Effects of mindfulness and fantasizing on depression and rumination: A network perspective

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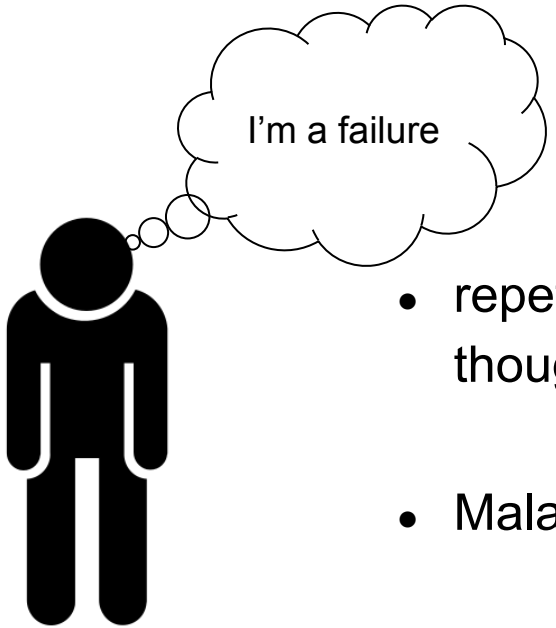
16.09.2022

Depression (MDD) debilitates individuals and societies…

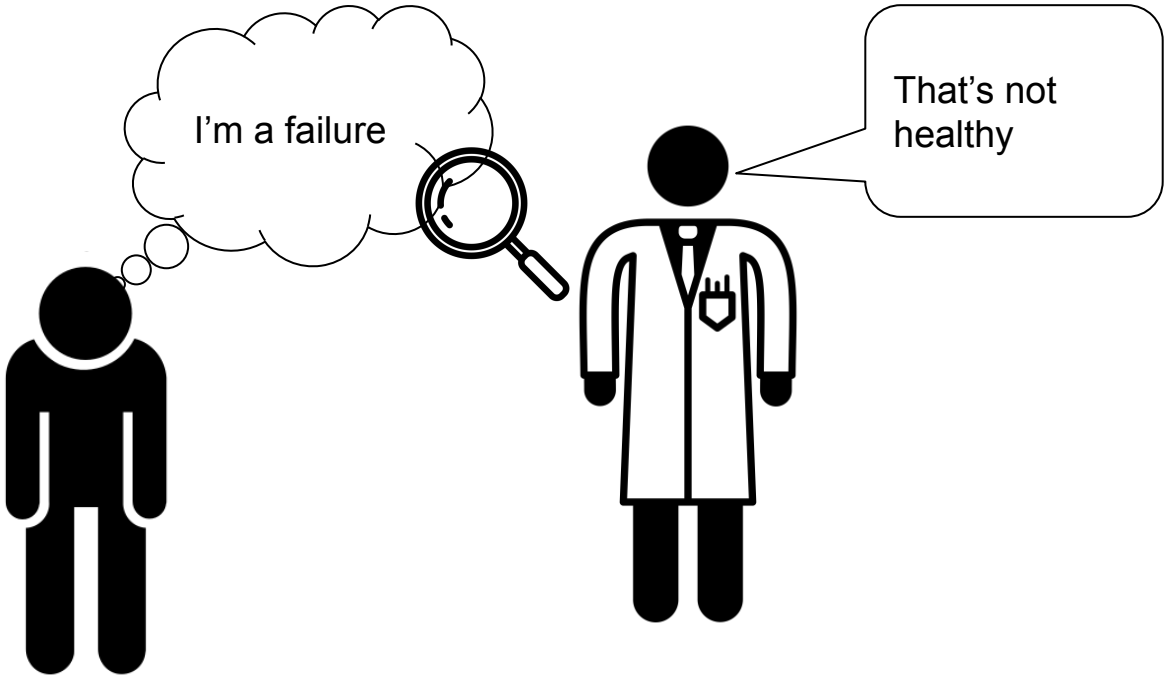
- Affects more than 20% of people at some point in their lives (Hasin et al., 2018)
- Is associated with unemployment, financial troubles, and other mental and physical disorders (Kessler, 2011)

