The Dynamics of Affect: Simulating Individual Differences in Emotional Experience

Presented as part of a symposium on computational approaches to personality research

Ashley D. Brown

Department of Psychology, Northwestern University
Partially supported by a grant from the National Science Foundation, SMA-1419324
Slides at http://personality-project.org/brown/

ISSID: July 25, 2017

Introduction: Motivation, RST

Constructing the CTA-RST Model

Study 1: Extraversion and Varieties of Positive Affect

Study 2: Affect and Goal Velocity

Study 3: RST and Affective Synchrony

Discussion and Wrap-up

Appendix: Extra Slides

Motivation

The Need for Precision in Personality Psychology

- Personality influences life outcomes.

Motivation

The Need for Precision in Personality Psychology

- Personality influences life outcomes.
- Want to intervene in the problems that personality can create?

Motivation

The Need for Precision in Personality Psychology

- Personality influences life outcomes.
- Want to intervene in the problems that personality can create?
- If so, you need to understand the mechanisms underlying personality.

Motivation

The Need for Precision in Personality Psychology

- Personality influences life outcomes.
- Want to intervene in the problems that personality can create?
- If so, you need to understand the mechanisms underlying personality.
- Tie together: Lexical & Biological, Structure & Process

Motivation

The Need for Precision in Personality Psychology

- Personality influences life outcomes.
- Want to intervene in the problems that personality can create?
- If so, you need to understand the mechanisms underlying personality.
- Tie together: Lexical & Biological, Structure & Process
- Reinforcement Sensitivity Theory (RST, Gray and McNaughton, 2000): A biological theory with strong foundations in experimental animal research...

Motivation

The Need for Precision in Personality Psychology

- Personality influences life outcomes.
- Want to intervene in the problems that personality can create?
- If so, you need to understand the mechanisms underlying personality.
- Tie together: Lexical & Biological, Structure & Process
- Reinforcement Sensitivity Theory (RST, Gray and McNaughton, 2000): A biological theory with strong foundations in experimental animal research...
- ...but what about the RST *of human personality*?

The Revised RST

(Gray and McNaughton, 2000)

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):
  - Sensitivity to cues for reward

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):
  - Sensitivity to cues for reward
  - Extraversion, positive affect (Depue and Collins, 1999)

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):
  - Sensitivity to cues for reward
  - Extraversion, positive affect (Depue and Collins, 1999)
  - Anger (Carver and Harmon-Jones, 2009)

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):
  - Sensitivity to cues for reward
  - Extraversion, positive affect (Depue and Collins, 1999)
  - Anger (Carver and Harmon-Jones, 2009)
- Fight-Flight-Freeze System (FFFS):

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):
  - Sensitivity to cues for reward
  - Extraversion, positive affect (Depue and Collins, 1999)
  - Anger (Carver and Harmon-Jones, 2009)
- Fight-Flight-Freeze System (FFFS):
  - Sensitivity to cues for punishment

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):
  - Sensitivity to cues for reward
  - Extraversion, positive affect (Depue and Collins, 1999)
  - Anger (Carver and Harmon-Jones, 2009)
- Fight-Flight-Freeze System (FFFS):
  - Sensitivity to cues for punishment
  - Active defensive behaviors

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):
  - Sensitivity to cues for reward
  - Extraversion, positive affect (Depue and Collins, 1999)
  - Anger (Carver and Harmon-Jones, 2009)
- Fight-Flight-Freeze System (FFFS):
  - Sensitivity to cues for punishment
  - Active defensive behaviors
  - Fear, panic

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):
  - Sensitivity to cues for reward
  - Extraversion, positive affect (Depue and Collins, 1999)
  - Anger (Carver and Harmon-Jones, 2009)
- Fight-Flight-Freeze System (FFFS):
  - Sensitivity to cues for punishment
  - Active defensive behaviors
  - Fear, panic
- Behavioral Inhibition System (BIS):

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):
  - Sensitivity to cues for reward
  - Extraversion, positive affect (Depue and Collins, 1999)
  - Anger (Carver and Harmon-Jones, 2009)
- Fight-Flight-Freeze System (FFFS):
  - Sensitivity to cues for punishment
  - Active defensive behaviors
  - Fear, panic
- Behavioral Inhibition System (BIS):
  - Sensitivity to cues for goal conflict

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):
  - Sensitivity to cues for reward
  - Extraversion, positive affect (Depue and Collins, 1999)
  - Anger (Carver and Harmon-Jones, 2009)
- Fight-Flight-Freeze System (FFFS):
  - Sensitivity to cues for punishment
  - Active defensive behaviors
  - Fear, panic
- Behavioral Inhibition System (BIS):
  - Sensitivity to cues for goal conflict
  - Biases resolution in favor of FFFS

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):
  - Sensitivity to cues for reward
  - Extraversion, positive affect (Depue and Collins, 1999)
  - Anger (Carver and Harmon-Jones, 2009)
- Fight-Flight-Freeze System (FFFS):
  - Sensitivity to cues for punishment
  - Active defensive behaviors
  - Fear, panic
- Behavioral Inhibition System (BIS):
  - Sensitivity to cues for goal conflict
  - Biases resolution in favor of FFFS
  - Behavioral inhibition

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):
  - Sensitivity to cues for reward
  - Extraversion, positive affect (Depue and Collins, 1999)
  - Anger (Carver and Harmon-Jones, 2009)
- Fight-Flight-Freeze System (FFFS):
  - Sensitivity to cues for punishment
  - Active defensive behaviors
  - Fear, panic
- Behavioral Inhibition System (BIS):
  - Sensitivity to cues for goal conflict
  - Biases resolution in favor of FFFS
  - Behavioral inhibition
    - Passive avoidance, defensive approach

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):
  - Sensitivity to cues for reward
  - Extraversion, positive affect (Depue and Collins, 1999)
  - Anger (Carver and Harmon-Jones, 2009)
- Fight-Flight-Freeze System (FFFS):
  - Sensitivity to cues for punishment
  - Active defensive behaviors
  - Fear, panic
- Behavioral Inhibition System (BIS):
  - Sensitivity to cues for goal conflict
  - Biases resolution in favor of FFFS
  - Behavioral inhibition
    - Passive avoidance, defensive approach
  - Increases attention, arousal

The Revised RST

(Gray and McNaughton, 2000)

- Behavioral Activation/Approach System (BAS):
  - Sensitivity to cues for reward
  - Extraversion, positive affect (Depue and Collins, 1999)
  - Anger (Carver and Harmon-Jones, 2009)
- Fight-Flight-Freeze System (FFFS):
  - Sensitivity to cues for punishment
  - Active defensive behaviors
  - Fear, panic
- Behavioral Inhibition System (BIS):
  - Sensitivity to cues for goal conflict
  - Biases resolution in favor of FFFS
  - Behavioral inhibition
    - Passive avoidance, defensive approach
  - Increases attention, arousal
  - Anxiety

RST's Drawbacks

RST's Drawbacks

- Evidence in favor of the RST of human personality is mixed: (Corr, 2004; Matthews and Gilliland, 1999; Pickering et al., 1997)

RST's Drawbacks

- Evidence in favor of the RST of human personality is mixed: (Corr, 2004; Matthews and Gilliland, 1999; Pickering et al., 1997)
  - Difficulty integrating with dominant top-down models (Mitchell et al., 2007; Poropat and Corr, 2015)

RST's Drawbacks

- Evidence in favor of the RST of human personality is mixed: (Corr, 2004; Matthews and Gilliland, 1999; Pickering et al., 1997)
  - Difficulty integrating with dominant top-down models (Mitchell et al., 2007; Poropat and Corr, 2015)
  - Failed attempts to create 'gold-standard' self-report measures (Wilson et al., 1990; Torrubia et al., 2001)

RST's Drawbacks

- Evidence in favor of the RST of human personality is mixed: (Corr, 2004; Matthews and Gilliland, 1999; Pickering et al., 1997)
  - Difficulty integrating with dominant top-down models (Mitchell et al., 2007; Poropat and Corr, 2015)
  - Failed attempts to create 'gold-standard' self-report measures (Wilson et al., 1990; Torrubia et al., 2001)
  - Making self-reports of RST might not be possible (Smillie, 2008)

Personality Dynamics and Causality

Disentangling Between- and Within-Person Variability

- RST is a model of personality *dynamics*.

Personality Dynamics and Causality

Disentangling Between- and Within-Person Variability

- RST is a model of personality *dynamics*.
- To structure, add process.

Personality Dynamics and Causality

Disentangling Between- and Within-Person Variability

- RST is a model of personality *dynamics*.
- To structure, add process.
- Experience-sampling research examines within-person variability (Rafaeli et al., 2007; Wilt et al., 2011)

Personality Dynamics and Causality

Disentangling Between- and Within-Person Variability

- RST is a model of personality *dynamics*.
- To structure, add process.
- Experience-sampling research examines within-person variability (Rafaeli et al., 2007; Wilt et al., 2011)
  - Shows that structural models alone are inadequate.

Personality Dynamics and Causality

Disentangling Between- and Within-Person Variability

- RST is a model of personality *dynamics*.
- To structure, add process.
- Experience-sampling research examines within-person variability (Rafaeli et al., 2007; Wilt et al., 2011)
  - Shows that structural models alone are inadequate.
  - Different theories bridge within/between persons findings (Fleeson, 2004; Revelle and Condon, 2015)

Personality Dynamics and Causality

Disentangling Between- and Within-Person Variability

- RST is a model of personality *dynamics*.
- To structure, add process.
- Experience-sampling research examines within-person variability (Rafaeli et al., 2007; Wilt et al., 2011)
  - Shows that structural models alone are inadequate.
  - Different theories bridge within/between persons findings (Fleeson, 2004; Revelle and Condon, 2015)
  - Still doesn't get at cause, because you can't randomly assign personality structure or process.

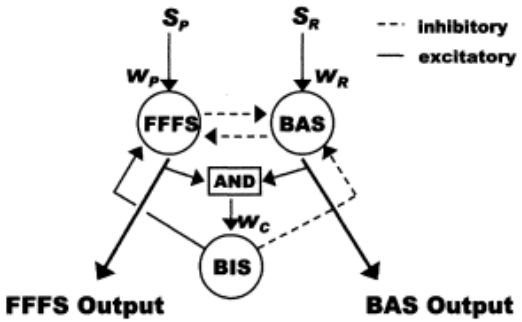
Personality Dynamics and Causality

Disentangling Between- and Within-Person Variability

- RST is a model of personality *dynamics*.
- To structure, add process.
- Experience-sampling research examines within-person variability (Rafaeli et al., 2007; Wilt et al., 2011)
  - Shows that structural models alone are inadequate.
  - Different theories bridge within/between persons findings (Fleeson, 2004; Revelle and Condon, 2015)
  - Still doesn't get at cause, because you can't randomly assign personality structure or process.
- Can't manipulate? Simulate!

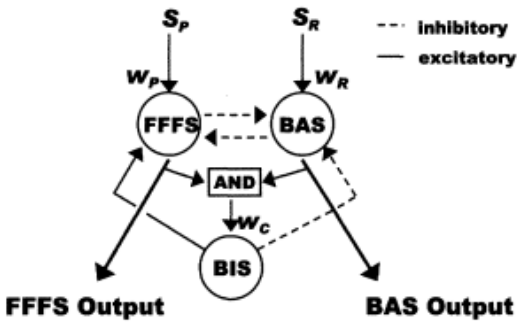
Building CTA-RST

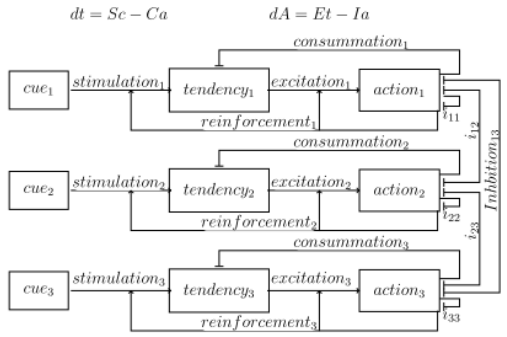
Building CTA-RST



- Used the Pickering (2008) model of RST.

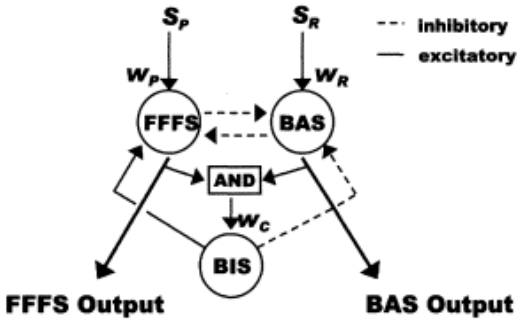
Building CTA-RST

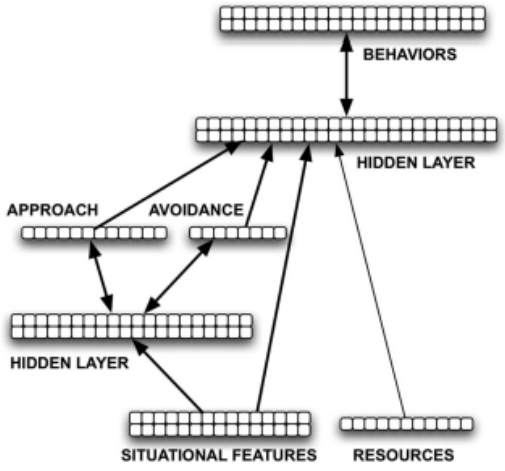


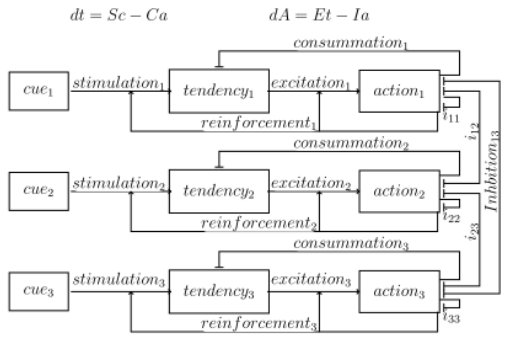


- Used the Pickering (2008) model of RST.
- Used the Cues-Tendencies-Actions model (CTA, Revelle and Condon, 2015) for multi-goal structure.

Building CTA-RST







- Used the Pickering (2008) model of RST.
- Used the Cues-Tendencies-Actions model (CTA, Revelle and Condon, 2015) for multi-goal structure.
- Used the positivity offset idea proposed by Cacioppo et al. (1997) and incorporated in the Read et al. (2010) Virtual Personalities model.

RST Meets CTA

2-Goal Flow-chart

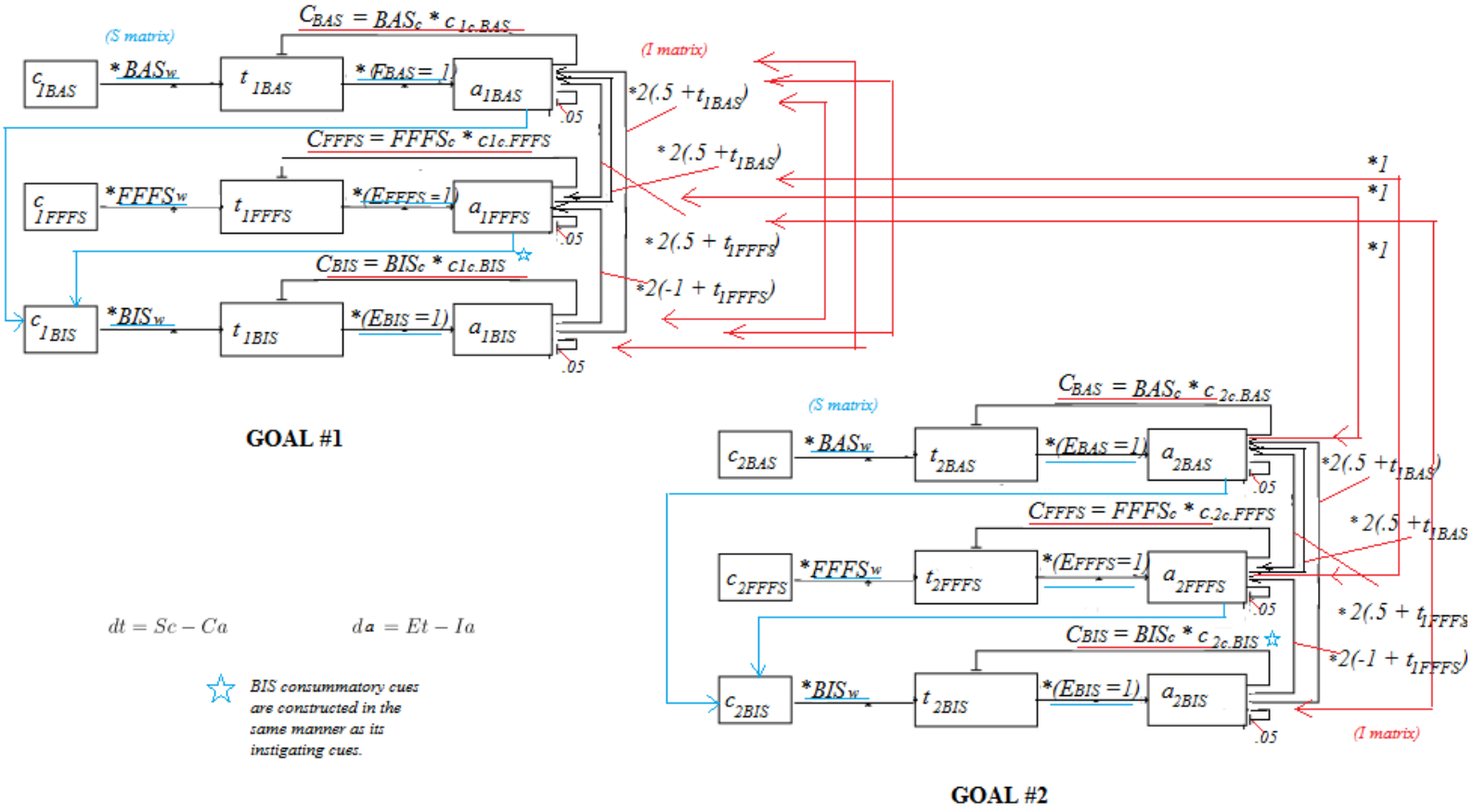


Figure: Adapted from Revelle and Condon, 2015

Operational Definitions

Raw Material

- Need to simulate two types of variables: traits and states

Operational Definitions

Raw Material

- Need to simulate two types of variables: traits and states
- CTA-RST contains traitlike 'weight' variables.
  - Created simulated participants' personalities by randomly assigning each a set of instigating (BAS_w, BIS_w, $FFFS_w$) and consummatory cue sensitivities (BAS_c, BIS_c, $FFFS_c$).
  - Weights drawn from normal distributions: $M = .5$, $SD = .2$.

Notation for BIS and FFFS functions is similar.

