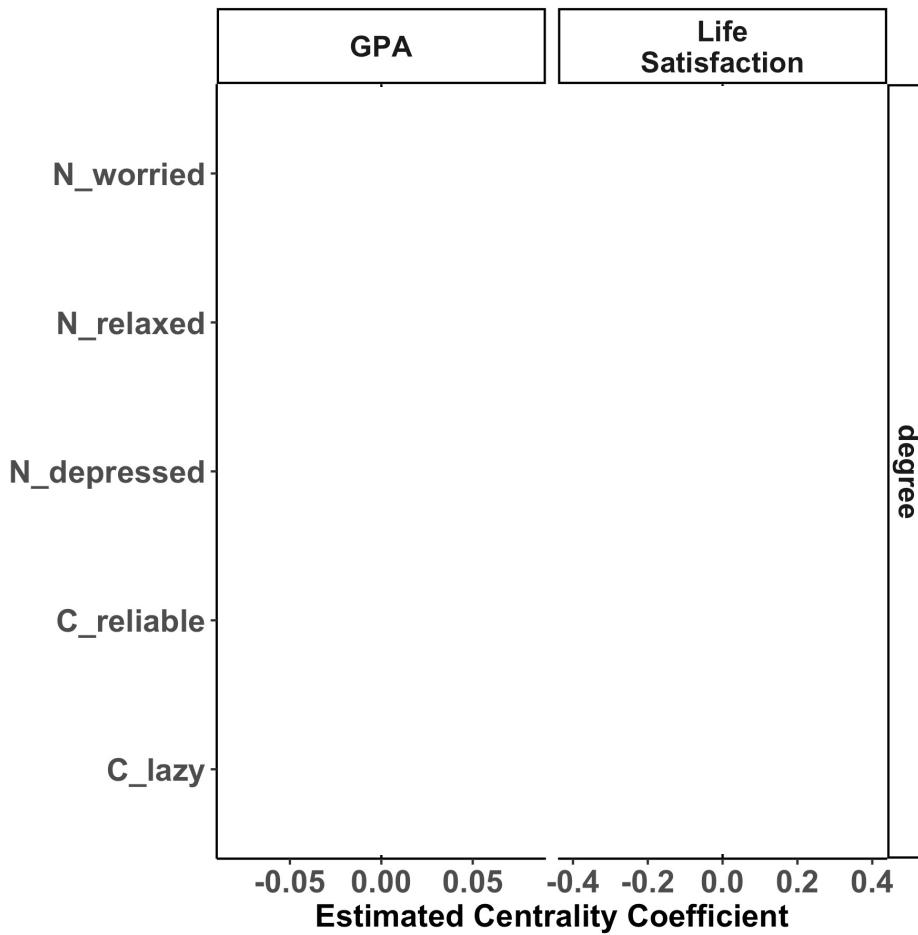
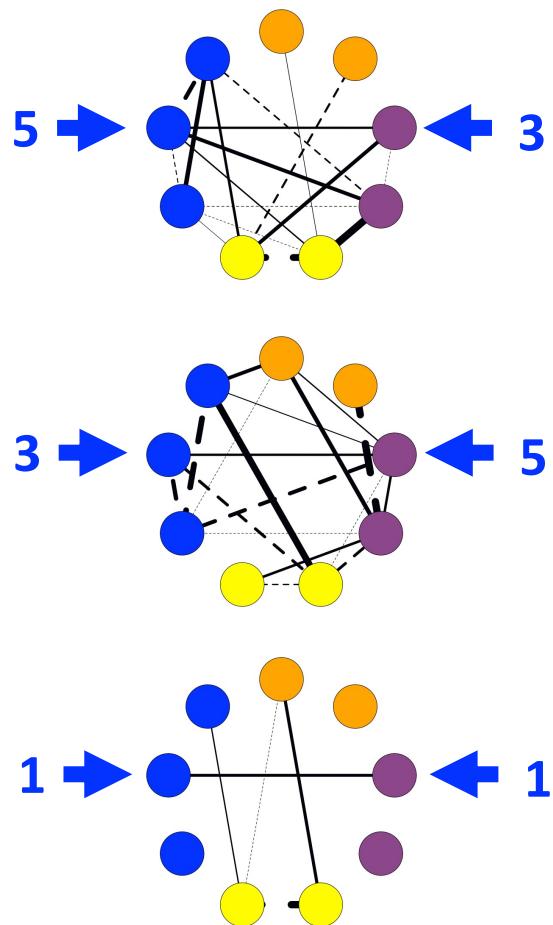
Subject 1