… and **rumination** plays a central role in it

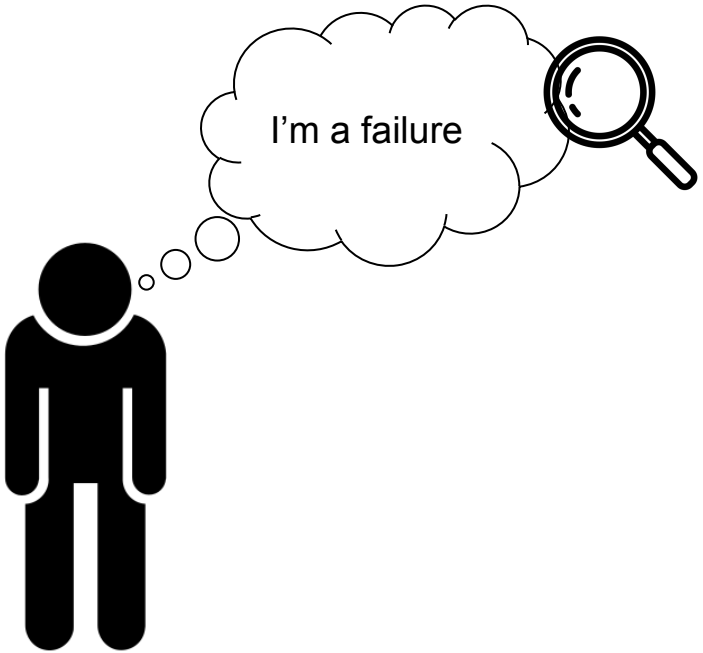


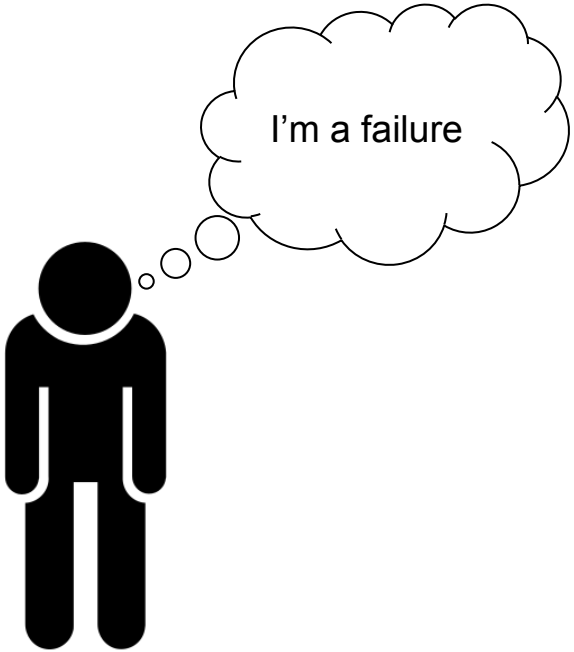
- repetitive, uncontrolled stream of negatively-valenced thoughts and memories that follow a common theme
- Maladaptive form of self-reflection