BAS function	Notation
Average position of goal's action over time interval t	$\overline{BAS}_{Ap}$
Average time spent doing goal-directed action over t	$\overline{BAS}_{At}$
Average falling velocity of goal's tendency over t	$\overline{BAS}_{Tvf}$
Instigating cue weight (sensitivity)	BAS_w
Consummatory cue weight (sensitivity)	BAS_c

Operational Definitions

Raw Material

- Need to simulate two types of variables: traits and states
- CTA-RST contains traitlike 'weight' variables.
  - Created simulated participants' personalities by randomly assigning each a set of instigating (BAS_w, BIS_w, $FFFS_w$) and consummatory cue sensitivities (BAS_c, BIS_c, $FFFS_c$).
  - Weights drawn from normal distributions: $M = .5$, $SD = .2$.
- CTA-RST produces statelike variables.

Notation for BIS and FFFS functions is similar.

BAS function	Notation
Average position of goal's action over time interval t	$\overline{BAS}_{Ap}$
Average time spent doing goal-directed action over t	$\overline{BAS}_{At}$
Average falling velocity of goal's tendency over t	$\overline{BAS}_{Tvf}$
Instigating cue weight (sensitivity)	BAS_w
Consummatory cue weight (sensitivity)	BAS_c

The Current Project

- Modeled data from three real studies:

The Current Project

- Modeled data from three real studies:
  - Do extraverts get more bang for the buck? (Smillie et al., 2012)

The Current Project

- Modeled data from three real studies:
  - Do extraverts get more bang for the buck? (Smillie et al., 2012)
    - Mood improvements due to pleasant stimuli don't depend on extraversion...

The Current Project

- Modeled data from three real studies:
  - Do extraverts get more bang for the buck? (Smillie et al., 2012)
    - Mood improvements due to pleasant stimuli don't depend on extraversion...
    - ...but mood improvements due to reward pursuit do.

The Current Project

- Modeled data from three real studies:
  - Do extraverts get more bang for the buck? (Smillie et al., 2012)
    - Mood improvements due to pleasant stimuli don't depend on extraversion...
    - ...but mood improvements due to reward pursuit do.
  - Velocity explains state personality/affect link: (Wilt et al., 2016)

The Current Project

- Modeled data from three real studies:
  - Do extraverts get more bang for the buck? (Smillie et al., 2012)
    - Mood improvements due to pleasant stimuli don't depend on extraversion...
    - ...but mood improvements due to reward pursuit do.
  - Velocity explains state personality/affect link: (Wilt et al., 2016)
    - Experience-sampling data: States and 'goal velocity'

The Current Project

- Modeled data from three real studies:
  - Do extraverts get more bang for the buck? (Smillie et al., 2012)
    - Mood improvements due to pleasant stimuli don't depend on extraversion...
    - ...but mood improvements due to reward pursuit do.
  - Velocity explains state personality/affect link: (Wilt et al., 2016)
    - Experience-sampling data: States and 'goal velocity'
    - State extraversion/positive affect: velocity increases

The Current Project

- Modeled data from three real studies:
  - Do extraverts get more bang for the buck? (Smillie et al., 2012)
    - Mood improvements due to pleasant stimuli don't depend on extraversion...
    - ...but mood improvements due to reward pursuit do.
  - Velocity explains state personality/affect link: (Wilt et al., 2016)
    - Experience-sampling data: States and 'goal velocity'
    - State extraversion/positive affect: velocity increases
    - State neuroticism/negative affect: velocity decreases

The Current Project

- Modeled data from three real studies:
  - Do extraverts get more bang for the buck? (Smillie et al., 2012)
    - Mood improvements due to pleasant stimuli don't depend on extraversion...
    - ...but mood improvements due to reward pursuit do.
  - Velocity explains state personality/affect link: (Wilt et al., 2016)
    - Experience-sampling data: States and 'goal velocity'
    - State extraversion/positive affect: velocity increases
    - State neuroticism/negative affect: velocity decreases
  - Affective synchrony and trait affects: (Wilt et al., 2011)

The Current Project

- Modeled data from three real studies:
  - Do extraverts get more bang for the buck? (Smillie et al., 2012)
    - Mood improvements due to pleasant stimuli don't depend on extraversion...
    - ...but mood improvements due to reward pursuit do.
  - Velocity explains state personality/affect link: (Wilt et al., 2016)
    - Experience-sampling data: States and 'goal velocity'
    - State extraversion/positive affect: velocity increases
    - State neuroticism/negative affect: velocity decreases
  - Affective synchrony and trait affects: (Wilt et al., 2011)
    - Correlation between experience of positive and negative affect is an individual difference.

The Current Project

- Modeled data from three real studies:
  - Do extraverts get more bang for the buck? (Smillie et al., 2012)
    - Mood improvements due to pleasant stimuli don't depend on extraversion...
    - ...but mood improvements due to reward pursuit do.
  - Velocity explains state personality/affect link: (Wilt et al., 2016)
    - Experience-sampling data: States and 'goal velocity'
    - State extraversion/positive affect: velocity increases
    - State neuroticism/negative affect: velocity decreases
  - Affective synchrony and trait affects: (Wilt et al., 2011)
    - Correlation between experience of positive and negative affect is an individual difference.
    - Synchrony between energetic/tense affect predicted by interaction between positive/negative trait affects.

The Current Project

- Modeled data from three real studies:
  - Do extraverts get more bang for the buck? (Smillie et al., 2012)
    - Mood improvements due to pleasant stimuli don't depend on extraversion...
    - ...but mood improvements due to reward pursuit do.
  - Velocity explains state personality/affect link: (Wilt et al., 2016)
    - Experience-sampling data: States and 'goal velocity'
    - State extraversion/positive affect: velocity increases
    - State neuroticism/negative affect: velocity decreases
  - Affective synchrony and trait affects: (Wilt et al., 2011)
    - Correlation between experience of positive and negative affect is an individual difference.
    - Synchrony between energetic/tense affect predicted by interaction between positive/negative trait affects.
- Rationale for study selection:
  - One experimental study: mood manipulations interact with a trait to affect states.
  - Two observational studies of personality dynamics.
  - These most directly addressed the issue of state-trait or structure-process links within personality.

Study Parameters: Summary

(*Seed* sets random number generator)

Study	*Seed*	*N*	*G*	*X*	*T*	*t*
1: Smillie et al., 2012	2000	240	2	2	240	240
2: Wilt et al., 2016	2500	80	2	63	900	300
3: Wilt et al., 2011	1500	82	2	63	900	300

Study Parameters: Summary

(*Seed* sets random number generator)

Study	*Seed*	*N*	*G*	*X*	*T*	*t*
1: Smillie et al., 2012	2000	240	2	2	240	240
2: Wilt et al., 2016	2500	80	2	63	900	300
3: Wilt et al., 2011	1500	82	2	63	900	300

N = Participants

Study Parameters: Summary

(*Seed* sets random number generator)

Study	*Seed*	*N*	*G*	*X*	*T*	*t*
1: Smillie et al., 2012	2000	240	2	2	240	240
2: Wilt et al., 2016	2500	80	2	63	900	300
3: Wilt et al., 2011	1500	82	2	63	900	300

N = Participants

G = Goals

Study Parameters: Summary

(*Seed* sets random number generator)

Study	*Seed*	*N*	*G*	*X*	*T*	*t*
1: Smillie et al., 2012	2000	240	2	2	240	240
2: Wilt et al., 2016	2500	80	2	63	900	300
3: Wilt et al., 2011	1500	82	2	63	900	300

N = Participants

G = Goals

X = Experiences

Study Parameters: Summary

(*Seed* sets random number generator)

Study	*Seed*	*N*	*G*	*X*	*T*	*t*
1: Smillie et al., 2012	2000	240	2	2	240	240
2: Wilt et al., 2016	2500	80	2	63	900	300
3: Wilt et al., 2011	1500	82	2	63	900	300

N = Participants

G = Goals

X = Experiences

T = Total time (iterations)

Study Parameters: Summary

(*Seed* sets random number generator)

Study	*Seed*	*N*	*G*	*X*	*T*	*t*
1: Smillie et al., 2012	2000	240	2	2	240	240
2: Wilt et al., 2016	2500	80	2	63	900	300
3: Wilt et al., 2011	1500	82	2	63	900	300

N = Participants

G = Goals

X = Experiences

T = Total time (iterations)

t = Measurement interval (iterations)

Study 1: Smillie et al. (2012)

Do Extraverts Get More Bang for the Buck?

-
-
-
-
-

Study 1: Smillie et al. (2012)

Do Extraverts Get More Bang for the Buck?

- State Positive Affect, Sim Experiment 1:
-
-
-
-

Study 1: Smillie et al. (2012)

Do Extraverts Get More Bang for the Buck?

- State Positive Affect, Sim Experiment 1:
-
- State Negative Affect, Sim Experiment 1:
-
-

Study 1: Smillie et al. (2012)

Do Extraverts Get More Bang for the Buck?

- State Positive Affect, Sim Experiment 1:
-
- State Negative Affect, Sim Experiment 1:
- State Pleasant Affect, Sim Experiment 4:
-

Study 1: Smillie et al. (2012)

Do Extraverts Get More Bang for the Buck?

- State Positive Affect, Sim Experiment 1:
- State Energetic Affect, Sim Experiment 4:
- State Negative Affect, Sim Experiment 1:
- State Pleasant Affect, Sim Experiment 4:
-

Study 1: Smillie et al. (2012)

Do Extraverts Get More Bang for the Buck?

- State Positive Affect, Sim Experiment 1:
- State Energetic Affect, Sim Experiment 4:
- State Negative Affect, Sim Experiment 1:
- State Pleasant Affect, Sim Experiment 4:
- Trait (EPQ) Extraversion, Sim Experiments 1 and 4:

Study 1: Smillie et al. (2012)

Do Extraverts Get More Bang for the Buck?

- State Positive Affect, Sim Experiment 1 =
- State Energetic Affect, Sim Experiment 4 =

$$EA_S = \overline{BAS}_{Tvf}$$

- State Negative Affect, Sim Experiment 1:
- State Pleasant Affect, Sim Experiment 4:
- Trait (EPQ) Extraversion, Sim Experiments 1 and 4:

Study 1: Smillie et al. (2012)

Do Extraverts Get More Bang for the Buck?

- State Positive Affect, Sim Experiment 1 =
- State Energetic Affect, Sim Experiment 4 =

$$EA_S = \overline{BAS}_{Tvf}$$

- State Negative Affect, Sim Experiment 1:
- State Pleasant Affect, Sim Experiment 4:

$$PA_S = \overline{BAS}_{Ap}$$

- Trait (EPQ) Extraversion, Sim Experiments 1 and 4:

Study 1: Smillie et al. (2012)

Do Extraverts Get More Bang for the Buck?

- State Positive Affect, Sim Experiment 1 =
- State Energetic Affect, Sim Experiment 4 =

$$EA_S = \overline{BAS}_{Tvf}$$

- State Negative Affect, Sim Experiment 1:

$$NA_S = \overline{FFFS}_{Ap}$$

- State Pleasant Affect, Sim Experiment 4:

$$PA_S = \overline{BAS}_{Ap}$$

- Trait (EPQ) Extraversion, Sim Experiments 1 and 4:

Study 1: Smillie et al. (2012)

Do Extraverts Get More Bang for the Buck?

- State Positive Affect, Sim Experiment 1 =
- State Energetic Affect, Sim Experiment 4 =

$$EA_S = \overline{BAS}_{Tvf}$$

- State Negative Affect, Sim Experiment 1:

$$NA_S = \overline{FFFS}_{Ap}$$

- State Pleasant Affect, Sim Experiment 4:

$$PA_S = \overline{BAS}_{Ap}$$

- Trait (EPQ) Extraversion, Sim Experiments 1 and 4:

$$E_{EPQ} = E_T = BAS_c + BIS_c + FFFS_c$$

Study 1: Method

Study 1: Method

Simulated Experiment 1, Experience 2

Goal 1				Goal 2				
C_BAS	C_C.BAS	C_FFFS	C_C.FFFS	C_BAS	C_C.BAS	C_FFFS	C_C.FFFS	Condition
0.95	0.5	0.05	0.05	0.5	0.5	0.5	0.5	Pos
0.05	0.05	0.95	0.5	0.5	0.5	0.5	0.5	Neg
0.05	0.5	0.05	0.5	0.5	0.5	0.5	0.5	Neu

Simulated Experiment 4, Experience 2

Goal 1				Goal 2				
C_BAS	C_C.BAS	C_FFFS	C_C.FFFS	C_BAS	C_C.BAS	C_FFFS	C_C.FFFS	Condition
0.75	0.05	0.05	0.5	0.5	0.05	0.5	0.05	PI
0.95	0.25	0.05	0.95	0.05	0.95	0.05	0.95	Ap
0.05	0.5	0.05	0.5	0.5	0.5	0.5	0.5	Neu

Study 1: Method

Simulated Experiment 1, Experience 2

Goal 1				Goal 2				
C_BAS	C_C.BAS	C_FFFS	C_C.FFFS	C_BAS	C_C.BAS	C_FFFS	C_C.FFFS	Condition
0.95	0.5	0.05	0.05	0.5	0.5	0.5	0.5	Pos
0.05	0.05	0.95	0.5	0.5	0.5	0.5	0.5	Neg
0.05	0.5	0.05	0.5	0.5	0.5	0.5	0.5	Neu

Simulated Experiment 4, Experience 2

Goal 1				Goal 2				
C_BAS	C_C.BAS	C_FFFS	C_C.FFFS	C_BAS	C_C.BAS	C_FFFS	C_C.FFFS	Condition
0.75	0.05	0.05	0.5	0.5	0.05	0.5	0.05	PI
0.95	0.25	0.05	0.95	0.05	0.95	0.05	0.95	Ap
0.05	0.5	0.05	0.5	0.5	0.5	0.5	0.5	Neu

- Analyses
  - Descriptive statistics (*M*, *SD*)
  - Pre-post differences in affect
  - ANOVAs (manipulation check)
  - Moderated multiple regressions (MMRs)
  - Analyses of simple slopes
  - Correlations among baseline measures

Study 1: Method

Simulated Experiment 1, Experience 2

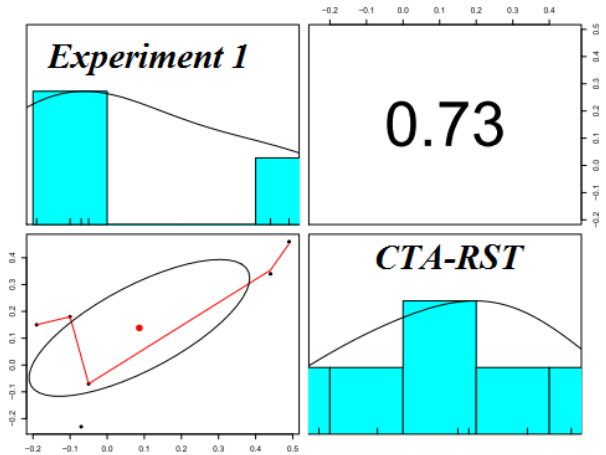
Goal 1				Goal 2				
C_BAS	C_C.BAS	C_FFFS	C_C.FFFS	C_BAS	C_C.BAS	C_FFFS	C_C.FFFS	Condition
0.95	0.5	0.05	0.05	0.5	0.5	0.5	0.5	Pos
0.05	0.05	0.95	0.5	0.5	0.5	0.5	0.5	Neg
0.05	0.5	0.05	0.5	0.5	0.5	0.5	0.5	Neu

Simulated Experiment 4, Experience 2

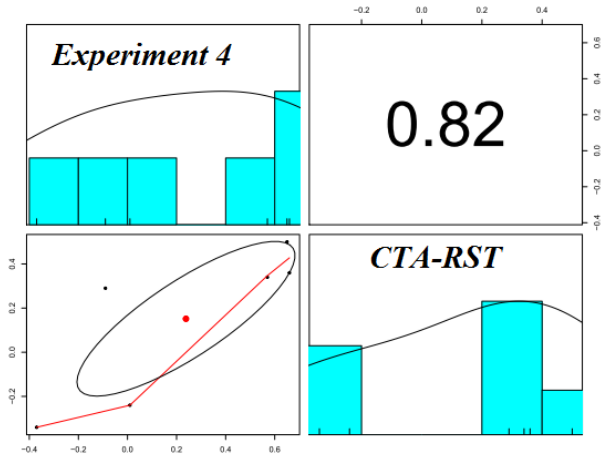
Goal 1				Goal 2				
C_BAS	C_C.BAS	C_FFFS	C_C.FFFS	C_BAS	C_C.BAS	C_FFFS	C_C.FFFS	Condition
0.75	0.05	0.05	0.5	0.5	0.05	0.5	0.05	PI
0.95	0.25	0.05	0.95	0.05	0.95	0.05	0.95	Ap
0.05	0.5	0.05	0.5	0.5	0.5	0.5	0.5	Neu

- Analyses
  - Descriptive statistics (*M*, *SD*)
  - Pre-post differences in affect
  - ANOVAs (manipulation check)
  - Moderated multiple regressions (MMRs)
  - Analyses of simple slopes
  - Correlations among baseline measures
- DVs calculated for target goal (G = 1) only

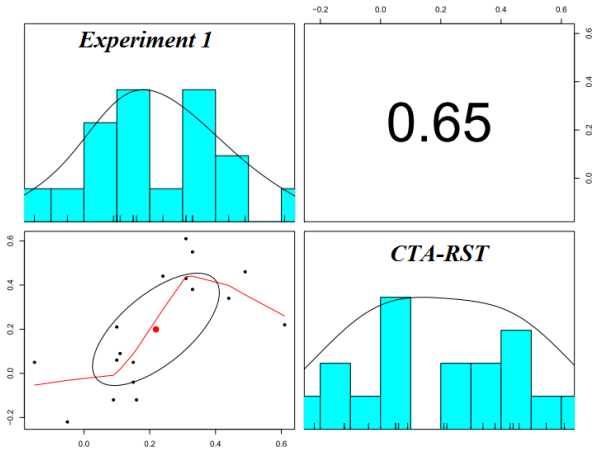
Correlating Original, Simulated Effect Sizes



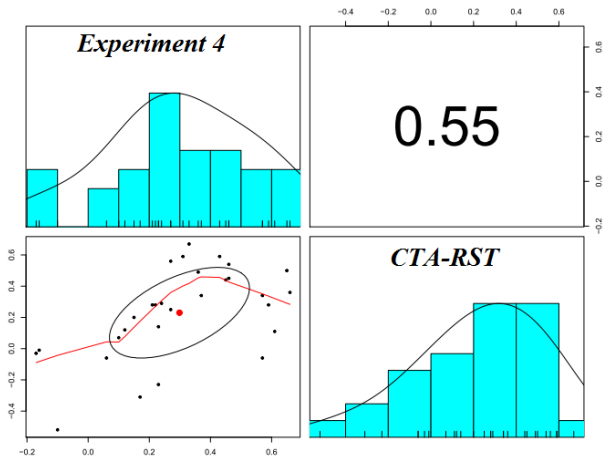
Changes in Affect



Changes in Affect



ANOVAs & MMRs



ANOVAs & MMRs

Study 2: Affect and Goal Velocity (Wilt et al., 2016)

Study 2: Affect and Goal Velocity (Wilt et al., 2016)

- State Extraversion:
  -
-
  -
-
  -
-
-

Study 2: Affect and Goal Velocity (Wilt et al., 2016)