Composites

Centrality

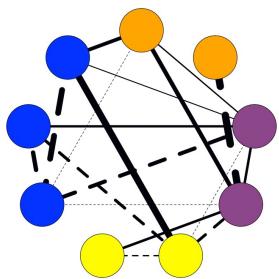
Density



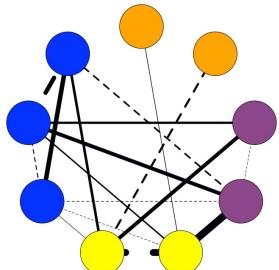
Composites

Centrality

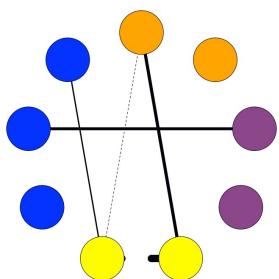
Density



.4
8

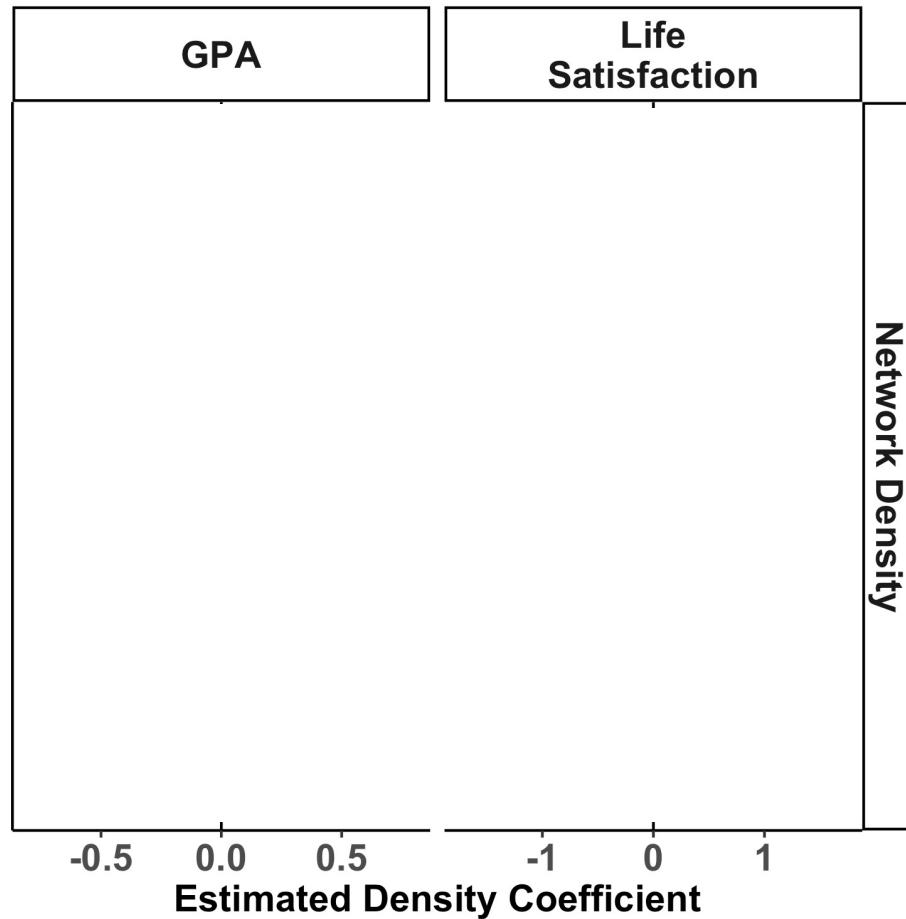


.31



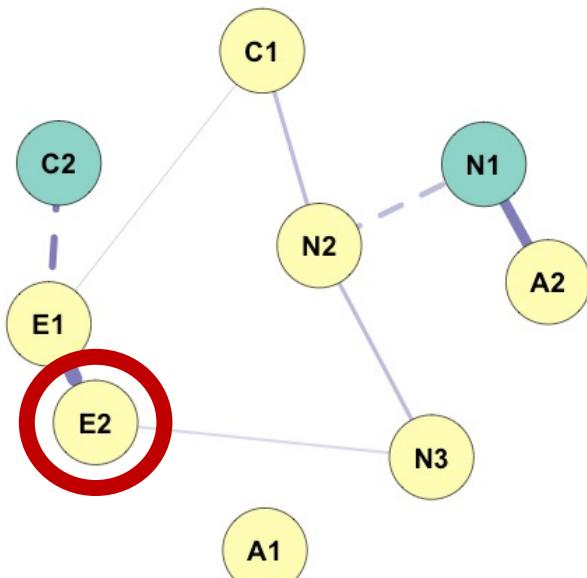
.14

Actual connections
—————
Possible Connections



Low Density, Degree

Contemporaneous Wave 1 for S62



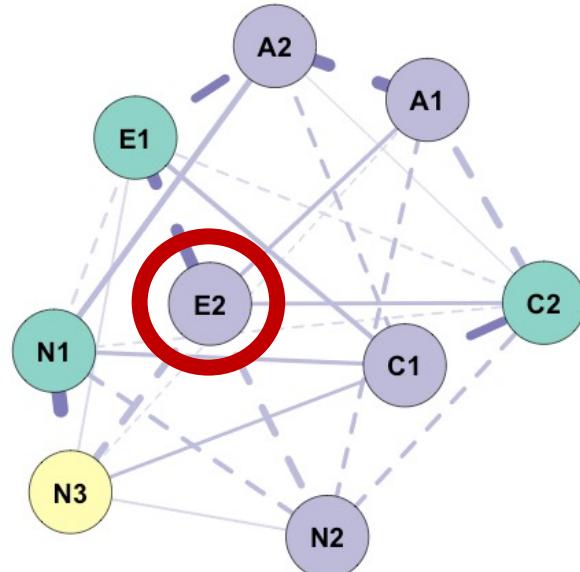
RIGIDITY



CHAOS

High Density, Degree

Contemporaneous Wave 1 for S95





Contemporaneous

Concurrent behaviors: While...

time



1
2
3
4
5
6
7
8
9
10
11

E					
A	0.02				
C	-0.05	0.08			
N	0.64	-0.12	-0.10		
O	0.26	-0.27	0.43	0.07	

Within Time-Points:

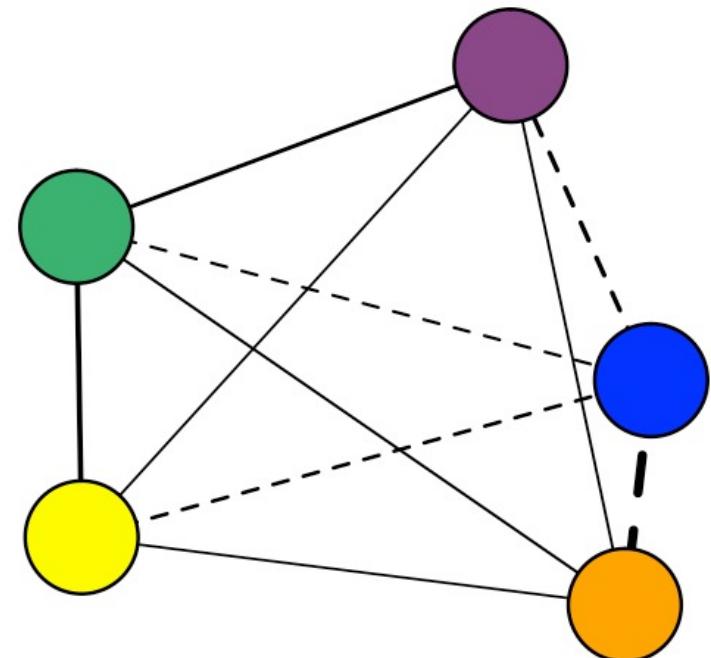
$$X_{it} \leftrightarrow X_{jt}$$

Contemporaneous

Concurrent behaviors: *While...*

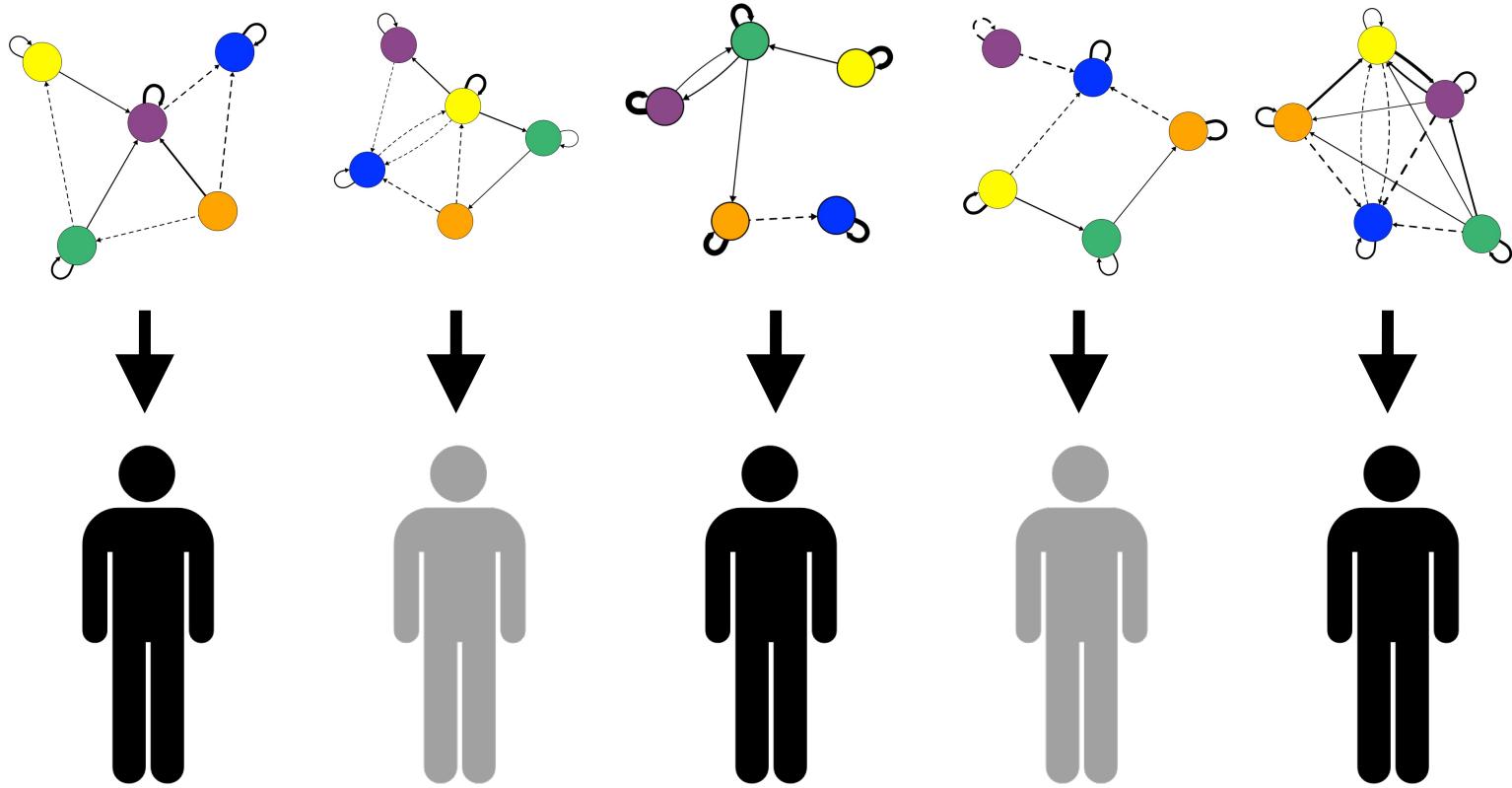
E | A | C | N | O

1	4	2	3	2	4
2	2	3	4	1	4
3	3	3	2	2	4
4	3	1	3	2	3
5	4	4	3	2	2
6	4	1	2	3	4
7	2	2	2	2	1
8	4	2	3	3	4
9	3	2	2	1	2
10	4	2	3	3	3
11	3	1	3	2	5



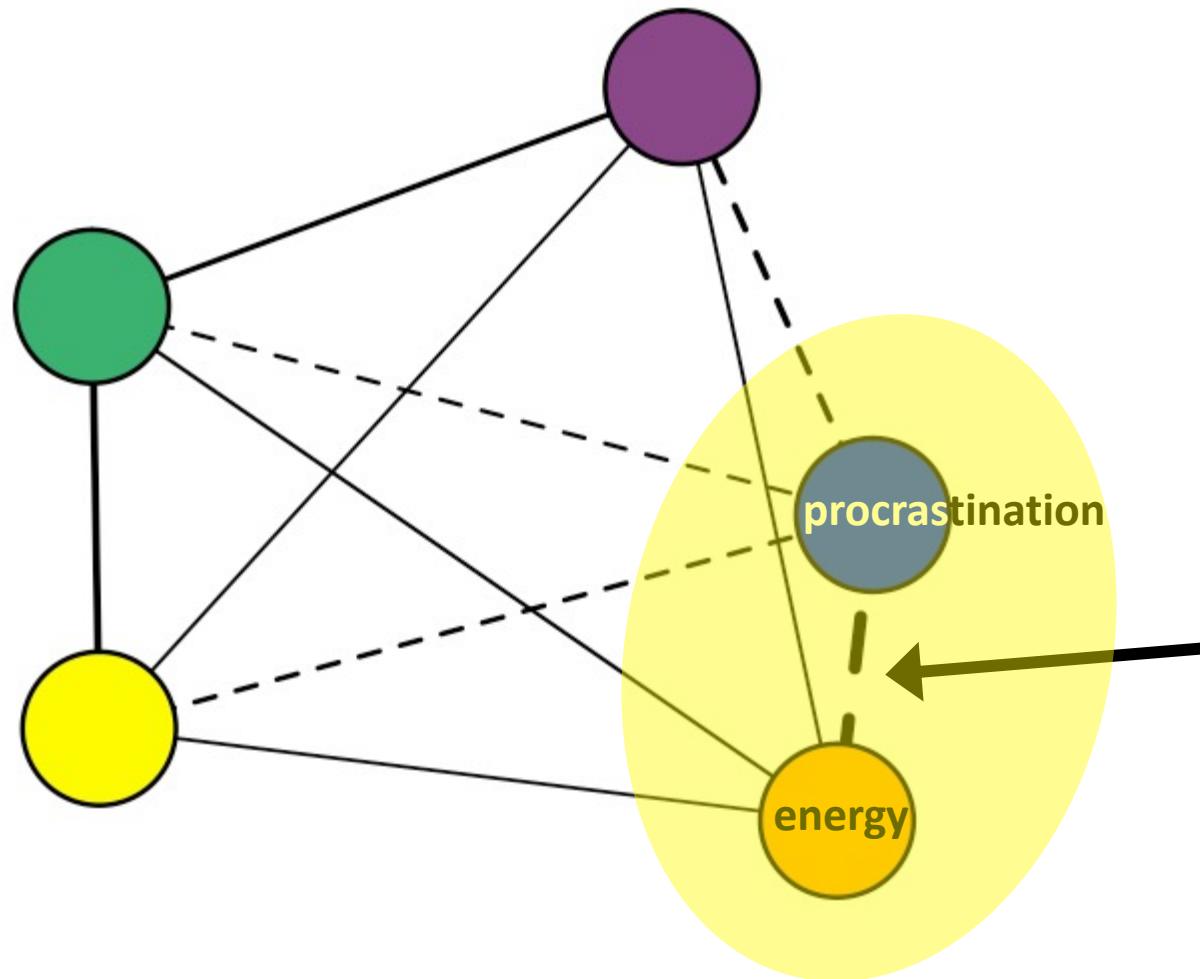
Within Time-Points:

$$X_{it} \leftrightarrow X_{jt}$$

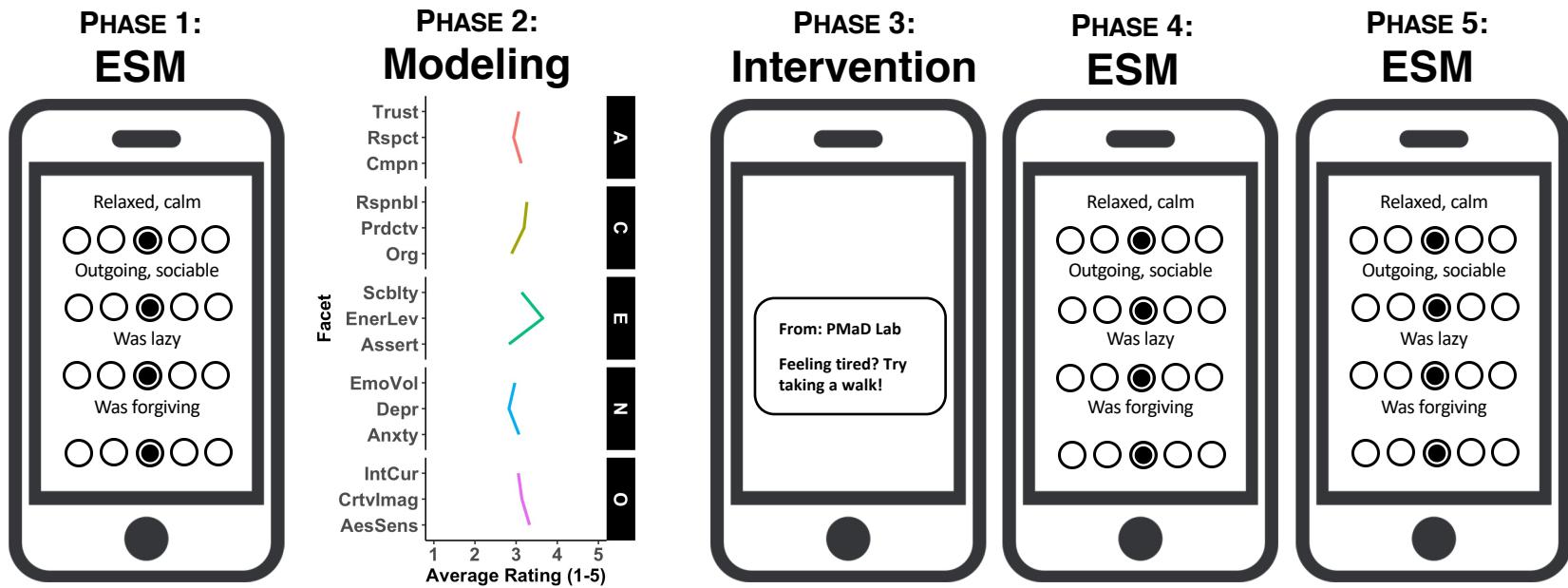


Idiographic

Personalized Interventions

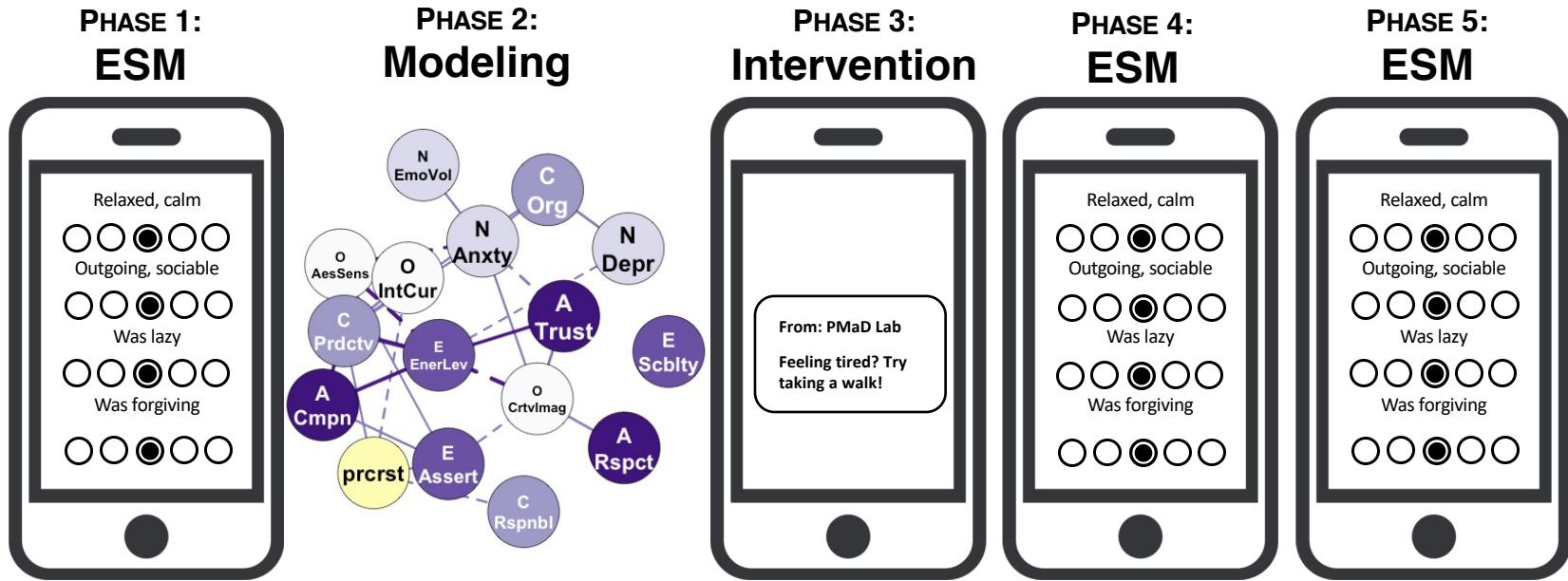


Personalized Interventions



Traditional Approach: Personality Profiles
(More of a trait is good/bad)

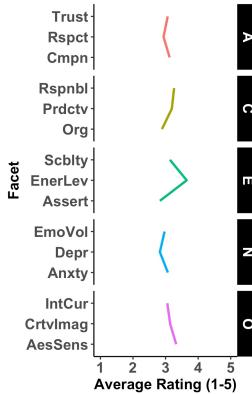
Personalized Interventions



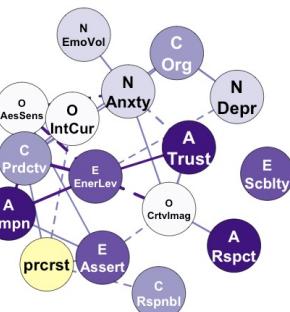
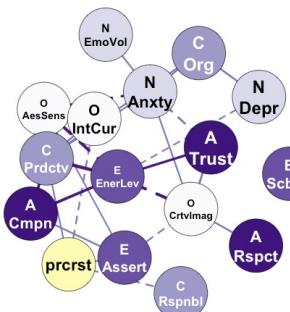
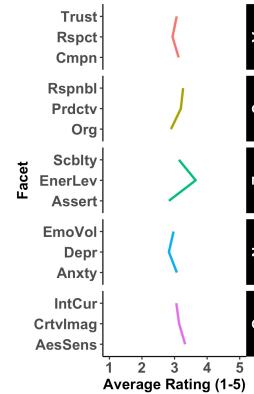
Our Approach: Idiographic Network Profiles
(Specific Personality-Behavior links good/bad)