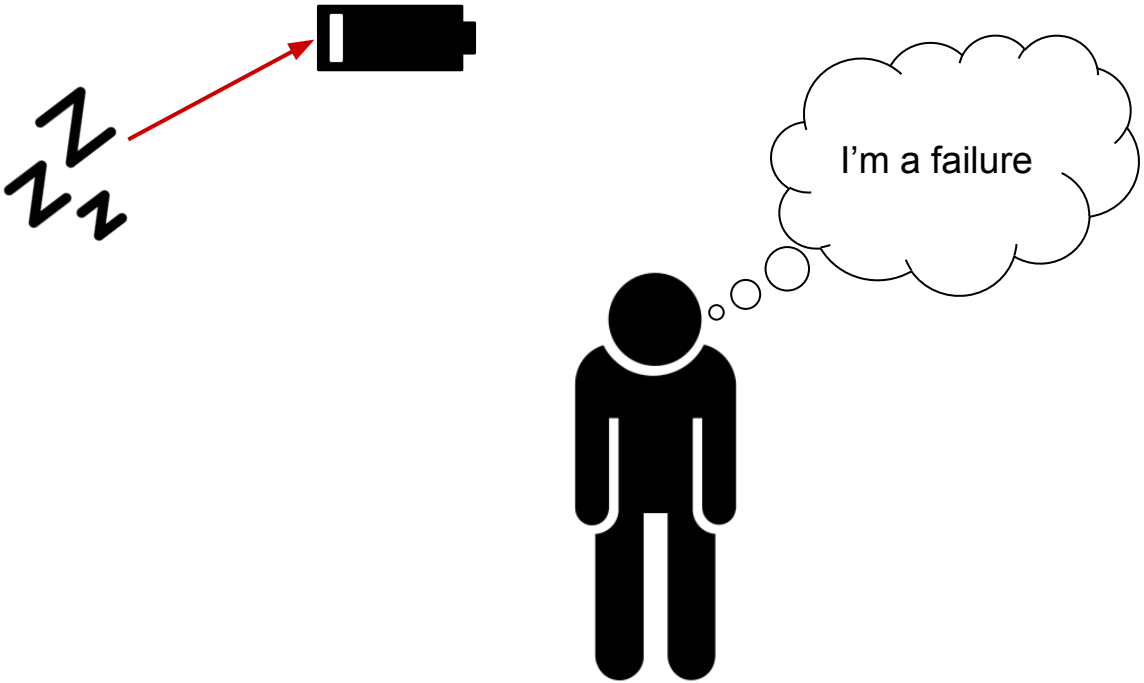
So, we need to investigate rumination!



But… what if we're missing something?