- State Extraversion:
  - (= Study 1 State Pleasant Affect, PA_S)
-
-
-
-

Study 2: Affect and Goal Velocity (Wilt et al., 2016)

- State Extraversion:
  - (= Study 1 State Pleasant Affect, PA_S)

$$E_S = \overline{BAS}_{Ap}$$

-
-
-
-
-

Study 2: Affect and Goal Velocity (Wilt et al., 2016)

- State Extraversion:
  - (= Study 1 State Pleasant Affect, PA_S)

$$E_S = \overline{BAS}_{Ap}$$

- State Neuroticism:
  -
-
  -
-
-

Study 2: Affect and Goal Velocity (Wilt et al., 2016)

- State Extraversion:
  - (= Study 1 State Pleasant Affect, PA_S)

$$E_S = \overline{BAS}_{Ap}$$

- State Neuroticism:
  -

$$N_S = \overline{FFFS}_{Ap}$$

-
-
-

Study 2: Affect and Goal Velocity (Wilt et al., 2016)

- State Extraversion:
  - (= Study 1 State Pleasant Affect, PA_S)

$$E_S = \overline{BAS}_{Ap}$$

- State Neuroticism:
  - (= Study 1 State Negative Affect, NA_S)

$$N_S = \overline{FFFS}_{Ap}$$

-
  -
-
-

Study 2: Affect and Goal Velocity (Wilt et al., 2016)

- State Extraversion:
  - (= Study 1 State Pleasant Affect, PA_S)

$$E_S = \overline{BAS}_{Ap}$$

- State Neuroticism:
  - (= Study 1 State Negative Affect, NA_S)

$$N_S = \overline{FFFS}_{Ap}$$

- State Positive Affect:
  - (= Study 1 State Energetic Affect, EA_S)
-
-

Study 2: Affect and Goal Velocity (Wilt et al., 2016)

- State Extraversion:
  - (= Study 1 State Pleasant Affect, PA_S)

$$E_S = \overline{BAS}_{Ap}$$

- State Neuroticism:
  - (= Study 1 State Negative Affect, NA_S)

$$N_S = \overline{FFFS}_{Ap}$$

- State Positive Affect:
  - (= Study 1 State Energetic Affect, EA_S)

$$PA_S = \overline{BAS}_{Tvf}$$

-

-

Study 2: Affect and Goal Velocity (Wilt et al., 2016)

- State Extraversion:
  - (= Study 1 State Pleasant Affect, PA_S)

$$E_S = \overline{BAS}_{Ap}$$

- State Neuroticism:
  - (= Study 1 State Negative Affect, NA_S)

$$N_S = \overline{FFFS}_{Ap}$$

- State Positive Affect:
  - (= Study 1 State Energetic Affect, EA_S)

$$PA_S = \overline{BAS}_{Tvf}$$

- State Negative Affect:

$$NA_S = \overline{FFFS}_{Tvf}$$

-

Study 2: Affect and Goal Velocity (Wilt et al., 2016)

- State Extraversion:
  - (= Study 1 State Pleasant Affect, PA_S)

$$E_S = \overline{BAS}_{Ap}$$

- State Neuroticism:
  - (= Study 1 State Negative Affect, NA_S)

$$N_S = \overline{FFFS}_{Ap}$$

- State Positive Affect:
  - (= Study 1 State Energetic Affect, EA_S)

$$PA_S = \overline{BAS}_{Tvf}$$

- State Negative Affect:

$$NA_S = \overline{FFFS}_{Tvf}$$

- Goal Velocity:

$$V_{BAS} = \overline{BAS}_{At}$$

Study 2: Results

Six Bivariate Multilevel Models

Study 2: Results

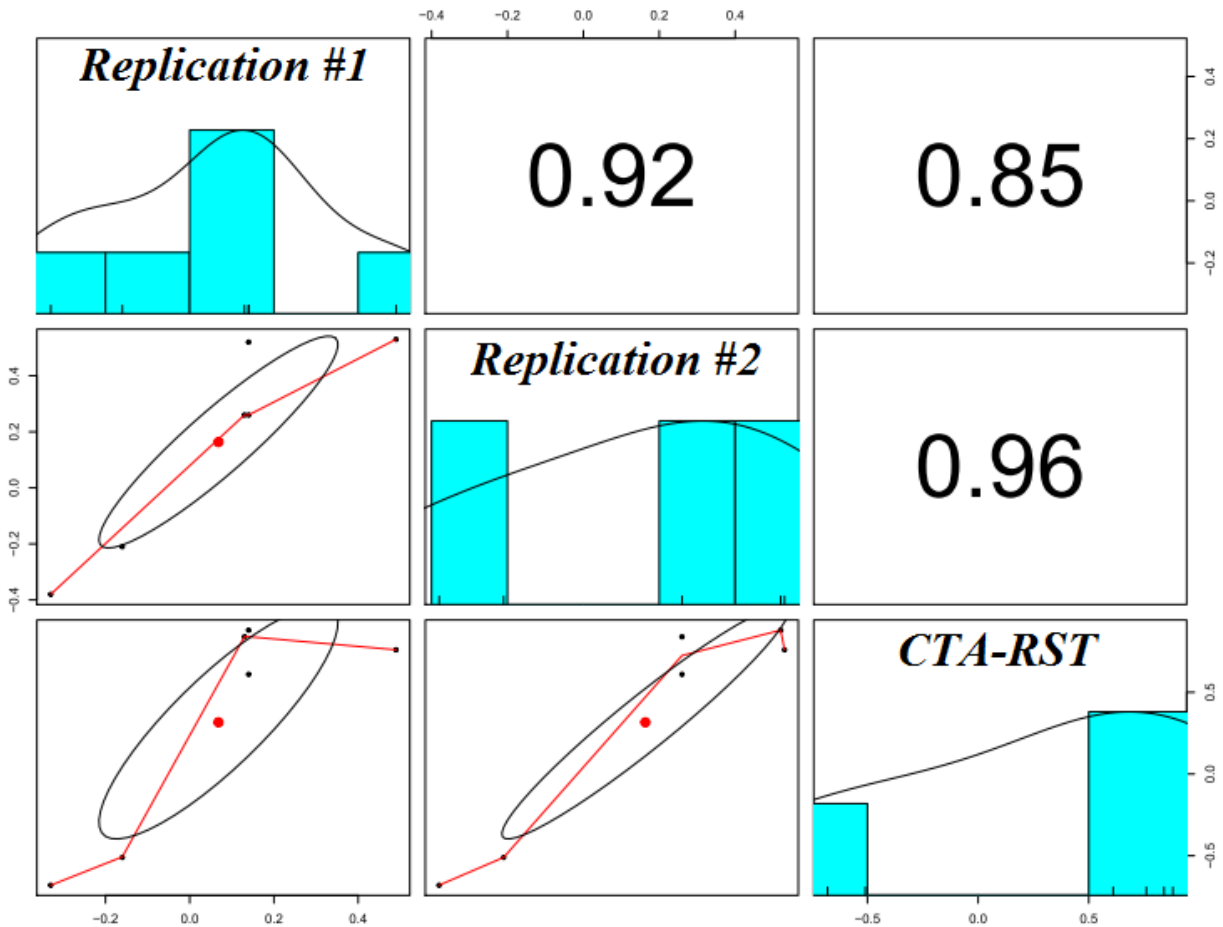
Six Bivariate Multilevel Models

- E_S predicts V
- N_S predicts V
- V predicts PA_S
- V predicts NA_S
- E_S predicts PA_S
- N_S predicts NA_S

Study 2: Results

Six Bivariate Multilevel Models

Figure: Replications = Observed data



- E_S predicts V
- N_S predicts V
- V predicts PA_S
- V predicts NA_S
- E_S predicts PA_S
- N_S predicts NA_S

Study 2: Results

Two 1-1-1 Multilevel Models

Study 2: Results

Two 1-1-1 Multilevel Models

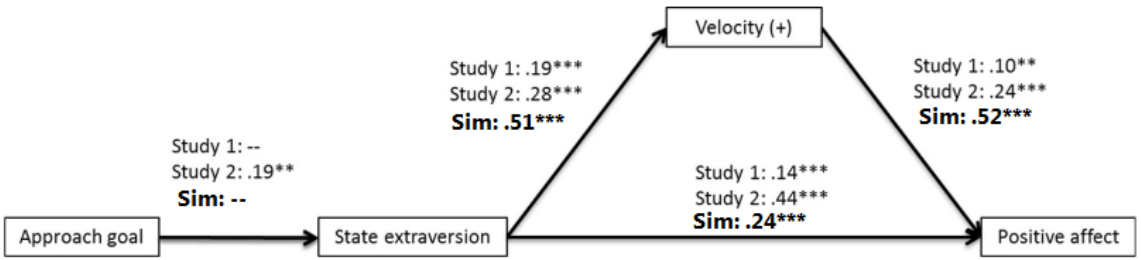


Fig. 1. Mediation model specifying that the relation between state extraversion and state positive affect is mediated through increased velocity toward goals. This figure shows the direct effects from mediation models specifying the relations between approach goals, state extraversion, velocity (+ = positively scored), and state positive affect. Numbers are unstandardized regression coefficients. ** = $p < 0.01$; *** = $p < 0.001$.

Figure: Model linking E_S to PA_S via V

Study 2: Results

Two 1-1-1 Multilevel Models

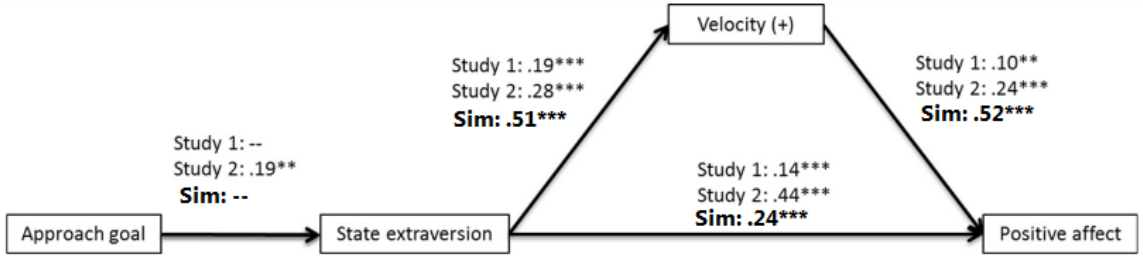


Fig. 1. Mediation model specifying that the relation between state extraversion and state positive affect is mediated through increased velocity toward goals. This figure shows the direct effects from mediation models specifying the relations between approach goals, state extraversion, velocity (+ = positively scored), and state positive affect. Numbers are unstandardized regression coefficients. ** = $p < 0.01$; *** = $p < 0.001$.

Figure: Model linking E_S to PA_S via V

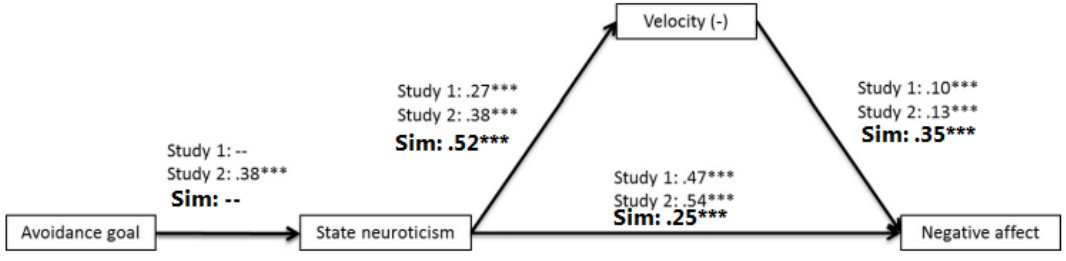


Fig. 2. Mediation model specifying that the relation between state neuroticism and state negative affect is mediated through decreased velocity toward goals. This figure shows the direct effects from mediation models specifying the relations between avoidance goals, state neuroticism, velocity (− = negatively scored), and state negative affect. Numbers are unstandardized regression coefficients. *** = $p < 0.001$.

Figure: Model linking N_S to NA_S via V

Study 3: Affective Synchrony (Wilt et al., 2011)

Study 3: Affective Synchrony (Wilt et al., 2011)

- State Pleasant Affect:

$$PA_S = \overline{BAS}_{Ap}$$

- State Unpleasant Affect:

$$UA_S = \overline{FFFS}_{Ap}$$

- State Energetic Affect:

$$EA_S = \overline{BAS}_{Tvf}$$

- State Tense Affect:

$$TA_S = \overline{FFFS}_{Tvf}$$

Study 3: Affective Synchrony (Wilt et al., 2011)

- State Pleasant Affect:

$$PA_S = \overline{BAS}_{Ap}$$

- State Unpleasant Affect:

$$UA_S = \overline{FFFS}_{Ap}$$

- State Energetic Affect:

$$EA_S = \overline{BAS}_{Tvf}$$

- State Tense Affect:

$$TA_S = \overline{FFFS}_{Tvf}$$

[1] PA_S = Study 1 PA_S, Study 2 E_S

Study 3: Affective Synchrony (Wilt et al., 2011)

- State Pleasant Affect:

$$PA_S = \overline{BAS}_{Ap}$$

- State Unpleasant Affect:

$$UA_S = \overline{FFFS}_{Ap}$$

- State Energetic Affect:

$$EA_S = \overline{BAS}_{Tvf}$$

- State Tense Affect:

$$TA_S = \overline{FFFS}_{Tvf}$$

[1] PA_S = Study 1 PA_S, Study 2 E_S

[2] UA_S = Study 1 NA_S, Study 2 N_S

Study 3: Affective Synchrony (Wilt et al., 2011)

- State Pleasant Affect:

$$PA_S = \overline{BAS}_{Ap}$$

- State Unpleasant Affect:

$$UA_S = \overline{FFFS}_{Ap}$$

- State Energetic Affect:

$$EA_S = \overline{BAS}_{Tvf}$$

- State Tense Affect:

$$TA_S = \overline{FFFS}_{Tvf}$$

---

[1] PA_S = Study 1 PA_S, Study 2 E_S
[2] UA_S = Study 1 NA_S, Study 2 N_S
[3] EA_S = Study 1 EA_S, Study 2 PA_S

Study 3: Affective Synchrony (Wilt et al., 2011)

- State Pleasant Affect:

$$PA_S = \overline{BAS}_{Ap}$$

- State Unpleasant Affect:

$$UA_S = \overline{FFFS}_{Ap}$$

- State Energetic Affect:

$$EA_S = \overline{BAS}_{Tvf}$$

- State Tense Affect:

$$TA_S = \overline{FFFS}_{Tvf}$$

---

[1] PA_S = Study 1 PA_S, Study 2 E_S
[2] UA_S = Study 1 NA_S, Study 2 N_S
[3] EA_S = Study 1 EA_S, Study 2 PA_S
[4] TA_S = Study 2 NA_S

Study 3: Affective Synchrony (Wilt et al., 2011)

- State Pleasant Affect:

$$PA_S = \overline{BAS}_{Ap}$$

- State Unpleasant Affect:

$$UA_S = \overline{FFFS}_{Ap}$$

- State Energetic Affect:

$$EA_S = \overline{BAS}_{Tvf}$$

- State Tense Affect:

$$TA_S = \overline{FFFS}_{Tvf}$$

- Trait Pleasant Affect:

$$PA_T = -BAS_c$$

- Trait Unpleasant Affect:

$$UA_T = -FFFS_c$$

- Trait Energetic Affect:

$$EA_T = BAS_w$$

- Trait Tense Affect:

$$TA_T = BIS_w + FFFS_w - BIS_c$$

---

[1] PA_S = Study 1 PA_S, Study 2 E_S
[2] UA_S = Study 1 NA_S, Study 2 N_S
[3] EA_S = Study 1 EA_S, Study 2 PA_S
[4] TA_S = Study 2 NA_S

Study 3: Results

Two bivariate multilevel models

Study 3: Results

Two bivariate multilevel models

Predictor	Outcome	R1			R2			Sim		
		β	*RNG*	*L*	β	*RNG*	*L*	β	*RNG*	*L*
TA_S	EA_S	-.26	(-.85, .26)	87.84	-.10	(-.99, .45)	141.67	-.21	(-.95, .15)	61.37
UA_S	PA_S	-.64	(-1.17,-.17)	60.90	-.27	(-1.09, .22)	187.87	-.26	(-1.75, .04)	472.72

Note. *R*1 = Replication 1, *R*2 = Replication 2, *Sim* = Simulation, *RNG* = Range, *L* = Likelihood ratio, TA_S = State tense affect, EA_S = State energetic affect, UA_S = State unpleasant affect, PA_S = State pleasant affect, $p < .001$ for all *L*.

Study 3: Results

Two bivariate multilevel models

Predictor	Outcome	R1			R2			Sim		
		β	*RNG*	*L*	β	*RNG*	*L*	β	*RNG*	*L*
TA_S	EA_S	-.26	(-.85, .26)	87.84	-.10	(-.99, .45)	141.67	-.21	(-.95, .15)	61.37
UA_S	PA_S	-.64	(-1.17,-.17)	60.90	-.27	(-1.09, .22)	187.87	-.26	(-1.75, .04)	472.72

Note. *R*1 = Replication 1, *R*2 = Replication 2, *Sim* = Simulation, *RNG* = Range, *L* = Likelihood ratio, TA_S = State tense affect, EA_S = State energetic affect, UA_S = State unpleasant affect, PA_S = State pleasant affect, $p < .001$ for all *L*.

- Correlation between average EA-TA and UA-PA relationships: R1 r = -.27, R2 r = -.05, Sim r = .06.