Target Behavior

Procrastination



Loneliness



1: ESM

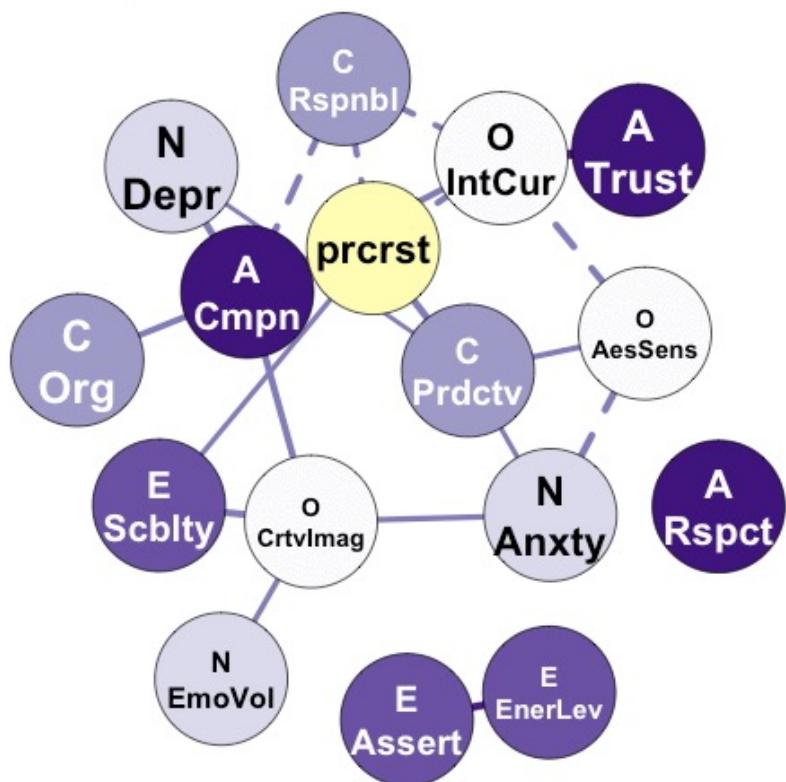
2: Modeling

3: Intervention

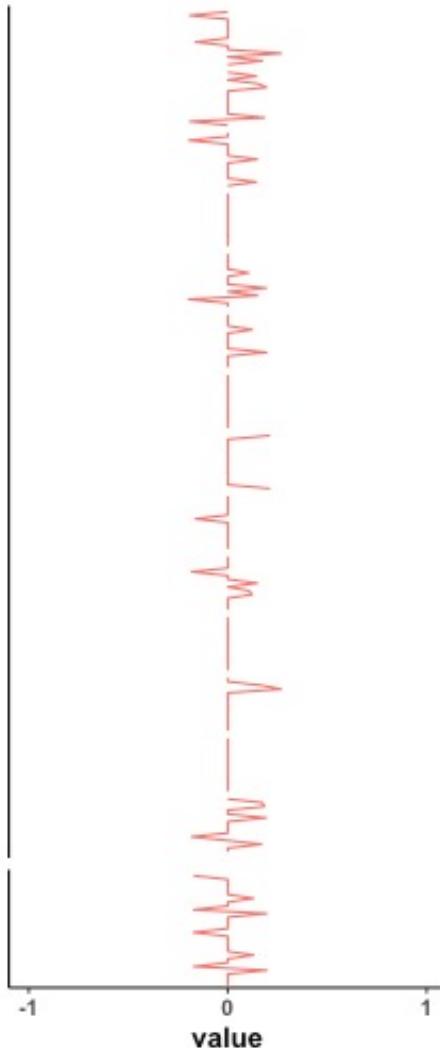
4: ESM

5: ESM

Wave 1: Contemporaneous for S10171



Edges



1: ESM

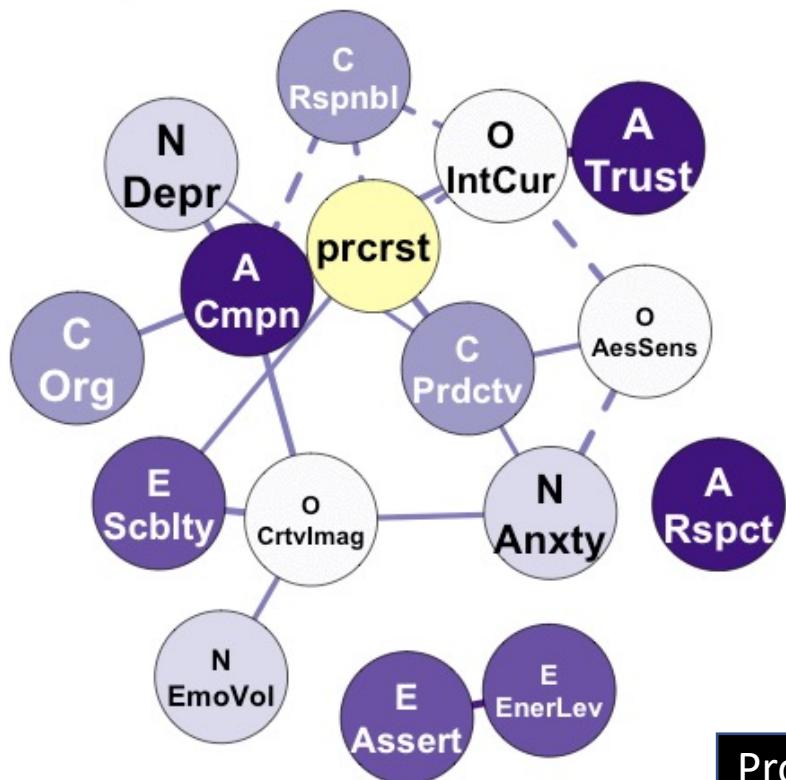
2: Modeling

3: Intervention

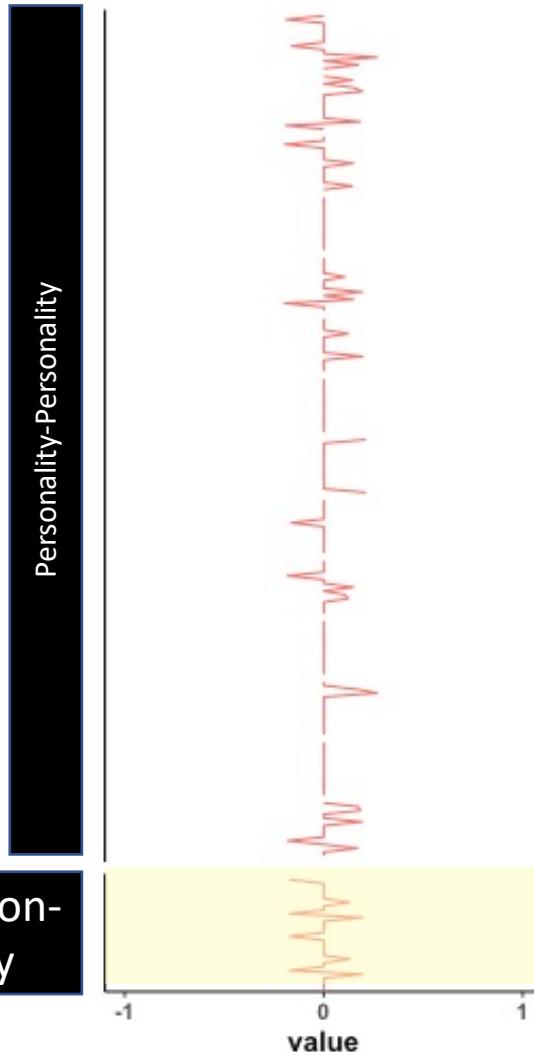
4: ESM

5: ESM

Wave 1: Contemporaneous for S10171



Procrastination-
Personality



1: ESM

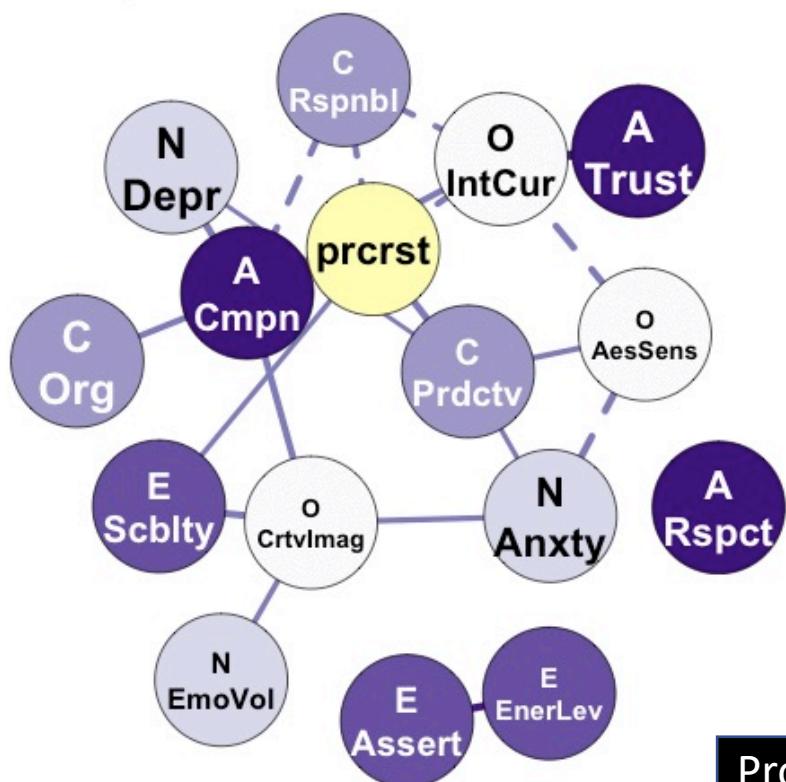
2: Modeling