I’m a failure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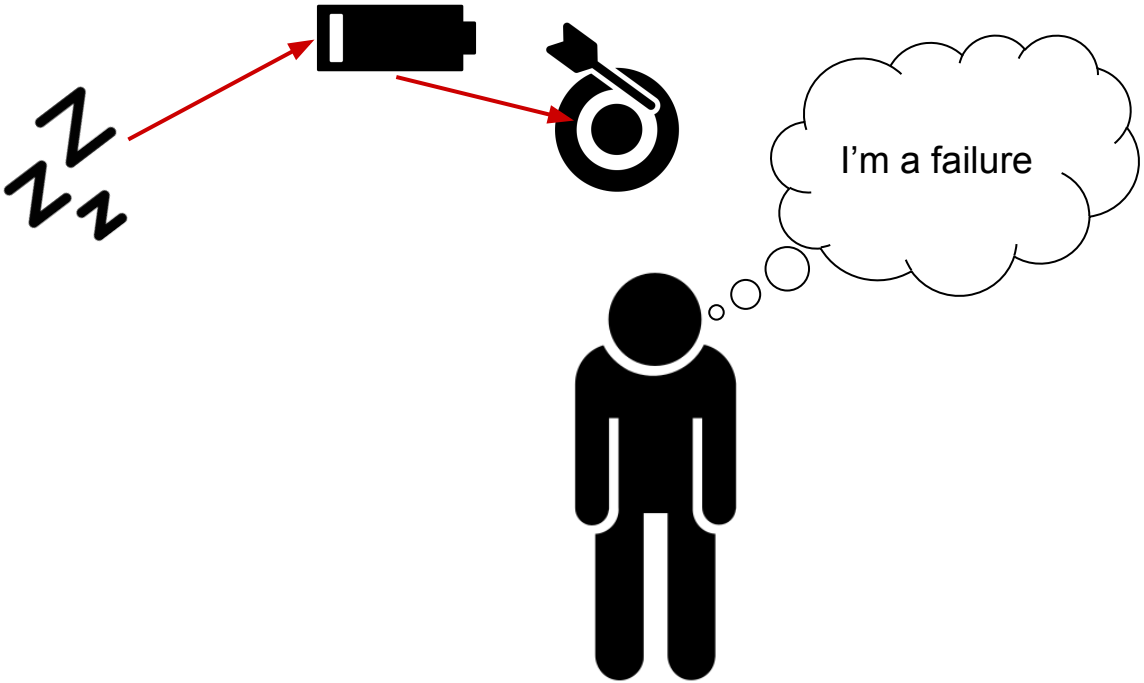
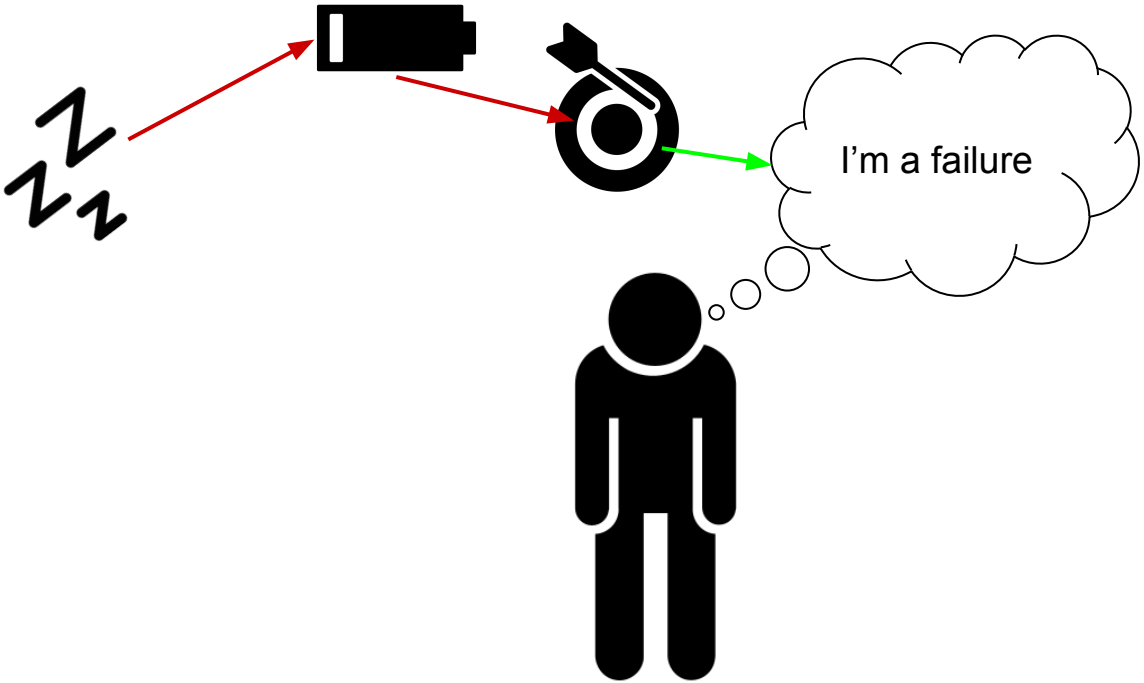