Study 3: Results

Two bivariate multilevel models

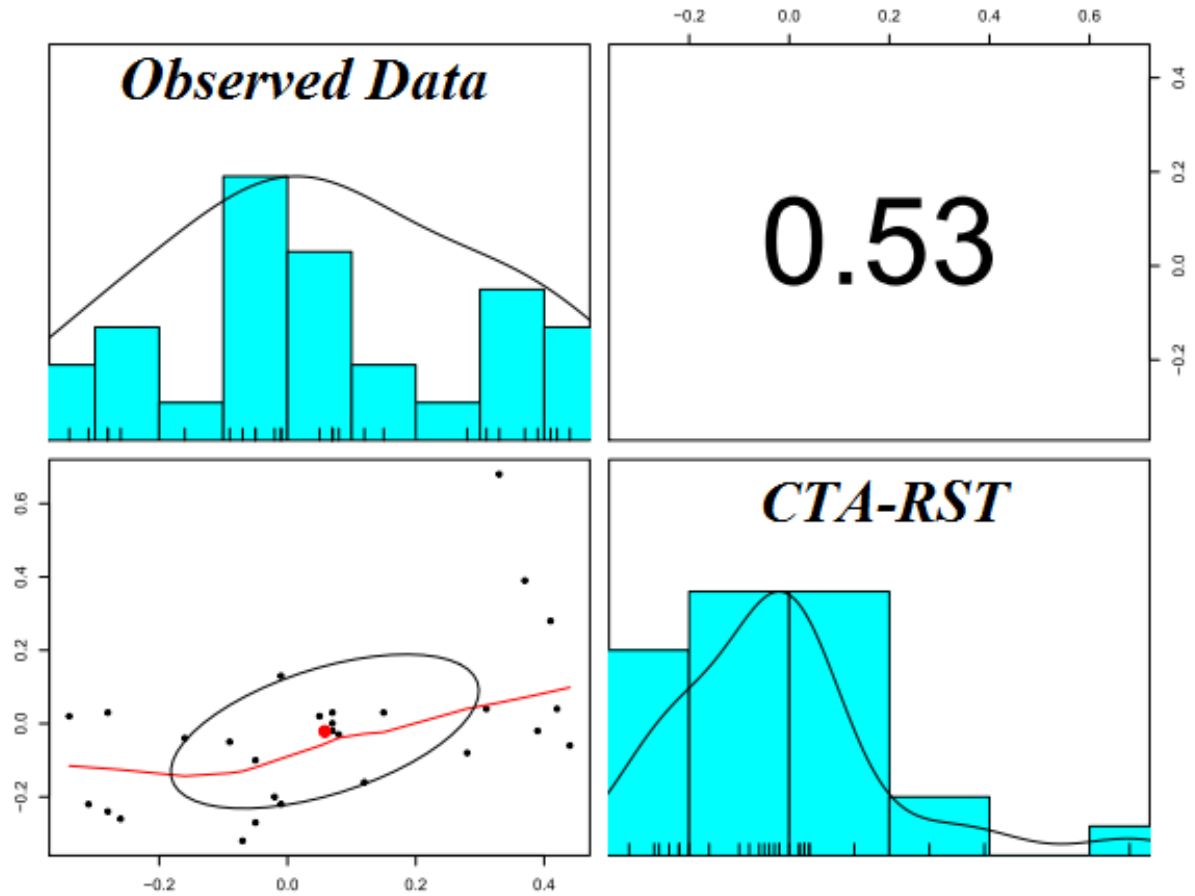
Predictor	Outcome	R1			R2			Sim		
		β	*RNG*	*L*	β	*RNG*	*L*	β	*RNG*	*L*
TA_S	EA_S	-.26	(-.85, .26)	87.84	-.10	(-.99, .45)	141.67	-.21	(-.95, .15)	61.37
UA_S	PA_S	-.64	(-1.17,-.17)	60.90	-.27	(-1.09, .22)	187.87	-.26	(-1.75, .04)	472.72

Note. *R*1 = Replication 1, *R*2 = Replication 2, *Sim* = Simulation, *RNG* = Range, *L* = Likelihood ratio, TA_S = State tense affect, EA_S = State energetic affect, UA_S = State unpleasant affect, PA_S = State pleasant affect, $p < .001$ for all *L*.

- Correlation between average EA-TA and UA-PA relationships: R1 r = -.27, R2 r = -.05, Sim r = .06.
- Next: Four moderated multilevel models:
  - $TA_S * EA_T * TA_T \rightarrow EA_S$
  - $TA_S * PA_T * UA_T \rightarrow EA_S$
  - $UA_S * PA_T * UA_T \rightarrow PA_S$
  - $UA_S * EA_T * TA_T \rightarrow PA_S$

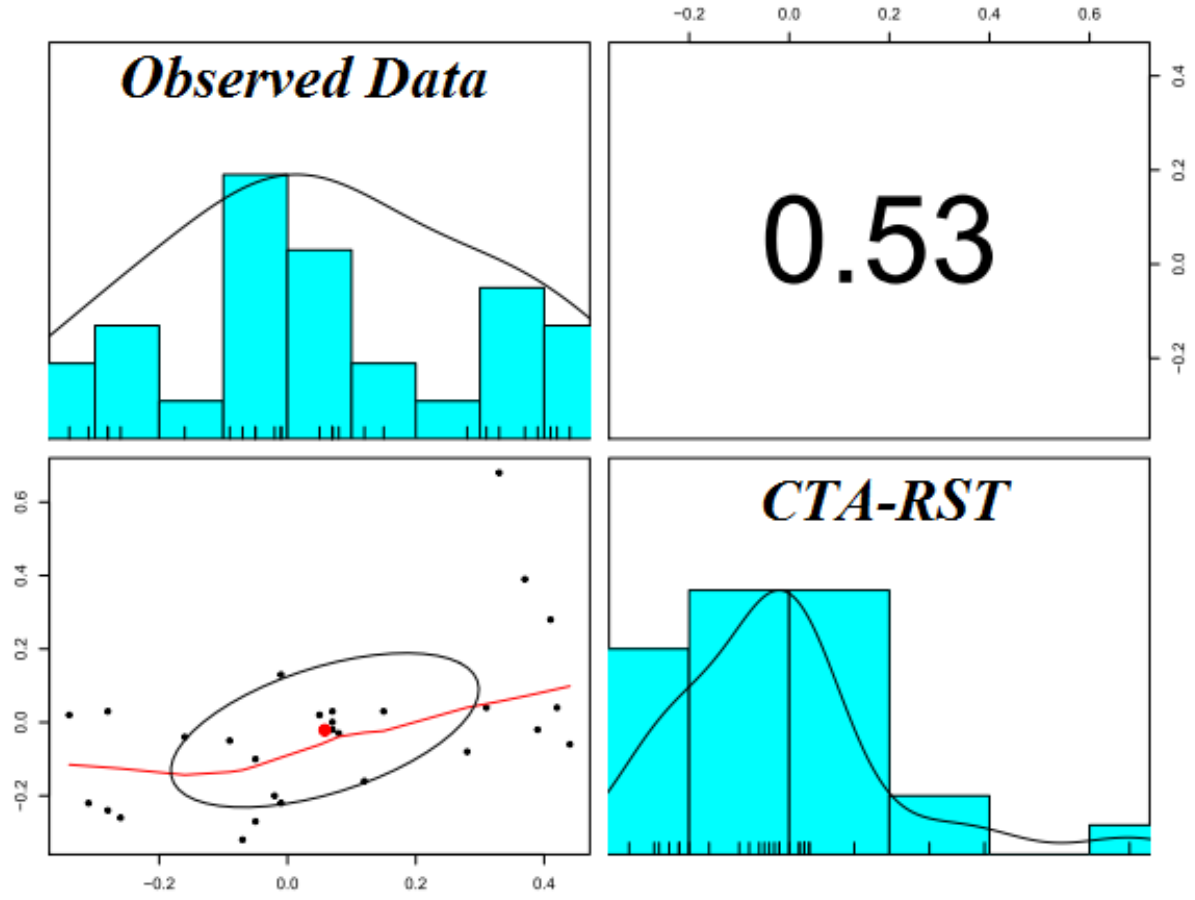
Study 3: Results

Four Moderated Multilevel Models



Study 3: Results

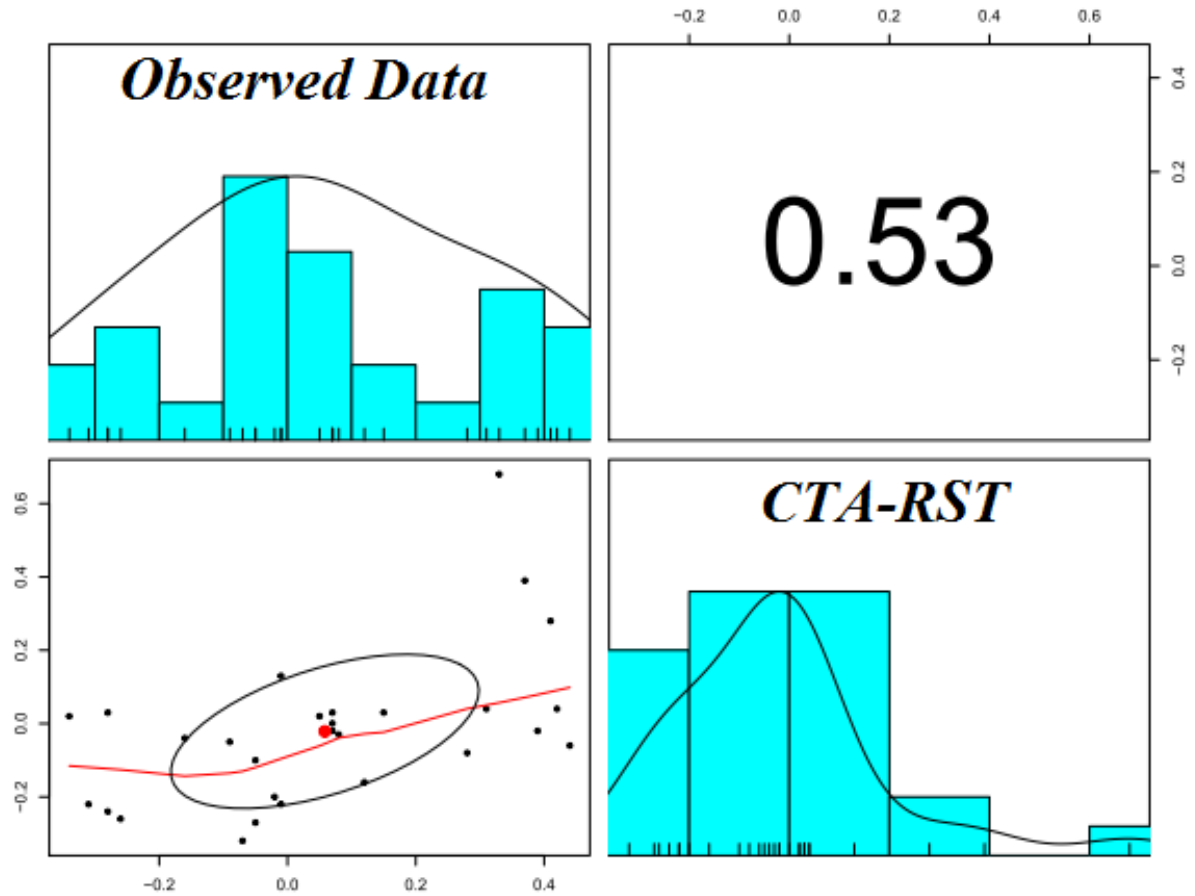
Four Moderated Multilevel Models



- State main effects much stronger than in observed data.

Study 3: Results

Four Moderated Multilevel Models



- State main effects much stronger than in observed data.
- Trait interaction effects not as strong as in observed data.

Operational Definitions: Summary

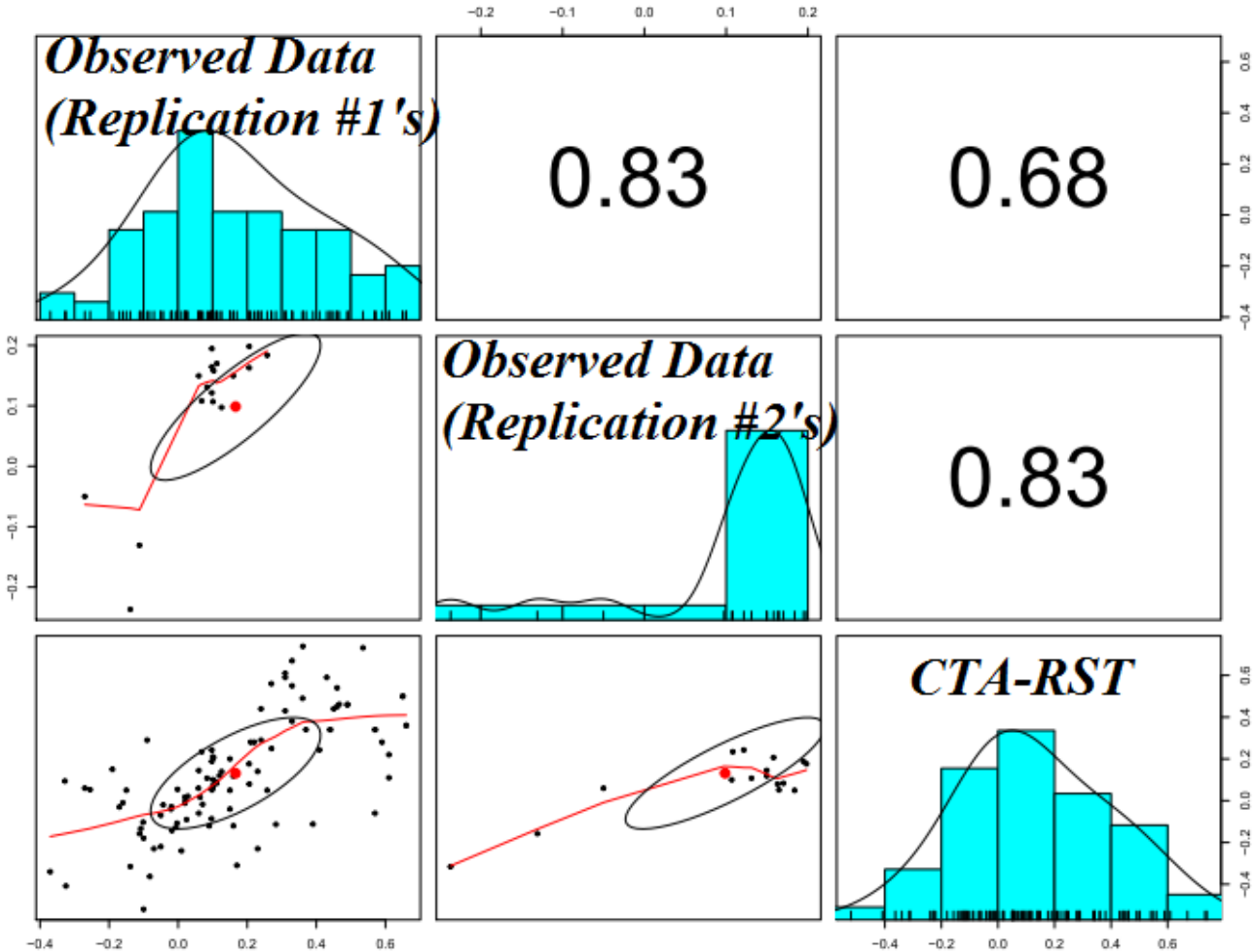
G = Goals measured, T = Total time (iterations), t = Measurement interval (iterations)

States Function	Smillie et al., 2012 Ch.4 (T = 240)	Wilt et al., 2016 Ch.5 (T = 900)	Wilt et al., 2011 Ch.6 (T = 900)
$\overline{BAS}_{Ap}$	$PA_S(t = 240, G = 1)$	$E_S(t = 300; G = 1, 2)$	$PA_S(t = 300; G = 1, 2)$
$\overline{FFFS}_{Ap}$	$NA_S(t = 240, G = 1)$	$N_S(t = 300; G = 1, 2)$	$UA_S(t = 300; G = 1, 2)$
$\overline{BAS}_{Tvf}$	$EA_S(t = 240, G = 1)$	$PA_S(t = 300; G = 1, 2)$	$EA_S(t = 300; G = 1, 2)$
$\overline{FFFS}_{Tvf}$	–	$NA_S(t = 300; G = 1, 2)$	$TA_S(t = 300; G = 1, 2)$
$\overline{BAS}_{At}$	–	$V_{BAS}(t = 300; G = 1, 2)$	–

Traits	Study	Function
E_T	Smillie et al., 2012 (Ch.4)	$BAS_c + BIS_c + FFFS_c$
PA_T	Wilt et al., 2011 (Ch.6)	$-BAS_c$
UA_T	Wilt et al., 2011 (Ch.6)	$-FFFS_c$
EA_T	Wilt et al., 2011 (Ch.6)	BAS_w
TA_T	Wilt et al., 2011 (Ch.6)	$BIS_w + FFFS_w - BIS_c$

Overall Model Fit

(All stats converted to effect sizes)



General Discussion

- We can't randomly assign people's personalities...

General Discussion

- We can't randomly assign people's personalities...
- ...so we haven't done a very good job *explaining* the personality structures that we've done such a good job of *describing*.

General Discussion

- We can't randomly assign people's personalities...
- ...so we haven't done a very good job *explaining* the personality structures that we've done such a good job of *describing*.
- BUT: computational modeling affords us an alternative means of experimentally manipulating individual differences.

General Discussion

- We can't randomly assign people's personalities...
- ...so we haven't done a very good job *explaining* the personality structures that we've done such a good job of *describing*.
- BUT: computational modeling affords us an alternative means of experimentally manipulating individual differences.
- I've shown not only that CTA-RST simulates within- and between-persons individual differences in affect and behavior...

General Discussion

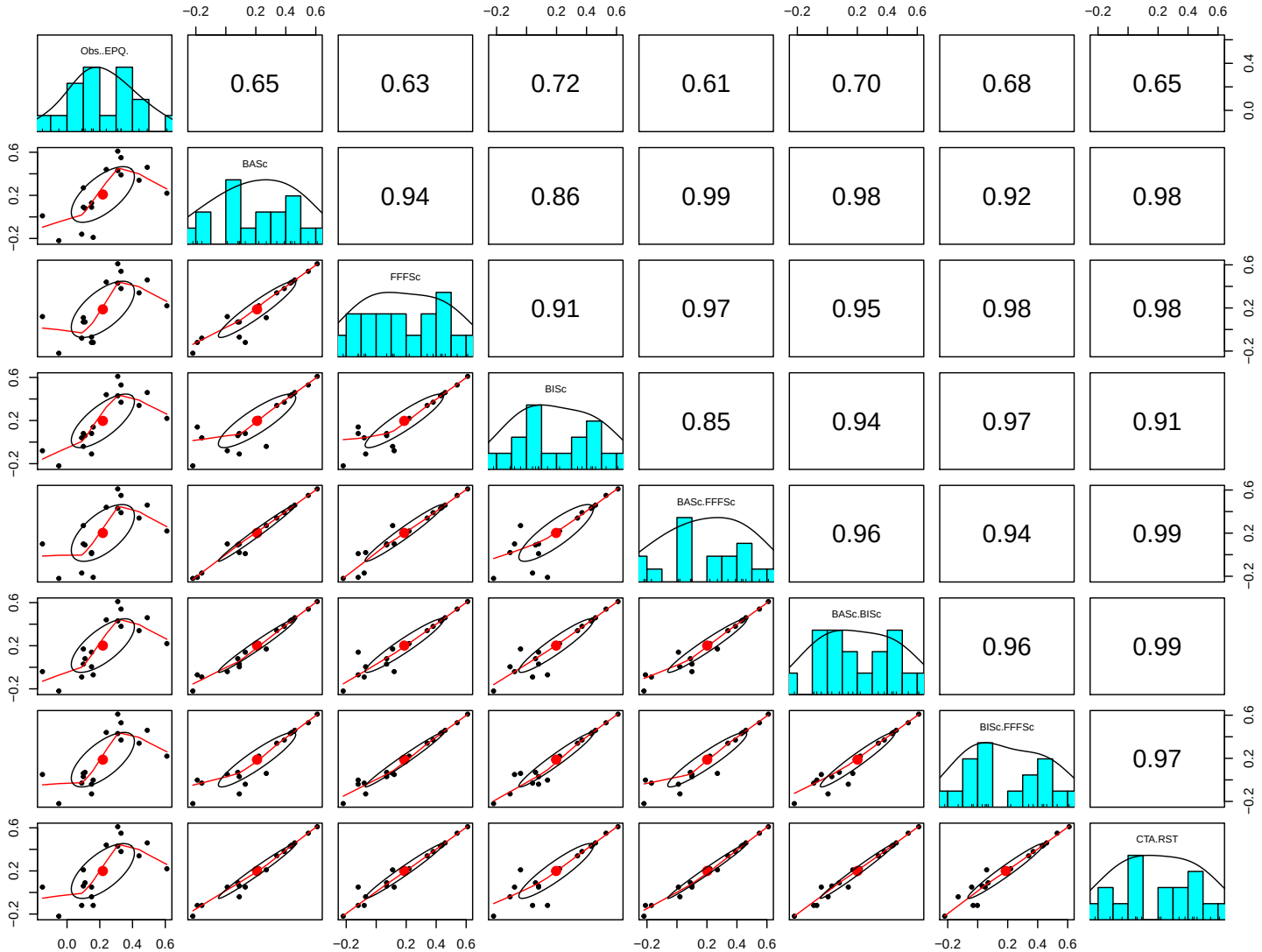
- We can't randomly assign people's personalities...
- ...so we haven't done a very good job *explaining* the personality structures that we've done such a good job of *describing*.
- BUT: computational modeling affords us an alternative means of experimentally manipulating individual differences.
- I've shown not only that CTA-RST simulates within- and between-persons individual differences in affect and behavior...
- ...but also that CTA-RST, unlike similar models, has shown itself capable of simulating, in detail, real data from real studies.