3: Intervention

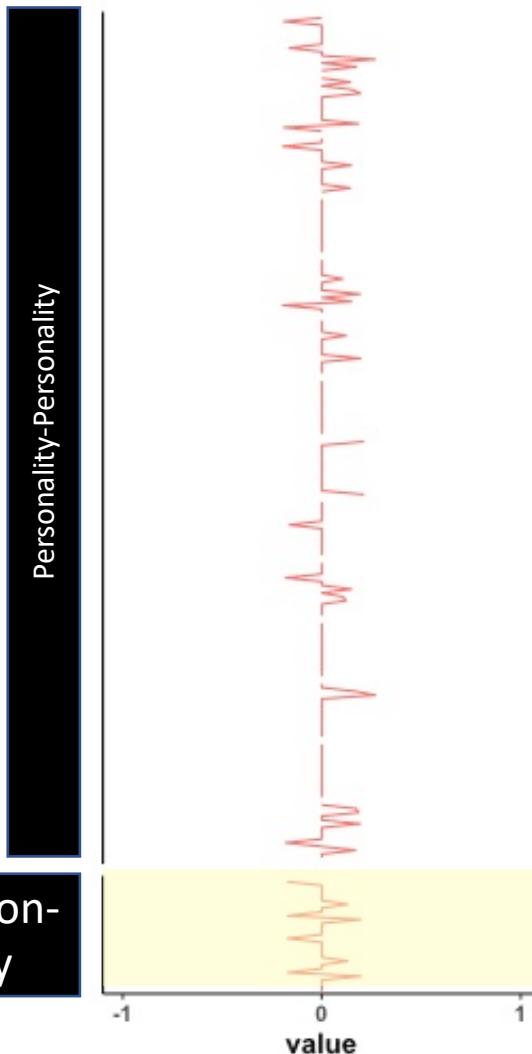
4: ESM

5: ESM

Wave 1: Contemporaneous for S10171



Procrastination-
Personality



1: ESM

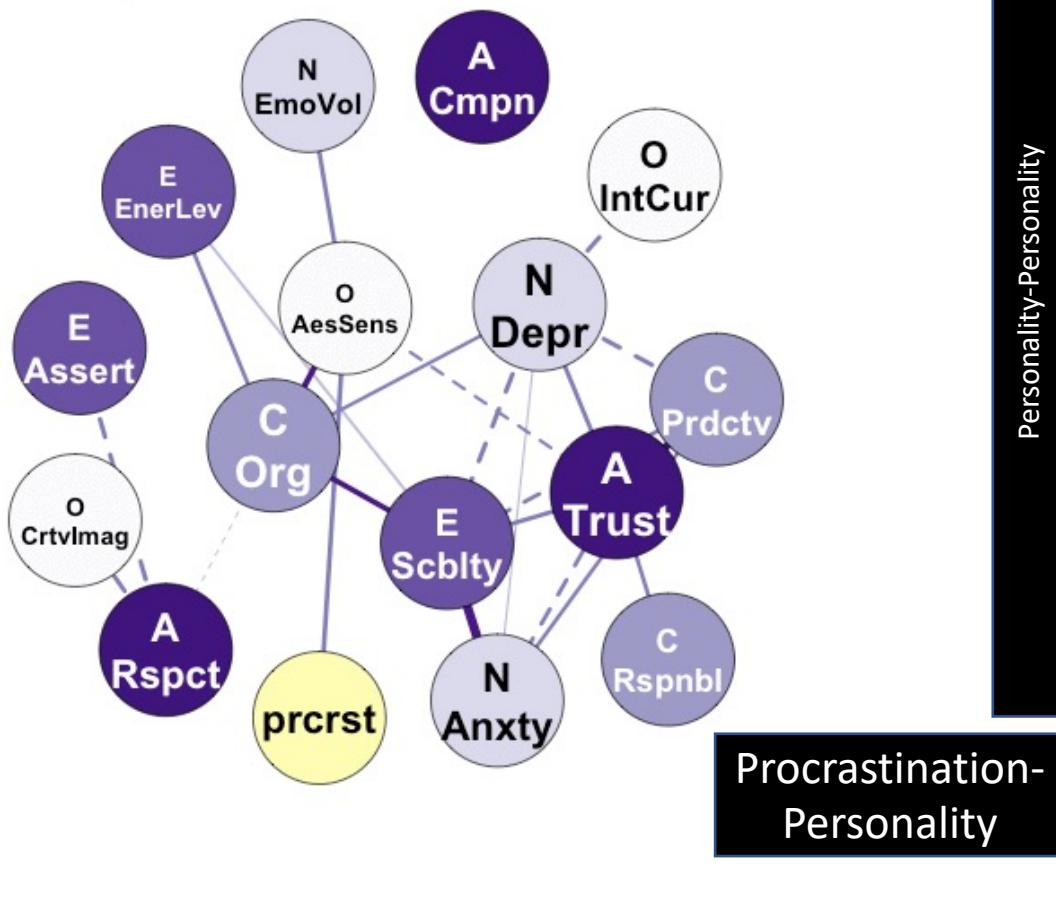
2: Modeling

3: Intervention

4: ESM

5: ESM

Wave 1: Contemporaneous for S443968



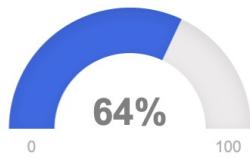
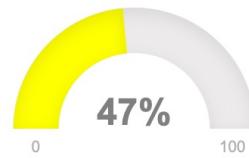
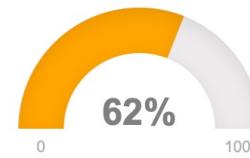
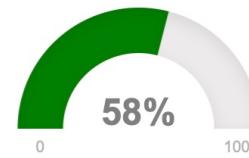
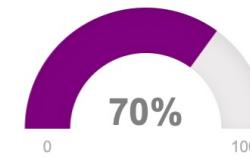
1: ESM