I'm a failure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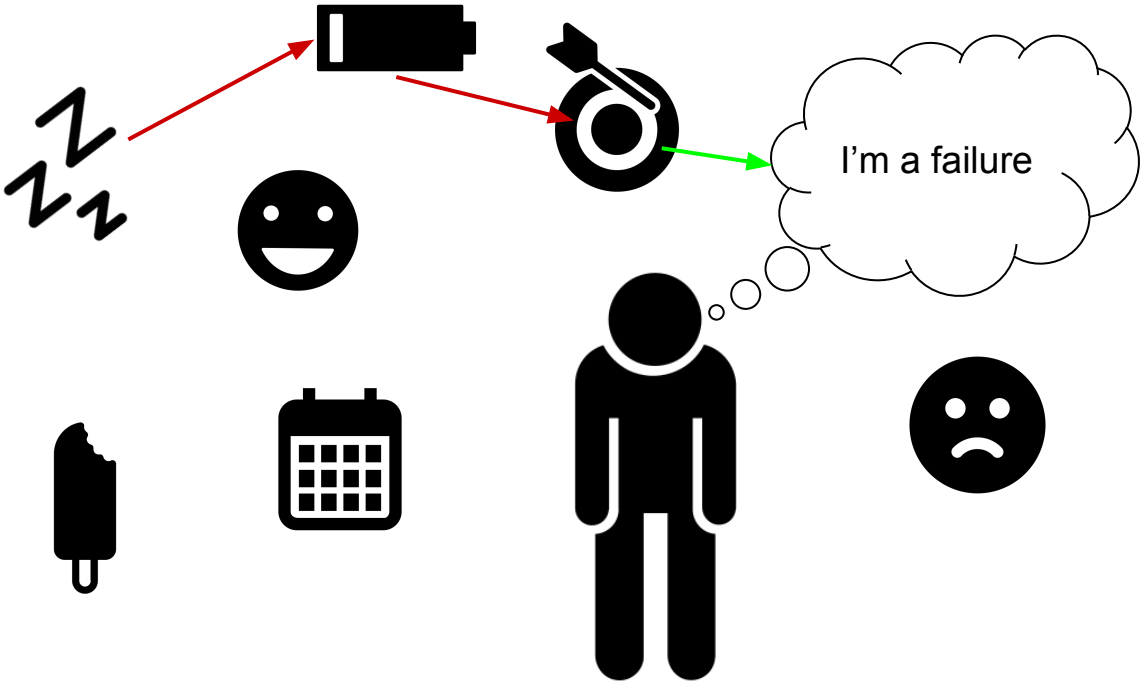
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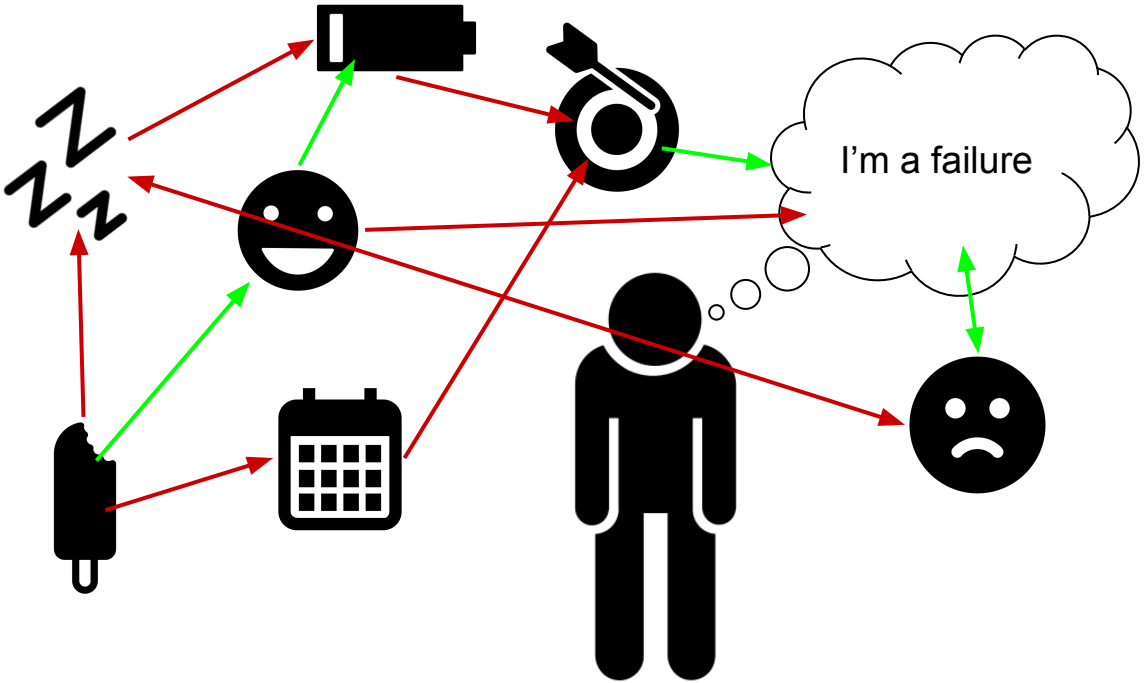
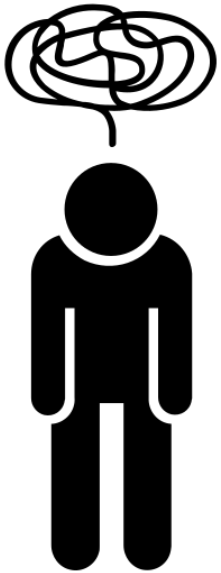

I'm a failure

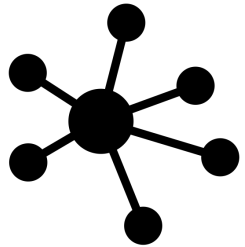
Maybe we cannot look at just one factor in isolation



Network analysis aims to explore systems holistically

- Analytical framework to *explore* interdependent interactions of multiple entities as one integrated system.