General Discussion

- We can't randomly assign people's personalities...
- ...so we haven't done a very good job *explaining* the personality structures that we've done such a good job of *describing*.
- BUT: computational modeling affords us an alternative means of experimentally manipulating individual differences.
- I've shown not only that CTA-RST simulates within- and between-persons individual differences in affect and behavior...
- ...but also that CTA-RST, unlike similar models, has shown itself capable of simulating, in detail, real data from real studies.
- Thank you!
  - Contact: AshleyBrown2011@u.northwestern.edu

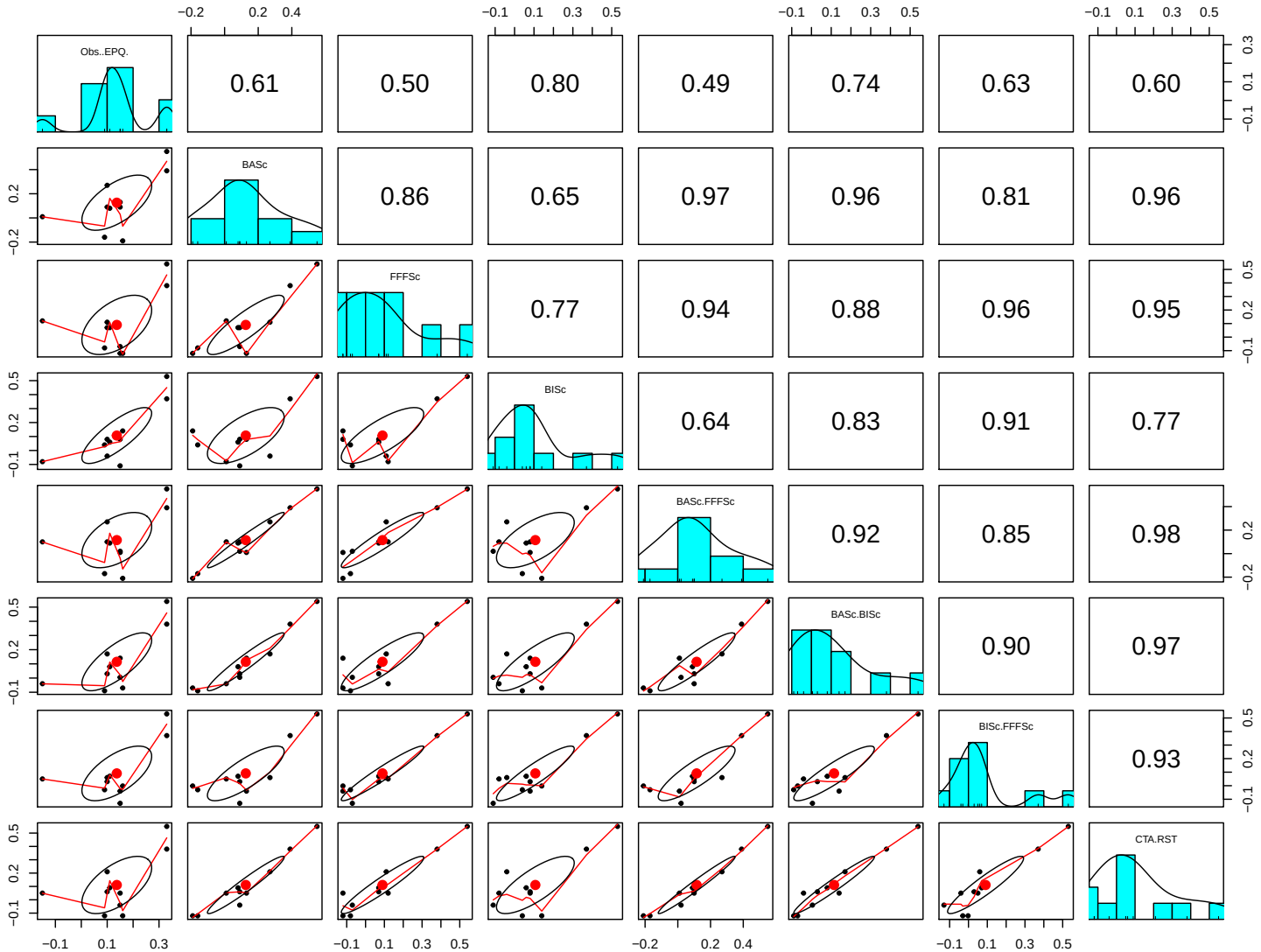
Study 1 Extraversions

Experiment 1: Comparison of effect sizes of original and simulated data, all analyses



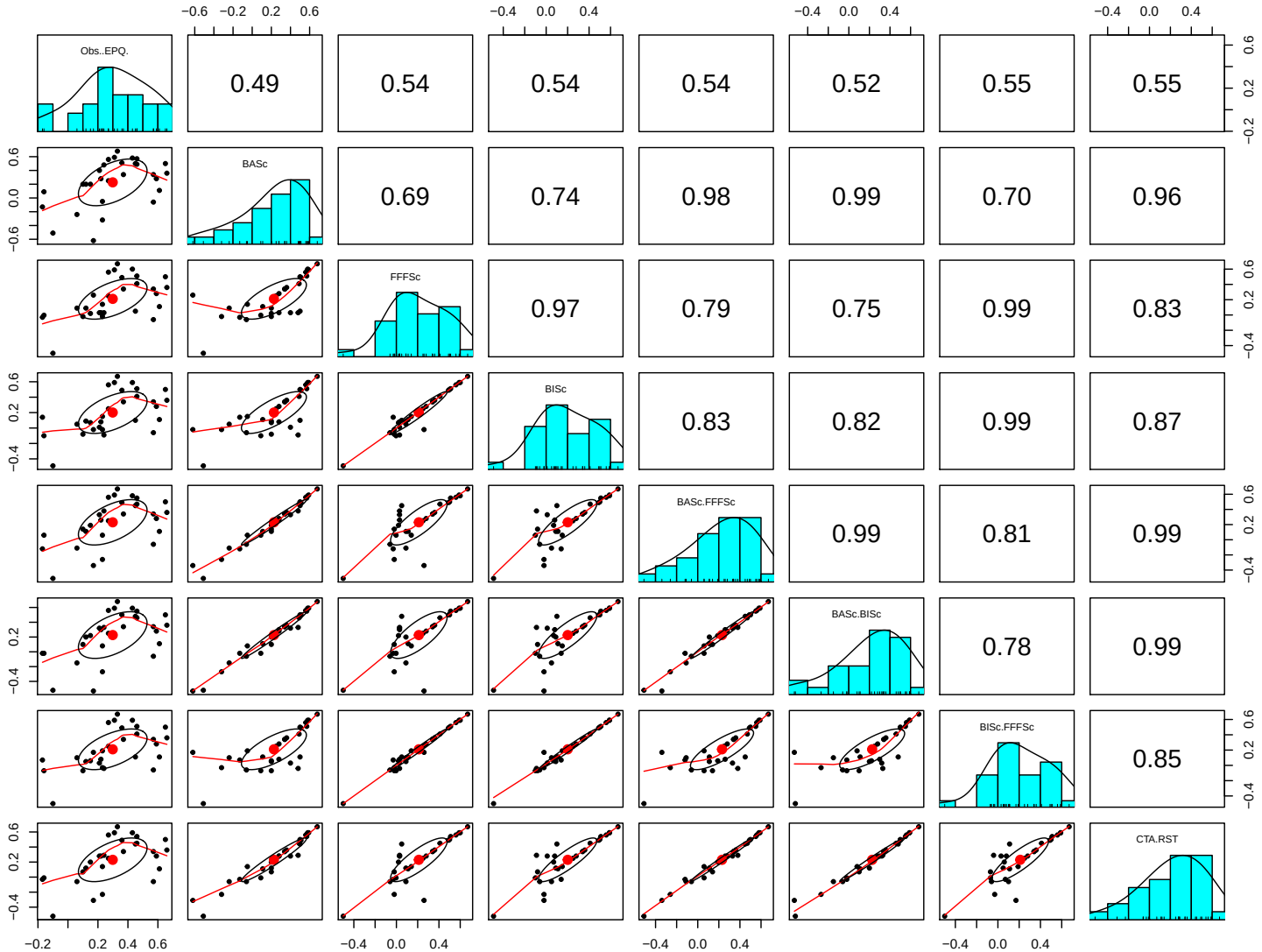
Study 1 Extraversions

Experiment 1: Comparison of effect sizes of original and simulated data, extraversion-dependent analyses only



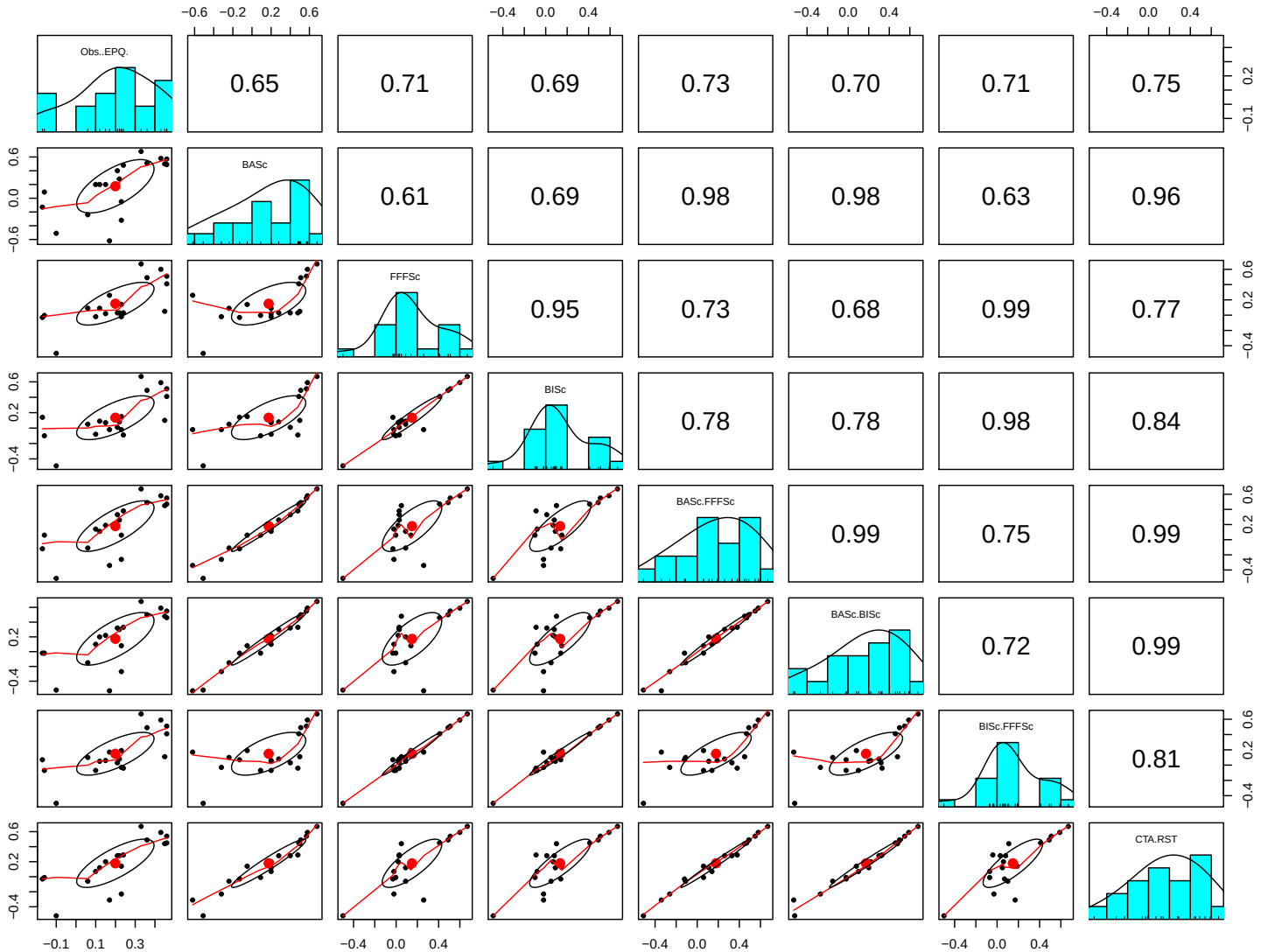
Study 1 Extraversions

Experiment 4: Comparison of effect sizes of original and simulated data, all analyses



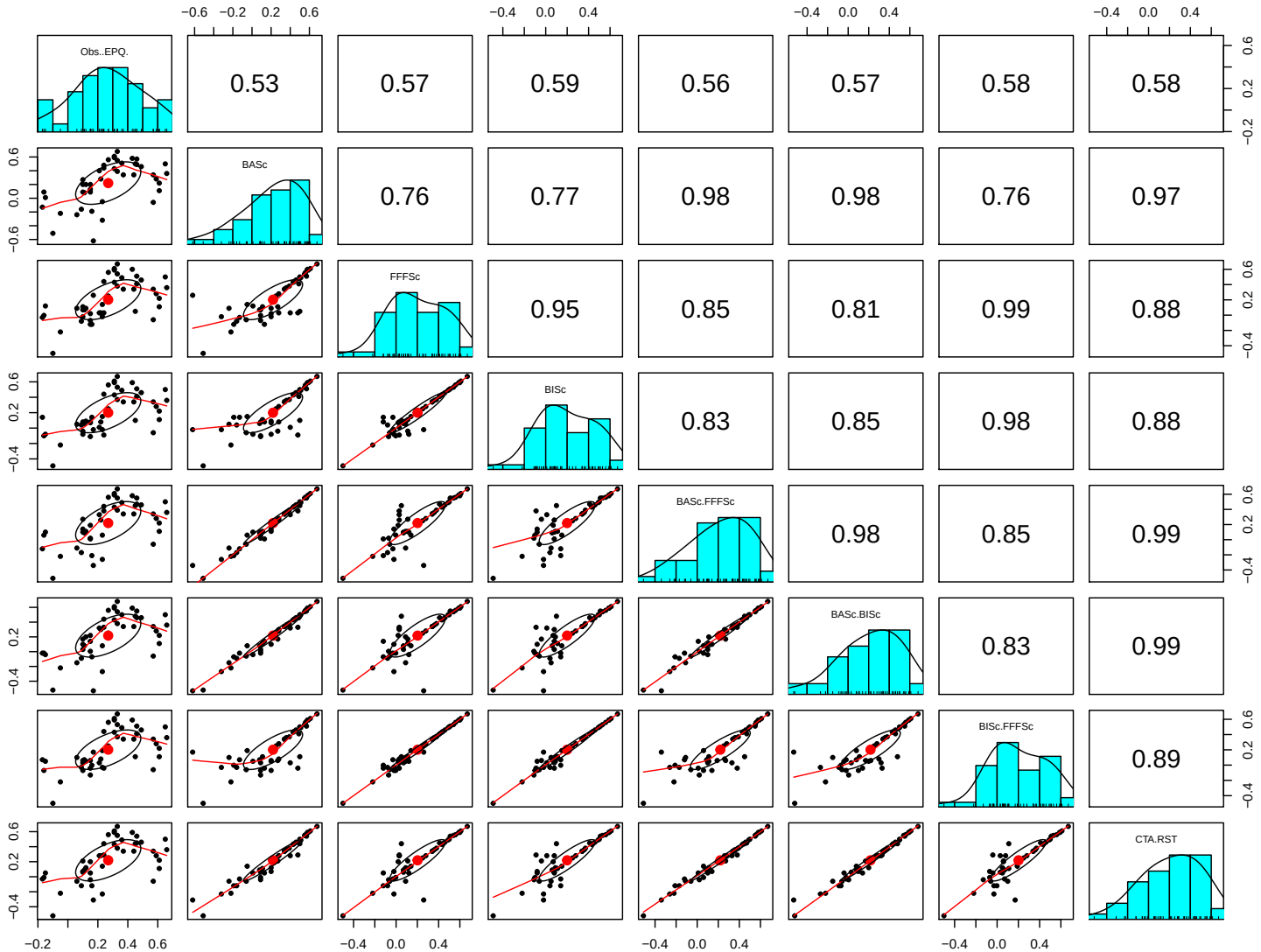
Study 1 Extraversions

Experiment 4: Comparison of effect sizes of original and simulated data, extraversion-dependent analyses only