2: Modeling

3: Intervention

4: ESM

5: ESM

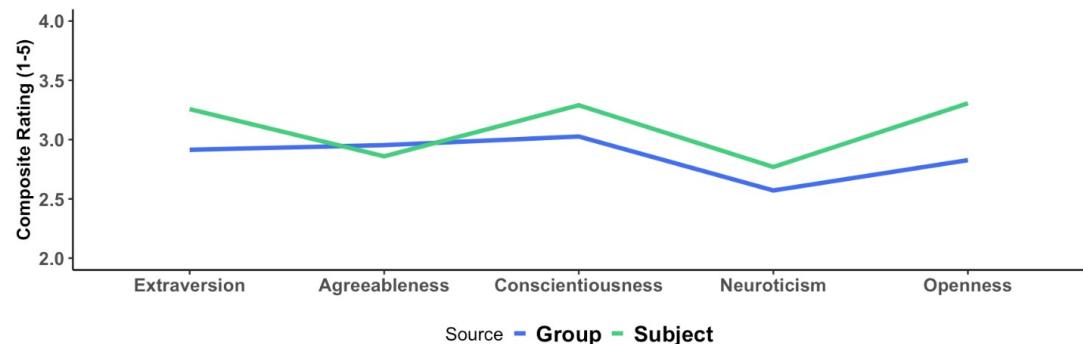
[template Results](#)[Home](#)[Overview](#)[Summary of Your Month](#)[Individualized Results](#)[Your Personalized Strategies](#)Extraversion
PercentileAgreeableness
PercentileConscientiousness
PercentileNeuroticism
PercentileOpenness
Percentile

Welcome to your personalized results

This document summarizes your personal results from the two weeks of surveys you completed. Our hope is that (1) this document provides you with some self-insight that you would not get from taking a regular personality quiz and that (2) you can use what you learn to improve your life by reducing your procrastination or loneliness.

Before we dive into your results, though, you should take a minute to learn a little more about the surveys you completed. In each survey, we asked you to do a number of different things from generating a word related to others to reporting what you were doing. If you'd like to learn more, these are summarized below (Measures).

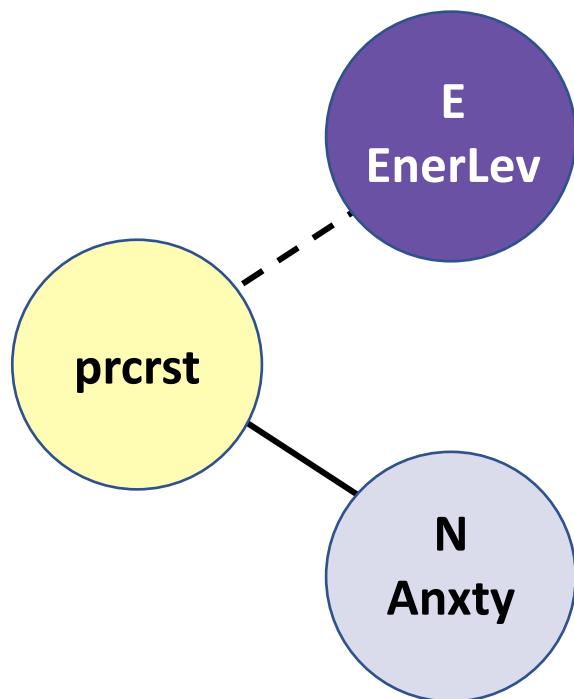
Once you're ready, look at the "What's Next" panel to see what you are going to do in the future.

[What's Next?](#)[Measures](#)

The next step is to review your responses from the surveys you took, so you can use them to improve your life.

Behavior-Personality Link

Personalized Strategy



Take a walk.

Log distracting
thoughts.

-0.2Procrastination-
Organization
"While" Link**-0.07**Procrastination-
Emotional Volatility
"While" Link**0**Procrastination ->
Organization "from"
Link**0**Procrastination ->
Emotional
Volatility "from"
Link**0.02**Procrastination <-
Organization "to"
Link**0**Procrastination <-
Emotional Volatility
"to" Link

Strategies

Below, we give you a set of strategies to use based on the relationship between your behaviors and Procrastination. Refer back to these often for inspiration about to tackle Procrastination in your life.

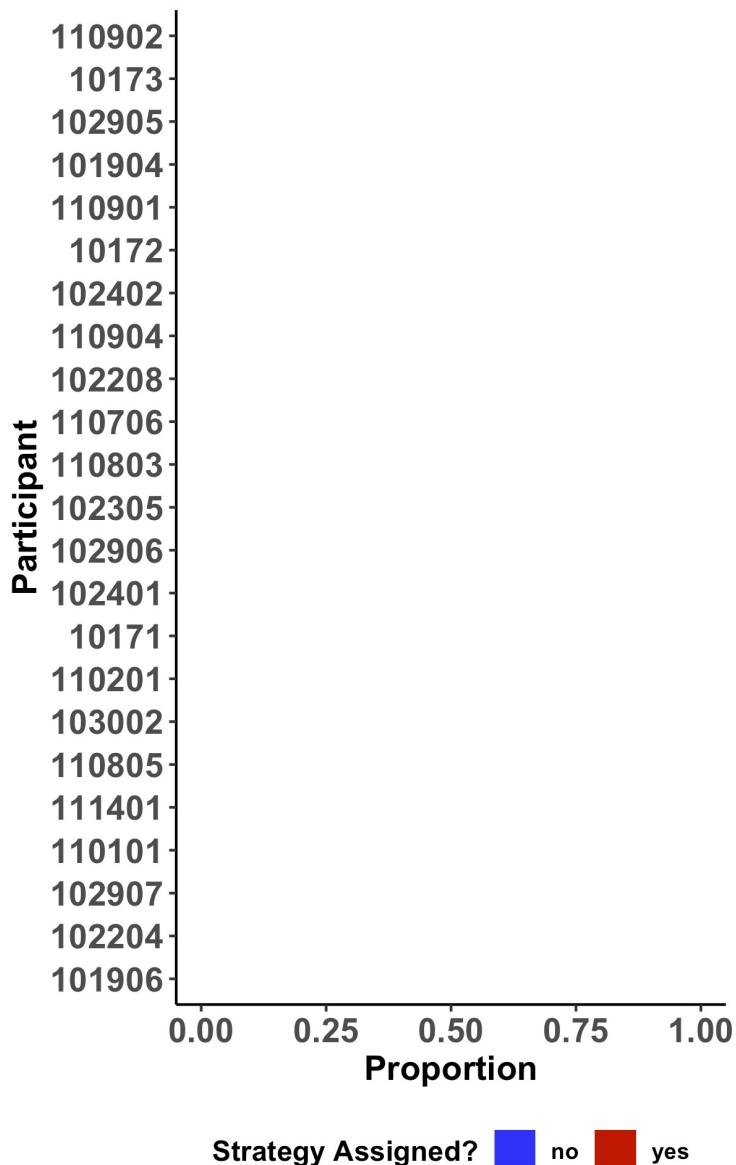
Pay special attention to the strategies themselves and refer to the longer descriptions as needed when you need more guidance.