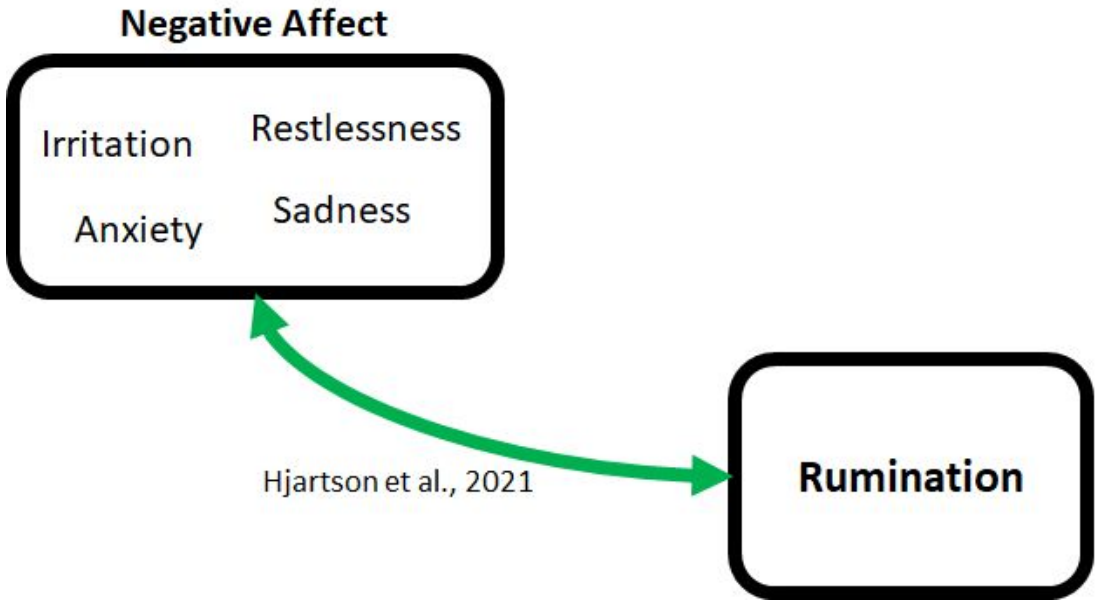
- In psychopathology: a reaction to perceived shortcomings of current diagnostic approach (see Borsboom & Cramer, 2013)