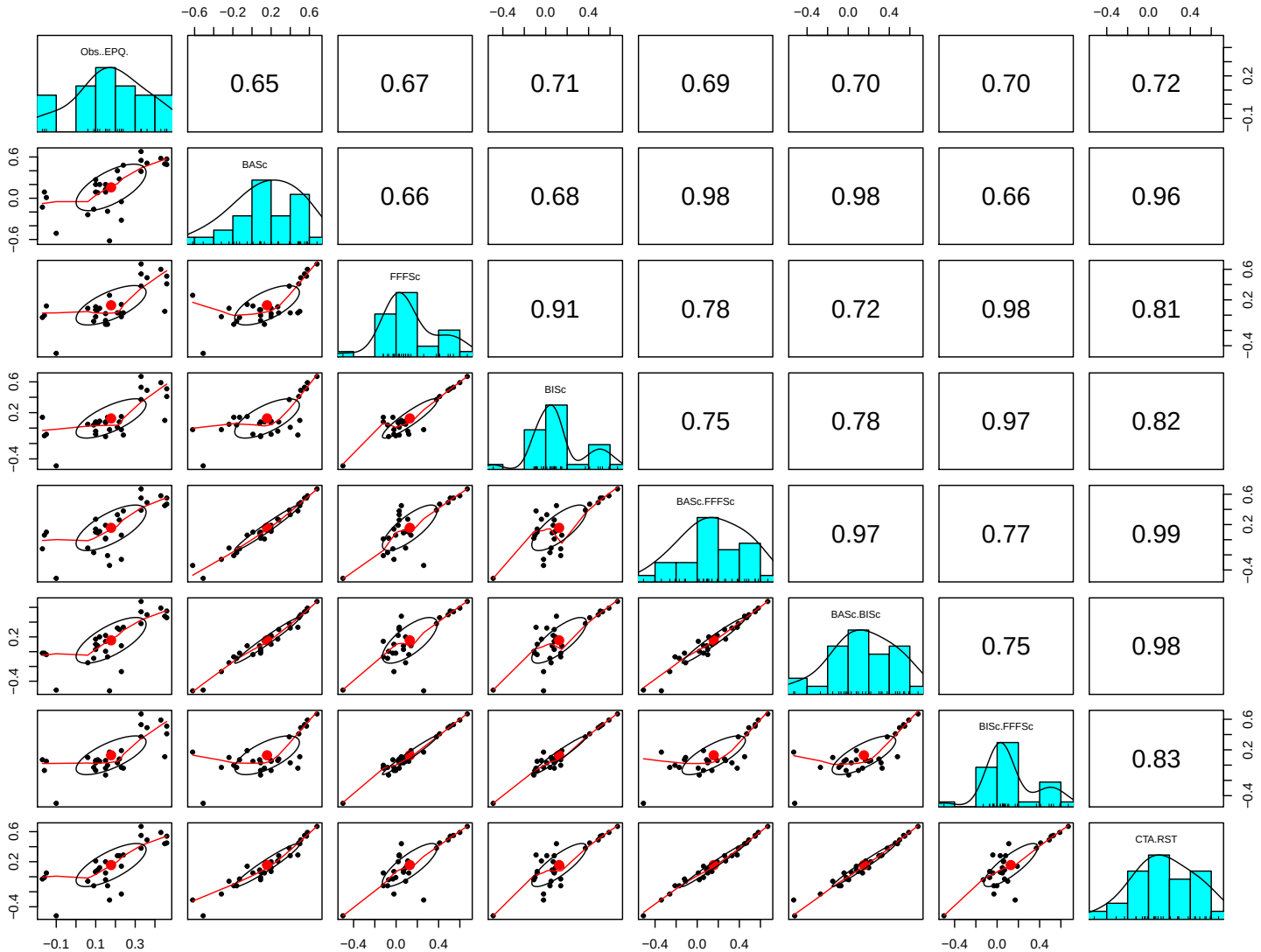
Study 1 Extraversions

Experiments 1, 4: Comparison of effect sizes of original and simulated data, all analyses



Study 1 Extraversions

Experiments 1, 4: Comparison of effect sizes of original and simulated data, extraversion-dependent analyses only

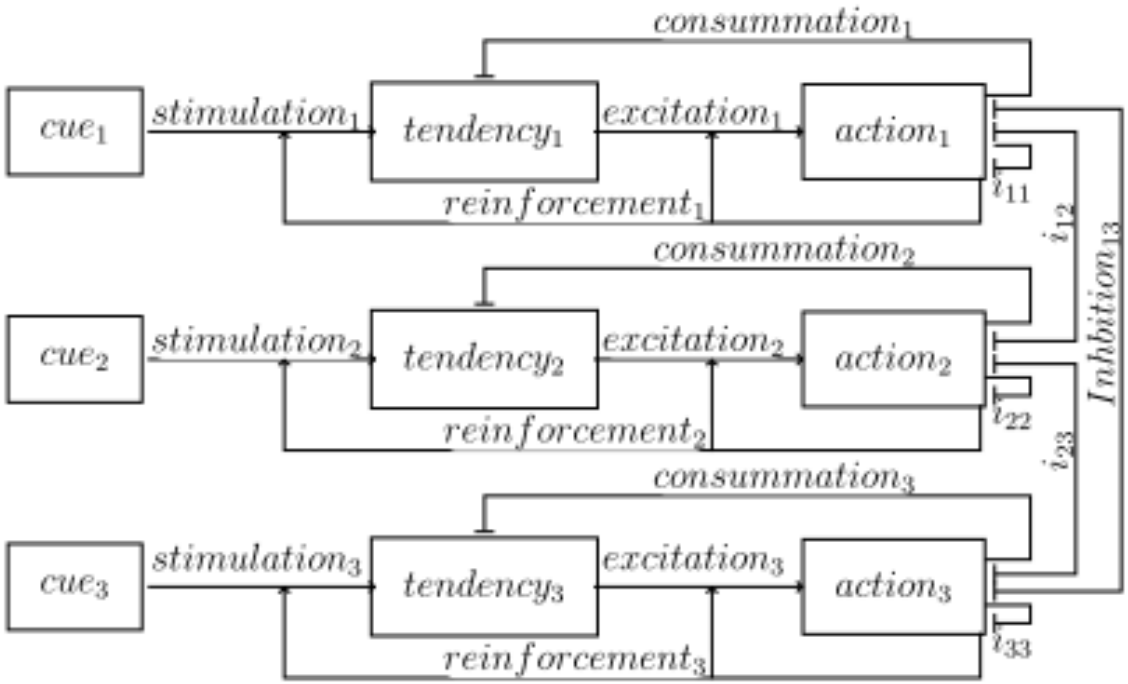


Revelle and Condon's CTA Model (2015)

Inspired by the Dynamics of Action model (Atkinson and Birch, 1970)

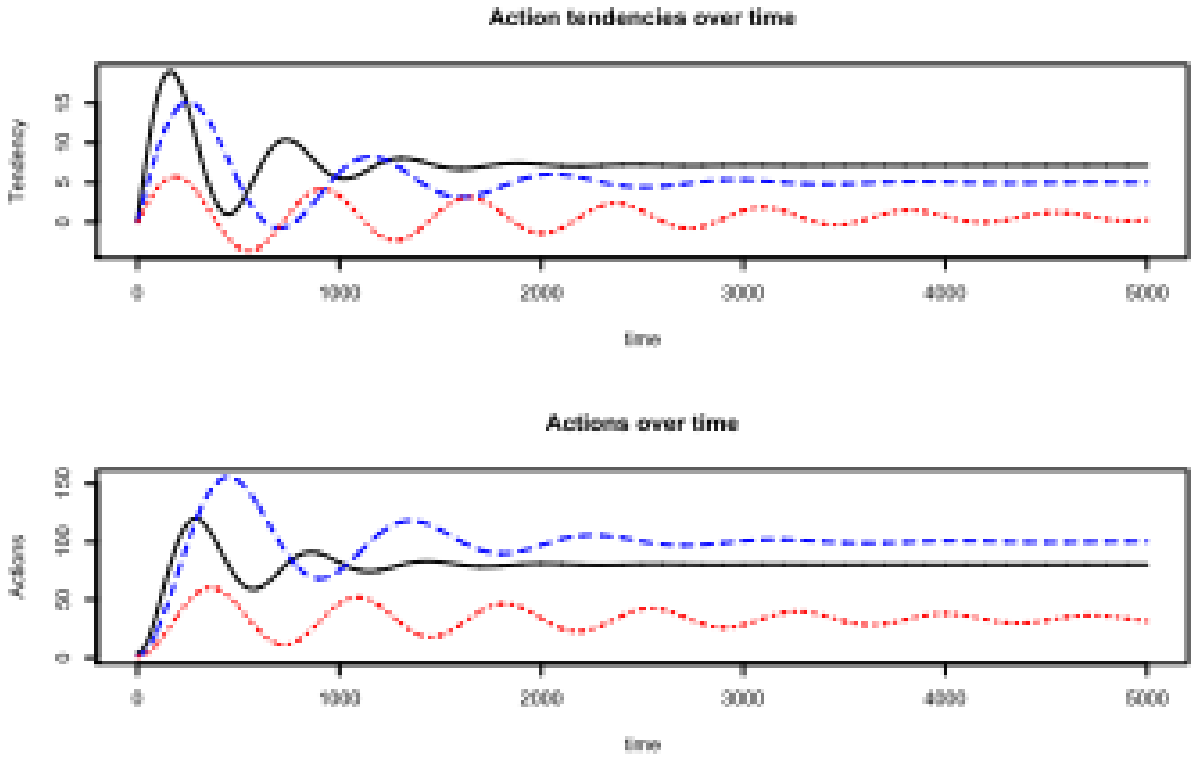
- Vectors: **c** = cues, **t** = tendencies, **a** = actions
- Matrices: **S** = sensitivities (link cue to tendency), **E** = excitations (link tendency to action), **C** = consummations, **I** = inhibitions

$$dt = Sc - Ca \qquad dA = Et - Ia$$



CTA: Three Compatible Tendencies/Actions

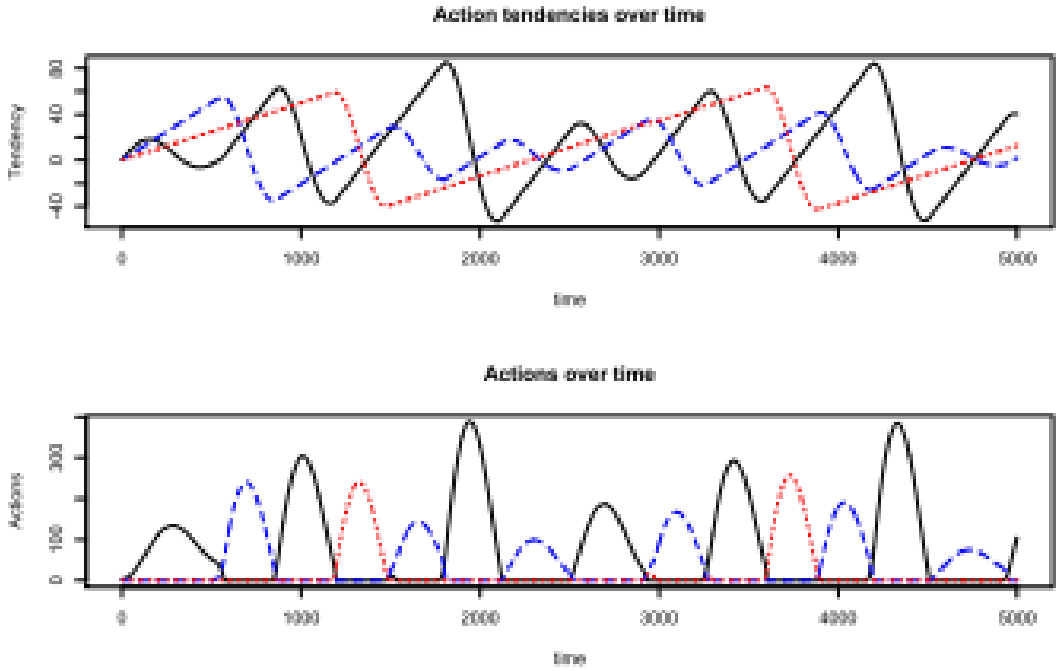
Revelle and Condon (2015)



- If actions A and B are compatible, the corresponding entry, I_{AB}, in the **I** matrix is $0 \leq I_{AB} < 1$.
- Here, **c**, **S**, and **I** vary.

CTA: Three Incompatible Tendencies/Actions

Revelle and Condon (2015)



- If actions A and B are compatible, the corresponding entry, I_{AB}, in the **I** matrix is $I_{AB} = 1$.
- Here, **c** varies and **S** = **I**.
- Flexible interpretation: Many people or many behaviors.

RST Meets CTA

Cues, **c**

- Instigating cues for rewards (BAS), punishments (FFFS), conflicts (BIS)
- Pickering's RST: Uniform distributions of reward, punishment cues (0 - 1)
- CTA default:

$$Cues = \mathbf{c} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 4 \end{bmatrix} \quad (1)$$

- CTA-RST: Normal distributions of reward, punishment cues (.05 - .95; M = .5, SD = .2)
- BIS cues start at 0; change/step is product of BAS, FFFS actions.
- *CueArray*: (subjects) x (experiences) x (3*goals)
- Cue vector (length = 3*goals) for each subject, experience.
- G = goals = 2 (here, always)

RST Meets CTA

Weights/Sensitivities, **S**

- Sensitivities to cues for reward (BAS), punishment (FFFS), goal conflict (BIS)
- Pickering's RST: Normal distributions of BAS, FFFS, BIS weights (.05 - .95; M = .5, SD = .2)
- CTA default:

$$\textit{Sensitivities} = \mathbf{S} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \tag{2}$$

- CTA-RST: Normal distributions of BAS, FFFS, BIS weights (.05 - .95; M = .5, SD = .2)
- *SensArray*: (subjects) x (3*goals) matrix
- Square (3*goals) diagonal matrix extracted for each subject.
- System sensitivities are the same for each goal.

RST Meets CTA

Tendencies, **t**

- BAS reward-goal, FFFS punishment-goal, BIS goal-conflict activations
- Pickering's RST: *BAS*, *BIS*, *FFFS* variables; all start at 0. As processing proceeds, e.g.:

$$\frac{dBAS}{dt} = k_{1BAS}(MaxE - BAS_{out})S_{BAS}w_{BAS} -$$

$$(Max_I + BAS)(k_{4BAS}FFFS_{out} + k_{2BAS}BIS_{out}) - k_{3BAS}(BAS)$$

- CTA default: All tendencies start at 0
- CTA-RST: BIS, FFFS tendencies start at 0; BAS tendencies start at .05 (positivity offset)
  - Small amount of random-normally distributed error (M = 0, SD = .005) introduced into tendency calculations at each iteration.

RST Meets CTA

Actions, **a**

- Approach to reward-goal cues (BAS), avoidance of punishment-goal cues (FFFS), inhibition in response to conflict (BIS)
- Pickering's RST: BAS_{out}, BIS_{out}, $FFFS_{out}$ variables; all start at 0.
- As processing proceeds, e.g., $BAS_{out} = max(BAS, 0)$
- CTA default: Actions' initial values = corresponding cues (e.g. <1, 2, 4>)
- CTA-RST: Actions' initial values = 0; later, if equation for $\mathbf{a}_i < 0$, it's set to 0.

RST Meets CTA

Consummations, **C**

- Extent to which acting satisfies the tendency to act.
- Combination of consummatory strengths of cues and consummatory sensitivities of individual
- In CTA-RST,**C** starts as a (subjects) x (experiences) x (3*goals) array; square (3*goals) diagonal matrix extracted for each subject.
- Each diagonal entry in CTA **C** is .05, but in CTA-RST it's

$$C_{system} = k_{Con} * S_{Con} * c_{Con} \quad (3)$$

- $k_{Con} = 1$ for all systems (BAS, BIS, and FFFS); same as in Pickering's model
- S_{Con} = consummatory sensitivity for system for that individual (random-normally distributed; M = .5, SD = .2)
- c_{Con} = consummatory cue for system for that situation (random-normally distributed; M = .5, SD = .2)

RST Meets CTA

Inhibitions, I

- System-to-system inhibitory links, between and within goals. Term I_{ij} describes jth system's inhibitory effect on ith system.
- **I** matrix = square (3*goals) matrix that's constant over subjects and experiences.
- For one goal, CTA-RST's (and Pickering's) analog to **I** is given by

$$I = \begin{bmatrix} k_{3A} & k_{4A} * (M_I + t_A) & k_{2A} * (M_I + t_A) \\ k_{4F} * (M_I + t_F) & k_{3F} & k_{2F} * (-M_E + a_F) \\ 0 & 0 & k_{3I} \end{bmatrix} \quad (4)$$

- i, j = 1 (BAS), 2 (FFFS), 3 (BIS)
- $k_{2A} = k_{2F} = k_{4A} = k_{4F} = 2$
- $k_{3A} = k_{3F} = k_{3I} = 0.05$ (Same as Pickering's)
- $M_E = 1$ and $M_I = .50$ (Same as Pickering's)

RST Meets CTA

Excitations, **E**

- **E** matrix = Tendency-to-action excitatory links, between and within goals.
- CTA default: Constant diagonal matrix with diagonal entries = 1
- Pickering essentially uses the same system.
- CTA-RST maintains the CTA and Pickering tradition.
- Each subject is assigned a (constant) square (3*goals) matrix; for one goal, e.g., it's

$$\textit{Excitations} = \mathbf{E} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \tag{5}$$

Study 1: Measures

Smillie et al. (2012), Experiments 1 and 4

- Extraversion: Ex.1: EPQ-R E (23 items) or IPIP E (10 items); Ex.4: EPQ-R E only
  - IPIP E items: sociability only
  - EPQ-R E items: sociability and impulsivity (61, 63, 67, 69)
- Positive Affect, Ex.1: interested, excited, strong, enthusiastic, alert, inspired, determined, attentive, active, proud
- Negative Affect, Ex.1: distressed, upset, guilty, scared, hostile, irritable, ashamed, nervous, jittery, afraid
- Pleasant Affect, Ex.4: cheerful, happy, contented, satisfied, dissatisfied (R), depressed (R), sad (R), sorry (R)
- Appetitive Affect, Ex.4: alert, vigorous, active, energetic, unenterprising (R), sluggish (R), tired (R), passive (R)

Study 1: Results

Trait Descriptives, Pre-Post Differences in Affect

ORIGINAL DATA; * = differs significantly from others in that row for that experiment

Condition	E1: Negative (43)	E1: Neutral (43)	E1: Positive (43)	E4: Neutral (41)	E4: Pleasant (33)	E4: Appetitive (33)
$E_{T.EPQ}$ Mean:	16.74	16.37	15.83	13.87	14.58	15.27
Standard Deviation:	3.92	4.42	4.43	4.95	6.18	4.43
EA *r*:	-0.19	-0.05	0.44*	-0.09	0.01	0.66*
95% CI:	-0.47, 0.12	-0.35, 0.25	0.16, 0.65	-0.39, 0.22	-0.33, 0.36	0.41, 0.82
NA *r*:	0.49*	-0.07	-0.10			
95% CI:	0.22, 0.66	-0.37, 0.24	-0.40, 0.21			
PIA *r*:				-0.37	0.65*	0.57*
95% CI:				-0.61, -0.07	0.39, 0.81	0.28, 0.76

SIMULATED DATA; * = differs significantly from others in that row for that experiment

Condition	E1: Negative (40)	E1: Neutral (40)	E1: Positive (40)	E4: Neutral (40)	E4: Pleasant (40)	E4: Appetitive (40)
$E_{T.EPQ}$ Mean:	-0.08	-0.62	0.10	-0.21	0.01	-0.69
Standard Deviation:	1.79	1.45	1.82	1.86	1.50	1.70
EA *r*:	0.15	-0.07	0.34*	0.29	-0.24	0.36*
95% CI:	-0.17, 0.44	-0.38, 0.24	0.04, 0.59	-0.03, 0.55	-0.52, 0.07	0.06, 0.61
NA *r*:	0.46*	-0.23	-0.18			
95% CI:	0.17, 0.67	-0.50, 0.09	-0.47, 0.14			
PIA *r*:				-0.34	0.50*	0.34*
95%CI:				-0.59, -0.03	0.23, 0.70	0.04, 0.59

Study 1: Real v. Simulated Effect Sizes (2 slides)

EXP.1: Correlations, ANOVAs, and Moderated Multiple Regressions (MMRs); * $p < .05$