You'll use these strategies to set daily goals to help you tackle Procrastination. Evidence suggests that goals like these are most successful when planned out in advance in an if...then format. So, for example, if I am procrastinating, I will take a walk. You can think of Procrastination as the "if", and the strategies below as your "thens." The idea is that when you catch yourself procrastinating you can then use your strategies to interrupt that.

Cognitions

Everyone has ideas about what they *should* be doing and what others are doing that they are not. Sometimes, this is reasonable and sometimes it isn't. How do you tell the difference? There are several different ways but most come back to catching yourself and asking whether a belief is reasonable. For example, are you avoiding studying for a statistics test because you think you simply can't learn statistics? What evidence do you have for this? Is it possible that your belief that you can't is influencing your ability to study effectively? You can teach yourself to challenge these beliefs until it becomes natural.

Strategy	Description
Close your eyes and breathe for one minute.	When the demands of life get to be too much, it is easy to get swept away by thoughts and emotions. One way to cope with these is to take a "mindful minute" where you let the feelings flow through you without engaging with them. One way to do that is focus on your breath. When thoughts arise, note them and continue to focus on your breathing. You might try a short guided meditation app if you struggle with this.
Log distracting thoughts	Most people experience a constant stream of thoughts. Particularly for behaviors like procrastination, it is easy to allow the feeling to sweep your thoughts down a rabbit hole of all the things you could or should be doing. The bad news is that this compounds your worries by wasting your time. The next time you notice yourself getting distracted by a stream of thoughts, write them down in your logger. Then, return to them later when you have time to reengage with them fully and attentively.



Did
participants
use their
assigned
strategies?

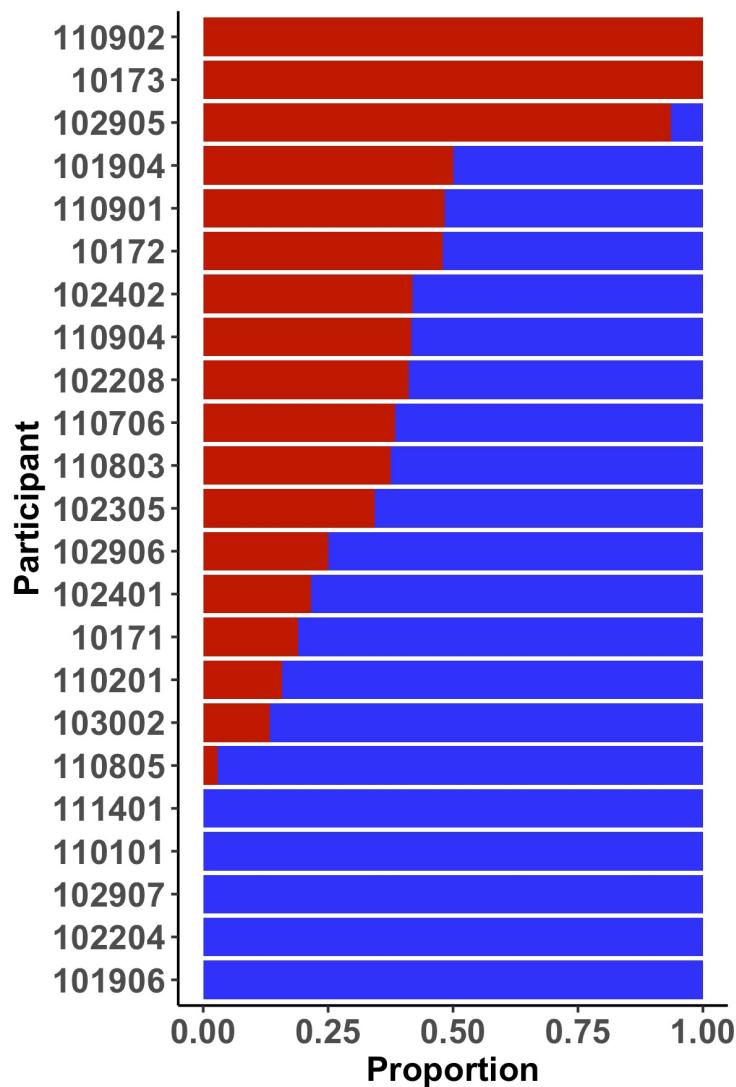
1: ESM

2: Modeling

3: Intervention

4: ESM

5: ESM



Rewarded yourself for meeting studying goals

Changed location to avoid distractions

Take a walk

Identified study goals before starting a session

Scheduled study time

Take a 2 minute break to sketch out an idea.

Ranked tasks by priority

Chunked study content

Use a software like Freedom to block messages and the web

Close your eyes and breathe for one minute.

Wrote down a daily plan

Did a weekly review

Planned a session following class

Used free time during the school day to study

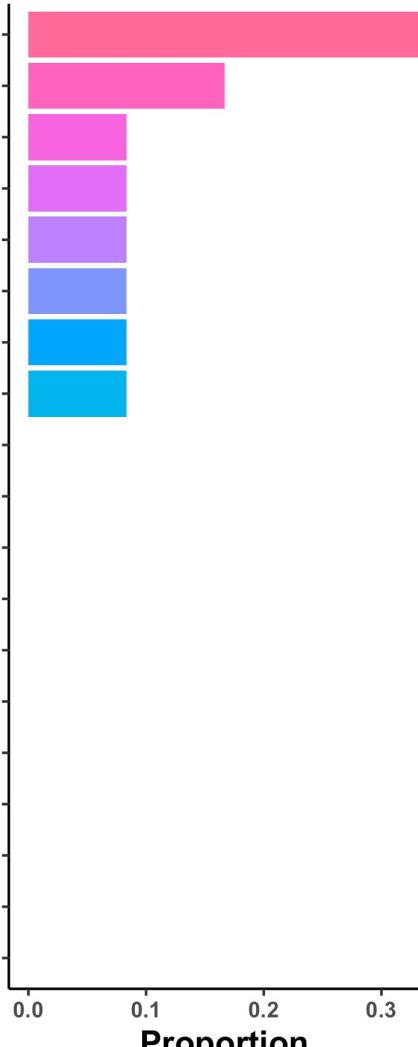
Plan a study session around content, not time

Took a scheduled study break

Log distracting thoughts

Avoided late night studying or studying while tired.

Avoided late night studying or studying while tired.



Procrastination network

Scheduled study time

Take a 2 minute break to sketch out an idea.

Ranked tasks by priority

Close your eyes and breathe for one minute.

Ask a family or friend to check in with you at a specified time

Called a friend you hadn't spoken to today

Write your current thoughts and feelings and write down a positive reframing of them

Avoided late night studying or studying while tired.

Took a scheduled study break

Identified study goals before starting a session

Took a scheduled study break

Use a software like Freedom to block messages and the web

Take a 2 minute break to sketch out an idea.

Chunked study content

Write your current thoughts and feelings and write down a positive reframing of them

Avoided late night studying or studying while tired.

0.00

0.05

0.10

0.15

Proportion