Analysis	Original Effect Size	95% CI	Sim Effect Size	95% CI
Correlations				
$r(E_{EPQ}$, Pre-NA)	r = .15	-.02, .31	r = .05	-.13, .23
$r(E_{EPQ}$, Pre-PA)	r = .10	-.07, .27	r = .21*	.03, .38
r(Pre-NA, Pre-PA)	r = -.05	-.22, .12	r = -.21*	-.38, -.03
ANOVAs				
3-way interaction, full ANOVA	r = .31*	.15, .46	r = .43*	.27, .57
Positive: Pre-PA $\rightarrow$ Post-PA	r = .44*	.16, .65	r = .34*	.04, .59
Negative: Pre-NA $\rightarrow$ Post-NA	r = .49*	.22, .69	r = .46*	.17, .67
Condition $\rightarrow$ Post-PA	r = .24*	.07, .39	r = .44*	.29, .58
Post-PA: Positive v. Negative	$>$*		$>$*	
Post-PA: Positive v. Neutral	$>$*		$>$*	
Condition $\rightarrow$ Post-NA	r = .31*	.14, .46	r = .61*	.48, .71
Post-NA: Negative v. Positive	$>$*		$>$*	
Post-NA: Negative v. Neutral	$>$*		$>$*	
MMR				
S1: Pre-PA $\rightarrow$ Post-PA	r = .61*	.49, .71	r = .22*	.04, .39
S1 v. S2	r = .33*	.17, .48	r = .56*	.42, .67
S2: $E_{EPQ} \rightarrow$ Post-PA	$r < .09$	-.08, .26	r = .12	-.06, .29
S2: Positive $\rightarrow$ Post-PA	r = .33*	.16, .47	r = .55*	.41, .66
S2: Negative $\rightarrow$ Post-PA	r = .11	-.06, .28	r = .09	-.09, .26
S2 vs. S3	$r < .10$	-.07, .27	$r < .10$	-.08, .27
Simple Slopes				
Positive: $E_{EPQ} \rightarrow$ Post-PA	r = .16	-.15, .44	r = .12	-.20, .41
Negative: $E_{EPQ} \rightarrow$ Post-PA	$r < .15$	-.16, .43	r = .04	-.28, .35
Neutral: $E_{EPQ} \rightarrow$ Post-PA	$r < .15$	-.16, .43	r = .05	-.27, .35

STUDY 1, EXP.4: Correlations, ANOVAs, and Moderated Multiple Regressions (MMRs); * $p < .05$

Analysis	Original Effect Size	95% CI	Sim Effect Size	95% CI
Correlations				
$r(E_{EPQ}$, Pre-PIA)	$r = .23^*$	.04, .40	$r = -.23^*$	-.39, -.05
$r(E_{EPQ}$, Pre-EA)	$r = .10$	-.09, .28	$r = .07$	-.11, .25
r(Pre-PIA, Pre-EA)	$r = .61^*$	.47, .72	$r = .11$	-.07, .28
ANOVAs				
3-way interaction, full ANOVA	$r = .27^*$	.09, .44	$r = .25^*$	.08, .41
Appetitive: Pre-EA → Post-EA	$r = .66^*$	.41, .82	$r = .36^*$	.06, .61
Appetitive: Pre-PIA → Post-PIA	$r = .57^*$	.28, .76	$r = .34^*$	.04, .59
Pleasant: Pre-PIA → Post-PIA	$r = .65^*$	.39, .81	$r = .50^*$	.23, .70
Neutral: Pre-PIA → Post-PIA	$r = .37^*$	.07, .61	$r = .34^*$	.03, .59
Condition → Post-EA	$r = .31^*$	.13, .47	$r = .59^*$	.45, .69
Post-EA: Appetitive v. Pleasant	$>^*$		$>^*$	
Post-EA: Appetitive v. Neutral	$>^*$		$>^*$	
Condition → Post-PIA	$r = .27^*$	.08, .44	$r = .56^*$	.42, .67
Post-PIA: Pleasant v. Appetitive	$=$		$=$	
Post-PIA: Pleasant v. Neutral	$>^*$		$>^*$	
MMRs				
S1a: Pre-EA → Post-EA	$r = .57^*$	.43, .69	$r = .06$	-.12, .23
S1a v. S2a	$r = .46^*$	.29, .60	$r = .74^*$	.65, .81
S2a: E_{EPQ} → Post-EA	$r = .21^*$	.02, .38	$r = .28^*$	.11, .44
S2a: Appetitive → Post-EA	$r = .46^*$	.30, .60	$r = .45^*$	.29, .58
S2a: Pleasant → Post-EA	$r < .10$	-.09, .28	$r = .52^*$	.38, .64
S2a v. S3a	$r = .15$	-.04, .33	$r = .19^*$	.01, .36
S3a: E_{EPQ} x Appetitive → Post-EA	$r = .22^*$	.03, .39	$r = .28^*$	.11, .44
S1b: Pre-PIA → Post-PIA	$r = .59^*$	.45, .70	$r = .28^*$	.11, .44
S1b v. S2b	$r = .36^*$	.18, .52	$r = .67^*$	.56, .76
S2b: E_{EPQ} → Post-PIA	$r = .06$	-.13, .25	$r = .06$	-.12, .24
S2b: Appetitive → Post-PIA	$r = .43^*$	.27, .58	$r = .59^*$	.46, .70
S2b: Pleasant → Post-PIA	$r = .33^*$	.16, .49	$r = .67^*$	.56, .76
S2b v. S3b	$r = .12$	-.07, .30	$r = .11$	-.07, .29
Simple Slopes				
Appetitive: E_{EPQ} → Post-EA	$r = .45^*$	.13, .69	$r = .44^*$	.15, .66
Pleasant: E_{EPQ} → Post-EA	$r = .24$	-.11, .54	$r = .29$	-.02, .55
Neutral: E_{EPQ} → Post-EA	$r < .16$	-.16, .45	$r = .01$	-.30, .32
Appetitive: E_{EPQ} → Post-PIA	$r < .17$	-.18, .49	$r = .31$	-.002, .57
Pleasant: E_{EPQ} → Post-PIA	$r < .17$	-.18, .49	$r = .03$	-.28, .34
Neutral: E_{EPQ} → Post-PIA	$r = .23$	-.08, .50	$r = .14$	-.18, .43

Study 1: Discussion

- For the most part: Good, promising results!
- Compensatory model of extraversion worked well.
- CTA-RST modeled Ex.1 data particularly well.
- Differences between Observed and Simulated Ex.4 data:
  - Sim: PIA contrast $\rightarrow$ post-EA: S-
    - Obs: NS-
  - Sim: *r*(pre-EA, pre-PIA): NS+
    - Obs: S+
  - Sim: MMR Step 1 (pre-EA $\rightarrow$ post-EA): NS+
    - Obs: S+
  - Sim: $r(E_{EPQ}$, pre-PIA): S-
    - Obs: S+

Study 2: Measures

Two replications, R01 and R02; Wilt et al. (2016)

- State Extraversion: 1 (low) - 6 (high) scale; 30 min.
  - R01: bold, quiet (R), talkative
  - R02: assertive, withdrawn (R), unrestrained
- State Neuroticism: S:1-6; 30 min.
  - R01: touchy, temperamental, insecure
  - R02: steady (R), anxious, emotional
- State Positive Affect: S:1-6; 'right now.'
  - R01: alert, happy, attentive, strong
  - R02: happy, cheerful, pleased
- State Negative Affect: S:1-6; 'right now.'
  - R01: anxious, irritable, intense, upset
  - R02: grouchy, irritable, gloomy
- Goal Velocity (past 30 min.):
  - R01: 'I was moving quickly toward the goal,' 'I was moving slowly toward the goal,' 'I was doing better than expected.' (Each rated 1 (disagree) to 6 (agree).)
  - R02: Rate perceived progress toward goal: 1 (more slowly than expected) to 6 (more quickly than expected).

Study 2: Results

Descriptive Statistics

Table: Descriptive Statistics for Wilt et al. (2016) S1 and S2; Simulation

SD = Within-person standard deviation; α = Within-person alpha

Variable	M_{S1}	M_{S2}	M_{Sim}	SD_{S1}	SD_{S2}	SD_{Sim}	α_{S1}	α_{S2}	α_{Sim}
E_S	2.65	3.36	0	1.01	0.74	0.89	0.60	0.44	0.98
N_S	1.79	2.62	0	0.66	0.66	0.85	0.54	0.39	0.98
V	3.60	3.90	0	0.98	1.08	0.96	0.78	–	0.96
PA_S	3.27	3.86	0	0.75	0.90	1.12	0.62	0.83	0.89
NA_S	1.94	1.84	0	0.66	0.76	1.03	0.59	0.83	0.91

Study 2: Results

Six Bivariate Multilevel Models

Predictor	Outcome	b_{S1}	95% CI_{S2}	p_{S1}	b_{S2}	95% CI_{S2}	p_{S2}	b_{Sim}	99% CI_{Sim}	p_{Sim}
E_S	V	0.13	[.06, .21]	< .001	.26	[.18, .35]	< .001	0.84	[.73, .94]	< .001
N_S	V	-0.33	[-.44, -.23]	< .001	-.38	[-.43, -.32]	< .001	-0.68	[-.74, -.62]	< .001
V	PA_S	0.14	[.08, .20]	< .001	.26	[.19, .34]	< .001	0.61	[.54, .68]	< .001
V	NA_S	-0.16	[-.22, -.10]	< .001	-.21	[-.27, -.15]	< .001	-0.51	[-.60, -.42]	< .001
E_S	PA_S	0.14	[.08, .20]	< .001	.52	[.43, .62]	< .001	0.88	[.75, 1.01]	< .001
N_S	NA_S	0.49	[.40, .59]	< .001	.53	[.43, .63]	< .001	0.76	[.61, .88]	< .001

Study 2: Results

Two 1-1-1 Multilevel Models

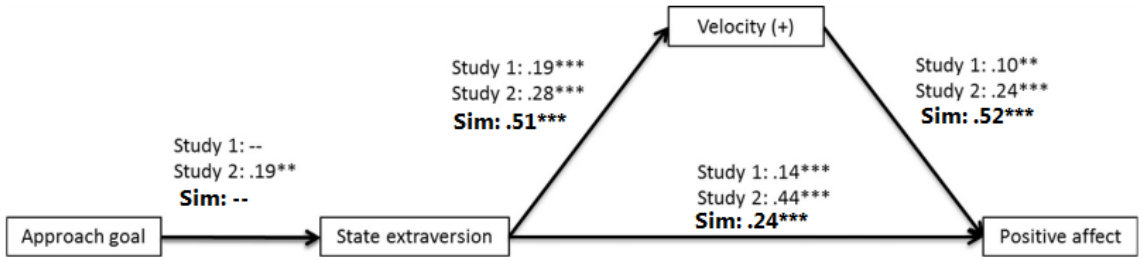


Fig. 1. Mediation model specifying that the relation between state extraversion and state positive affect is mediated through increased velocity toward goals. This figure shows the direct effects from mediation models specifying the relations between approach goals, state extraversion, velocity (+ = positively scored), and state positive affect. Numbers are unstandardized regression coefficients. ** = $p < 0.01$; *** = $p < 0.001$.

Figure: Model linking E_S to PA_S via V

Path	b_{S1}	95% CI_{S2}	p_{S1}	b_{S2}	95% CI_{S2}	p_{S2}	b_{Sim}	99% CI_{Sim}	p_{Sim}
Direct effects									
V ON E_S	.19	[.13, .24]	<.001	.28	[.20, .35]	<.001	0.51	[.40, .63]	< .001
PA_S ON V	.10	[.03, .17]	.004	.24	[.18, .30]	<.001	0.52	[.41, .62]	< .001
PA_S ON E_S	.14	[.07, .20]	<.001	.44	[.33, .54]	<.001	0.24	[.11, .37]	< .001
Indirect effect									
E_S to V to PA_S	.02	[.01, .03]	.010	.07	[.04, .09]	<.001	0.27	[.19, .34]	< .001
Total effect									
E_S to PA_S	.16	[.09, .22]	<.001	.50	[.40, .61]	<.001	0.51	[.34, .68]	< .001

Study 2: Results

1-1-1 Multilevel Models

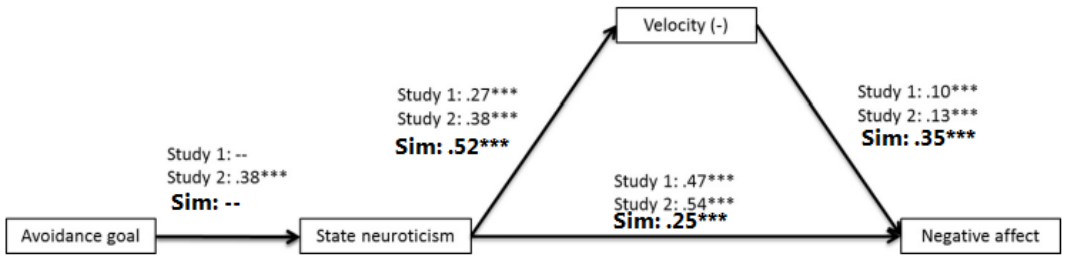


Fig. 2. Mediation model specifying that the relation between state neuroticism and state negative affect is mediated through decreased velocity toward goals. This figure shows the direct effects from mediation models specifying the relations between avoidance goals, state neuroticism, velocity (– = negatively scored), and state negative affect. Numbers are unstandardized regression coefficients. *** = $p < 0.001$.

Path	b_{S1}	95% CI_{S2}	p_{S1}	b_{S2}	95% CI_{S2}	p_{S2}	b_{Sim}	99% CI_{Sim}	p_{Sim}
Direct effects									
V (-) ON N_S	.27	[.17, .38]	< .001	.38	[.29, .47]	< .001	.52	[.44, .59]	< .001
NA_S ON V (-)	.09	[.05, .12]	< .001	.13	[.08, .18]	< .001	.35	[.27, .42]	< .001
NA_S ON N_S	.43	[.35, .50]	< .001	.54	[.43, .65]	< .001	.25	[.12, .39]	< .001
Indirect effect									
N_S to V (-) to NA	.12	[.06, .17]	< .001	.20	[.13, .27]	< .001	.18	[.13, .23]	< .001
Total effect									
N_S to NA_S	.54	[.43, .65]	< .001	.74	[.57, .91]	< .001	.43	[.28, .58]	< .001

Study 3: Affective Synchrony

Two replications, R01 and R02; Wilt et al. (2011)

- Scoring
  - All items scored on descriptiveness scale from 1 (not at all) to 6 (very well); states, traits used same items.
  - State prompt: 'How are you feeling right now?'
  - Trait prompt: 'In general, I feel...'
- State/Trait Energetic Arousal
  - R01: energetic, alert, sluggish (R)
  - R02: excited, lively, full-of-pep, vigorous
- State/Trait Tense Arousal
  - R01: calm (R), relaxed (R), tense
  - R02: distressed, jittery, nervous, stirred-up
- State/Trait Pleasant Affect
  - R01: confident, cheerful, pleased
  - R02: happy, strong
- State/Trait Unpleasant Affect
  - R01: grouchy, irritable, gloomy
  - R02: irritable, upset

Study 3: Results

Descriptives and Bivariate MLMs

X_{BP} = between subjects variable, X_{WP} = within subjects variable

Variable	All Reports						Across Subjects							
	M	(S2)	(Sim)	*SD*	(S2)	(Sim)	*M*	(S2)	SD_{BP}	(S2)	(Sim)	SD_{WP}	(S2)	(Sim)
EA_S	3.99	2.43	0	1.08	1.10	1.26	3.96	2.48	0.51	0.77	1.26	0.98	0.80	1.11
TA_S	2.55	2.23	0	1.04	0.89	1.21	2.62	2.26	0.66	0.58	1.21	0.82	0.69	1.03
PA_S	3.91	3.32	0	1.09	1.14	1.34	3.86	3.42	0.68	0.80	1.34	0.87	0.80	0.81
UA_S	1.85	1.85	0	0.98	0.99	1.32	1.88	1.87	0.59	0.50	1.33	0.81	0.87	0.90
EA_T		3.95	0.02		1.07	1.07								
TA_T		2.49	-0.08		0.70	1.64								
PA_T		4.47	0.19		0.91	0.99								
UA_T		2.48	0.21		0.84	0.91								

Table: Results of Wilt et al. (2011) and Simulated Bivariate MLMs

$p < .001$ for all L-ratios

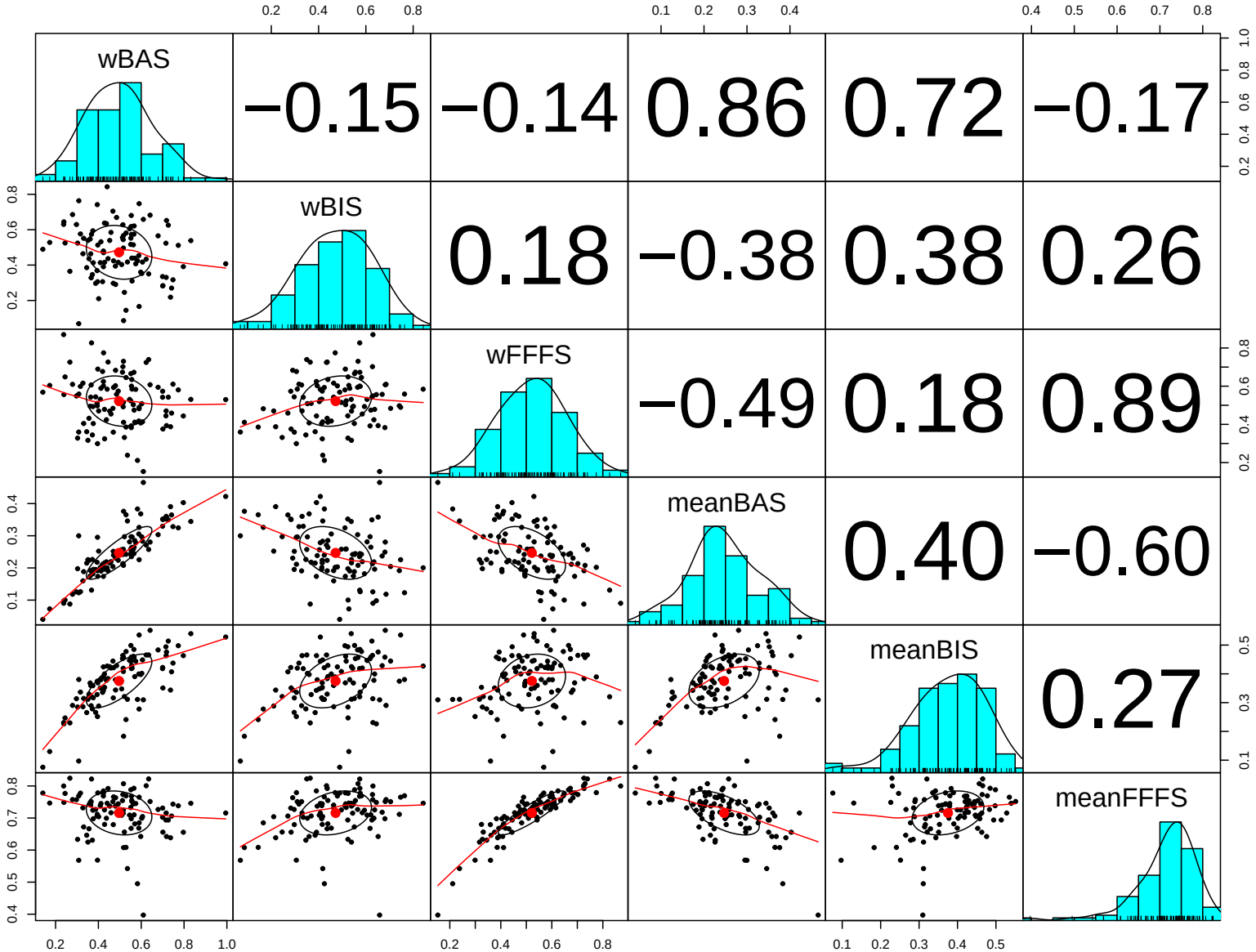
Predictor	Outcome	b_{S1}	$Range_{S1}$	L_{S1}	b_{S2}	$Range_{S2}$	L_{S2}	b_{Sim}	$Range_{Sim}$	L_{Sim}
TA_S	EA_S	-.26	[-.85, .26]	87.84	-.10	[-.99, .45]	141.67	-.21	[-.95, .15]	61.37
UA_S	PA_S	-.64	[-1.17,-.17]	60.90	-.27	[-1.09, .22]	187.87	-.26	[-1.75, .04]	472.72

Mod. MLM Results

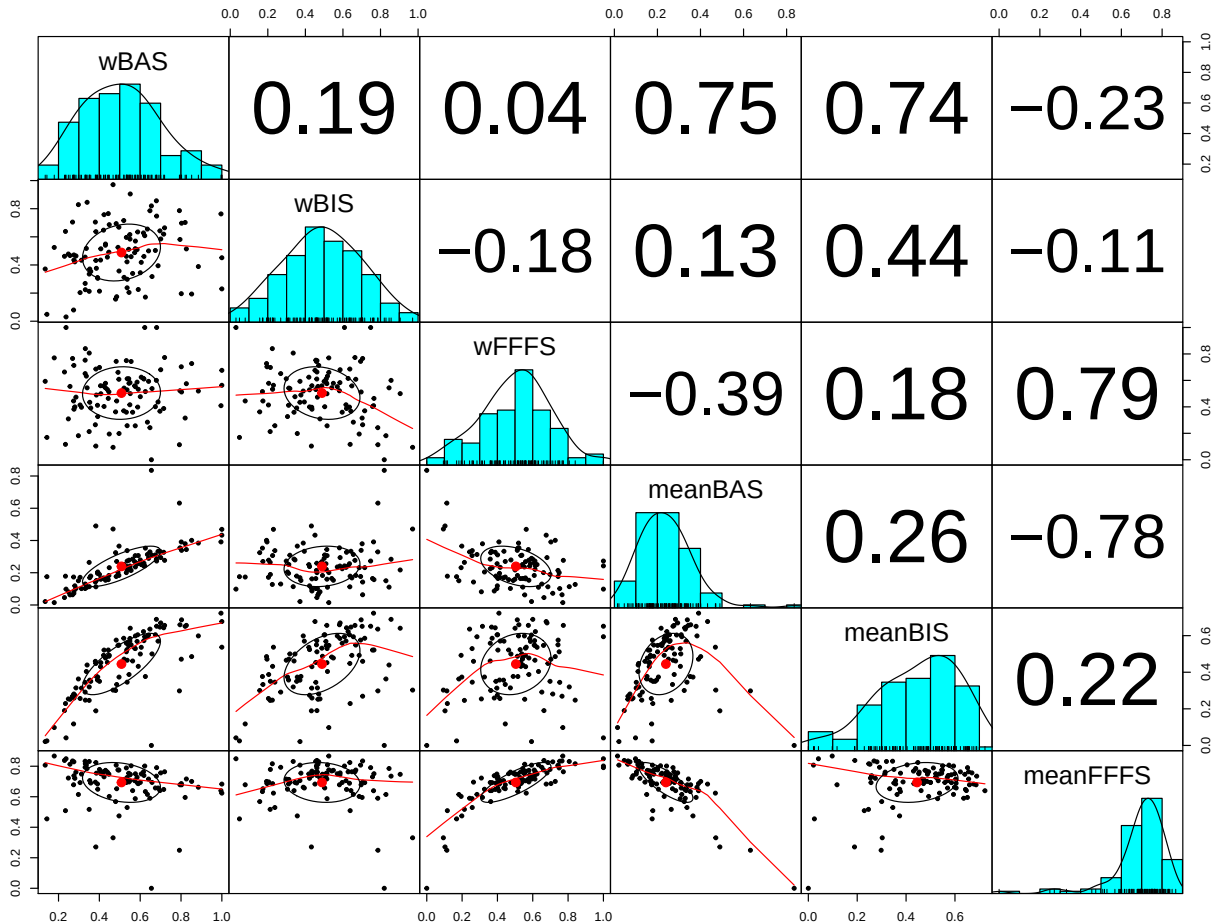
Predictor	Outcome	b_{S2}	95% CI_{S2}	p_{S2}	b_{Sim}	95% CI_{Sim}	p_{Sim}
Model 1: $EA_S \leftarrow TA_S * EA_T * TA_T$							
TA_S	EA_S	-0.01	[-.17, .15]	.88	-0.22	[-.27, -.16]	< .001
EA_T	EA_S	0.41	[.19, .62]	< .001	0.28	[.22, .34]	< .001
TA_T	EA_S	0.42	[.10, .74]	< .05	.04	[.004, .08]	< .05
TA_S x EA_T	EA_S	-0.16	[-.32, -.004]	< .05	-0.04	[-.09, .01]	.14
TA_S x TA_T	EA_S	0.15	[-.07, .38]	.19	0.03	[-.01, .06]	.13
EA_T x TA_T	EA_S	-0.34	[-.67, -.01]	< .05	0.02	[-.03, .07]	.41
TA_S x EA_T x TA_T	EA_S	0.39	[.16, .63]	< .001	-0.02	[-.06, .01]	.22
Model 2: $EA_S \leftarrow TA_S * PA_T * UA_T$							
TA_S	EA_S	-0.02	[-.20, .15]	.78	-0.20	[-.25, -.16]	< .001
PA_T	EA_S	0.08	[-.20, .37]	.56	-0.03	[-.12, .05]	.45
UA_T	EA_S	0.05	[-.26, .37]	.73	0.02	[-.07, .12]	.60
TA_S x PA_T	EA_S	-0.09	[-.28, .10]	.37	-0.05	[-.09, -.002]	< .05
TA_S x UA_T	EA_S	0.12	[-.09, .34]	.25	-0.16	[-.21, -.11]	< .001
PA_T x UA_T	EA_S	-0.31	[-.61,-.005]	< .05	-0.22	[-.34, -.11]	< .001
TA_S x PA_T x UA_T	EA_S	0.31	[.10, .51]	< .01	0.04	[-.02, .10]	.24
Model 3: $PA_S \leftarrow UA_S * PA_T * UA_T$							
UA_S	PA_S	-0.28	[-.38, -.17]	< .001	-0.24	[-.29, -.19]	< .001
PA_T	PA_S	0.33	[.09, .62]	< .05	0.68	[.54, .82]	< .001
UA_T	PA_S	0.28	[-.04, .60]	.09	-0.08	[-.23, .07]	.32
UA_S x PA_T	PA_S	-0.05	[-.17, .07]	.40	-0.27	[-.32, -.22]	< .001
UA_S x UA_T	PA_S	0.07	[-.06, .20]	.30	0.0004	[-.05, .05]	.99
PA_T x UA_T	PA_S	-0.07	[-.38,.23]	.63	-0.32	[-.51, -.14]	< .01
UA_S x PA_T x UA_T	PA_S	-0.01	[-.13, .12]	.93	0.13	[.06, .19]	< .001
Model 4: $PA_S \leftarrow UA_S * EA_T * TA_T$							
UA_S	PA_S	-0.26	[-.36, -.15]	.38	-0.26	[-.33, -.19]	< .001
EA_T	PA_S	0.37	[.13, .60]	< .01	0.39	[.22, .57]	< .001
TA_T	PA_S	0.44	[.09, .78]	< .05	-0.06	[-.17, .06]	.32
UA_S x EA_T	PA_S	-0.05	[-.15, .05]	.33	-0.10	[-.16, -.03]	< .001
UA_S x TA_T	PA_S	0.07	[-.08, .22]	.37	0.03	[-.02, .07]	< .05
EA_T x TA_T	PA_S	-0.28	[-.64, .08]	.12	0.03	[-.10, .17]	.64
UA_S x EA_T x TA_T	PA_S	0.07	[-.08, .22]	.37	-0.02	[-.07, .03]	.40

Replicated Smillie et al. (2006) Correlations

r of BAS/BIS = .40, BAS/FFFS = -.53, BIS/FFFS = .33



Replicated Pickering (2008) Correlations



- Pickering (2008) reported mBAS-mFFFS r = -0.87

Pickering 2016 Replications

Regressions: BAS

Weights' Regression Coefficients Predicting Mean BAS output

Weight	*B*	*SE*	*t*	$p > \|t\|$
(Intercept)	0.25505	0.02515	10.154	< .001 ***
BAS	0.45408	0.02637	17.221	< .001 ***
FFFS	-0.27270	0.03002	-9.085	< .001 ***
BIS	-0.15276	0.02652	-5.760	< .001 ***
Multiple R-squared:	0.8469			Adj. R-squared: 0.8422

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.232	.026		8.886	.000
	wa	.473	.030	.735	15.589	.000
	wf	-.293	.027	-.507	-10.762	.000
	wl	-.103	.029	-.168	-3.569	.001

a. Dependent Variable: meanbas

b.

Pickering 2016 Replications

Regressions: BIS

Weights' Regression Coefficients Predicting Mean BIS output

Weight	*B*	*SE*	*t*	$p > \|t\|$
(Intercept)	-0.1616	0.03901	-4.106	< .001 ***
BAS	0.50249	0.04095	12.271	< .001 ***
FFFS	0.19792	0.04662	4.246	< .001 ***
BIS	0.31779	0.04118	7.717	< .001 ***
Multiple R-squared:	0.679			Adj. R-squared: 0.669

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.122	.031		-3.984	.000
	was	.438	.035	.645	12.391	.000
	wf	.231	.032	.378	7.274	.000
	wl	.309	.034	.478	9.183	.000

a. Dependent Variable: meanbis

Pickering 2016 Replications

Regressions: FFFS

Weights' Regression Coefficients Predicting Mean FFFS output

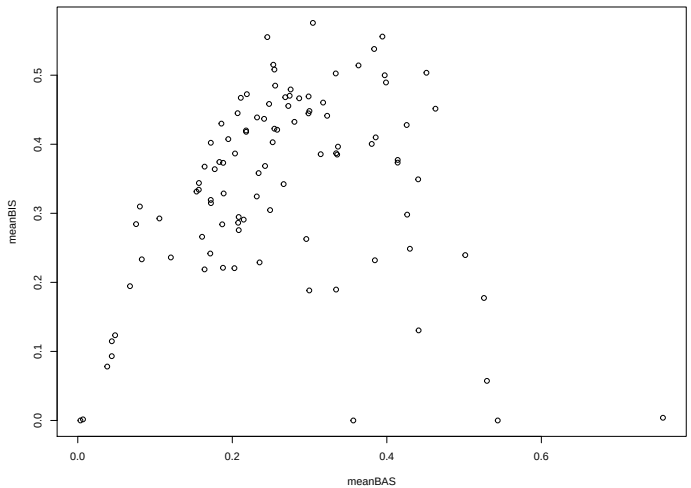
Weight	*B*	*SE*	*t*	$p > \|t\|$
(Intercept)	0.39134	0.02847	13.747	< .001 ***
BAS	-0.15750	0.02988	-5.270	< .001 ***
FFFS	0.50876	0.03005	4.934	< .001 ***
BIS	0.14830	0.03402	14.955	< .001 ***
Multiple R-squared:	0.7846			Adj. R-squared: 0.7779

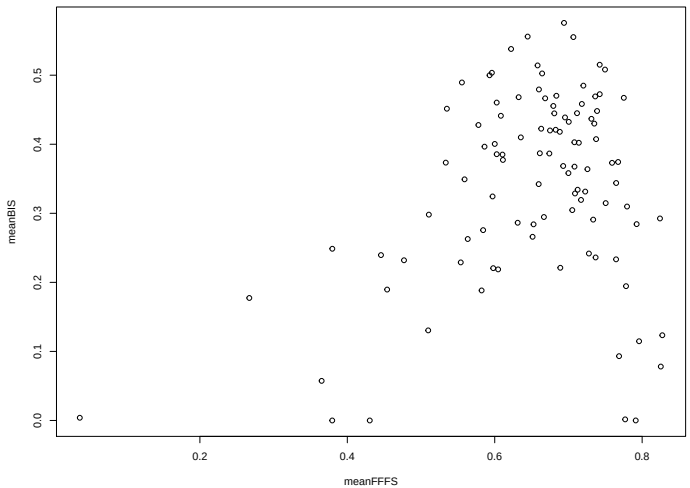
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.414	.031		13.186	.000
	ws	-.190	.036	-.264	-5.232	.000
	wf	.543	.033	.839	16.630	.000
	wl	.100	.035	.146	2.894	.005

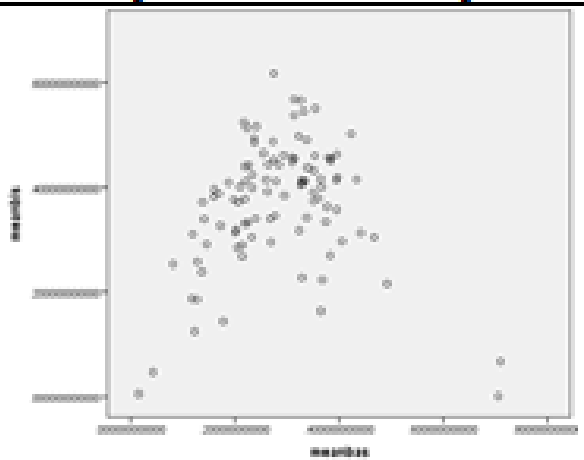
a. Dependent Variable: cesardis

Pickering 2016: BIS output = f(BAS, FFFS output)

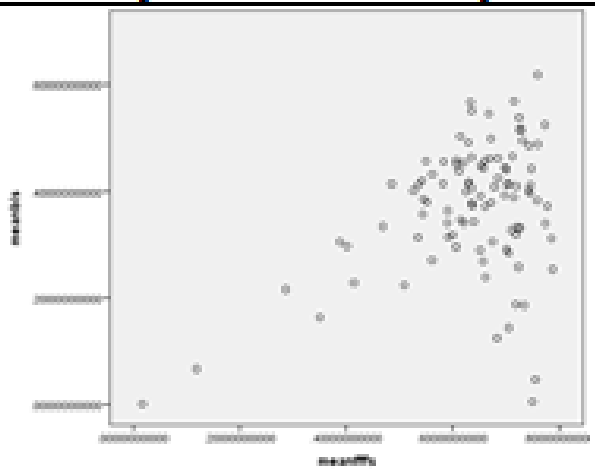




Mean BIS output vs. mean BAS output



Mean BIS output vs. mean FFFS output



References I

Atkinson, J. W. and Birch, D. (1970). *The dynamics of action*. John Wiley, New York, NY.

Cacioppo, J. T., Gardner, W. L., and Berntson, G. G. (1997). Beyond bipolar conceptualizations and measures: The case of attitudes and evaluative space. *Personality and Social Psychology Review*, 1(1):3–25.

Carver, C. S. and Harmon-Jones, E. (2009). Anger is an approach-related affect: Evidence and implications. *Psychological bulletin*, 135(2):183.

Corr, P. J. (2004). Reinforcement sensitivity theory and personality. *Neuroscience & Biobehavioral Reviews*, 28(3):317–332.

References II

Depue, R. A. and Collins, P. F. (1999). Neurobiology of the structure of personality: Dopamine, facilitation of incentive motivation, and extraversion. *Behavioral and Brain Sciences*, 22(03):491–517.

Fleeson, W. (2004). Moving personality beyond the person-situation debate: The challenge and the opportunity of within-person variability. *Current Directions in Psychological Science*, 13(2):83–87.

Gray, J. A. and McNaughton, N. (2000). *The neuropsychology of anxiety: An enquiry into the function of the septo-hippocampal system, 2nd edition*. New York: Oxford University Press.

Matthews, G. and Gilliland, K. (1999). The personality theories of H. J. eysenck and J. A. gray: A comparative review. *Personality and Individual Differences*, 26(4):583–626.

References III

Mitchell, J. T., Kimbrel, N. A., Hundt, N. E., Cobb, A. R., Nelson-Gray, R. O., and Lootens, C. M. (2007). An analysis of reinforcement sensitivity theory and the Five-Factor Model. *European Journal of Personality*, 21(7):869–887.

Pickering, A. D. (2008). Formal and computational models of RST. In Corr, P. J., editor, *The Reinforcement Sensitivity Theory of Personality*, pages 453–481. Cambridge University Press, Cambridge.

Pickering, A. D., Corr, P. J., Powell, J. H., Kumari, V., Thornton, J. C., and Gray, J. A. (1997). Individual differences in reactions to reinforcing stimuli are neither black nor white: to what extent are they gray? In Nyborg, H., editor, *The scientific study of human nature: Tribute to Hans J. Eysenck at eighty.* Pergamon/Elsevier Science Inc.

References IV

Poropat, A. E. and Corr, P. J. (2015). Thinking bigger: The cronbachian paradigm & personality theory integration. *Journal of Research in Personality*, 56:59–69.

Rafaeli, E., Rogers, G. M., and Revelle, W. (2007). Affective synchrony: Individual differences in mixed emotions. *Personality and Social Psychology Bulletin*, 33:915–932.

Read, S. J., Monroe, B. M., Brownstein, A. L., Yang, Y., Chopra, G., and Miller, L. C. (2010). A neural network model of the structure and dynamics of human personality. *Psychological review*, 117(1):61.

Revelle, W. and Condon, D. (2015). A model for personality at three levels. *Journal of Research in Personality*, 56:70–81.

Smillie, L. D. (2008). What is reinforcement sensitivity? Neuroscience paradigms for approach-avoidance process theories of personality. *European Journal of Personality*, 22(5):359–384.

References V

Smillie, L. D., Cooper, A. J., Wilt, J. A., and Revelle, W. (2012). Do extraverts get more bang for the buck? Refining the affective-reactivity hypothesis of extraversion. *Journal of Personality and Social Psychology*, 103(2):306–327.

Smillie, L. D., Pickering, A. D., and Jackson, C. J. (2006). The new reinforcement sensitivity theory: Implications for personality measurement. *Personality and Social Psychology Review*, 10(4):320–335.

Torrubia, R., Ávila, C., Moltó, J., and Caseras, X. (2001). The Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ) as a measure of Gray's anxiety and impulsivity dimensions. *Personality and Individual Differences*, 31(6):837–862.

Wilson, G. D., Gray, J. A., and Barrett, P. T. (1990). A factor analysis of the Gray-Wilson personality questionnaire. *Personality and Individual Differences*, 11(10):1037–1044.

References VI

Wilt, J. A., Bleidorn, W., and Revelle, W. (2016). Velocity explains the links between personality states and affect.

Wilt, J. A., Funkhouser, K., and Revelle, W. (2011). The dynamic relationships of affective synchrony to perceptions of situations. *Journal of Research in Personality*, 45(3):309–321.