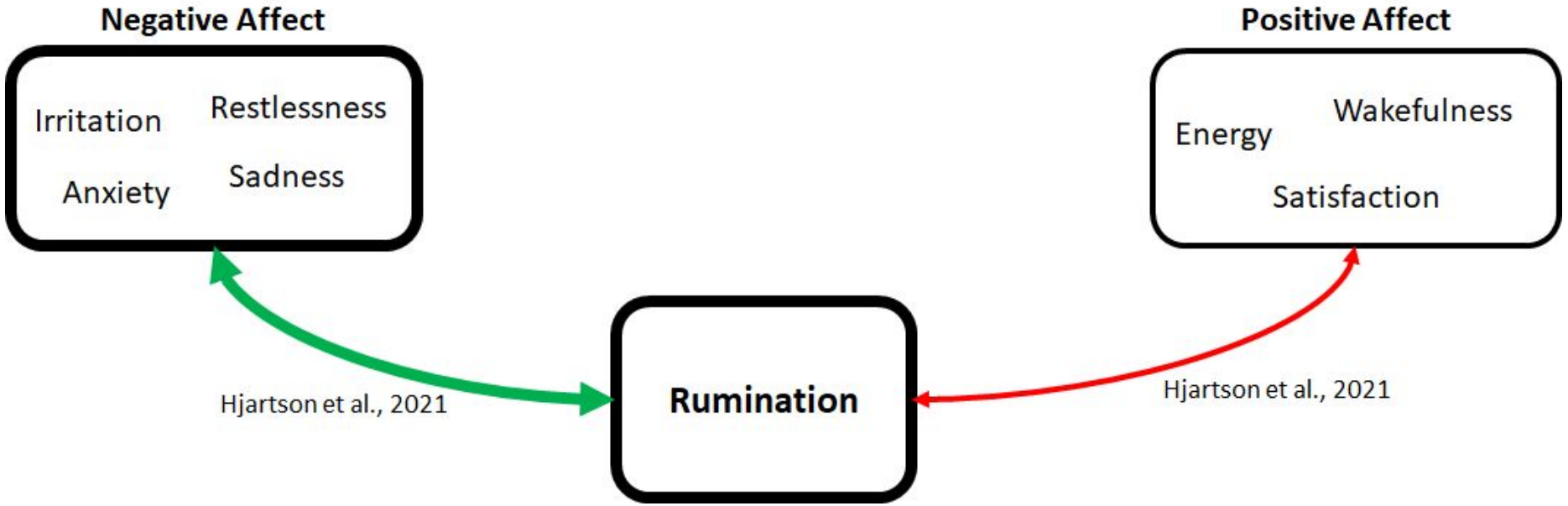


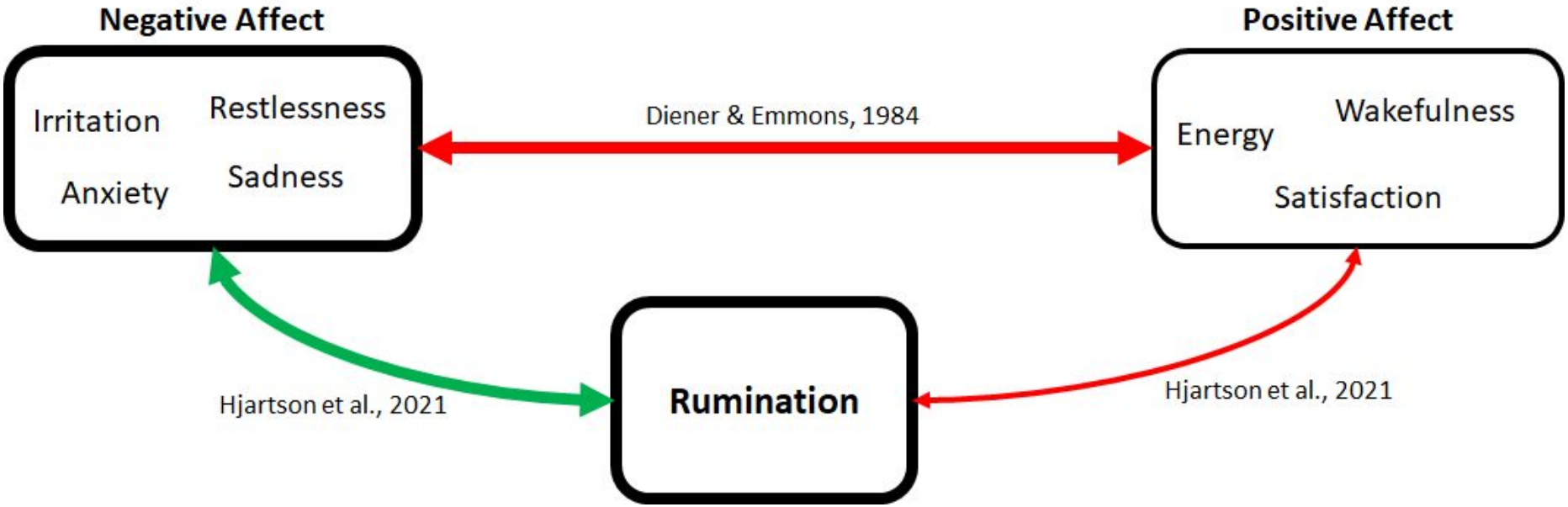
Research Question 1

How do the networks of symptoms differ between remitted MDD (rMDD) patients and healthy controls (HC) in general and what is the role of rumination in particular?

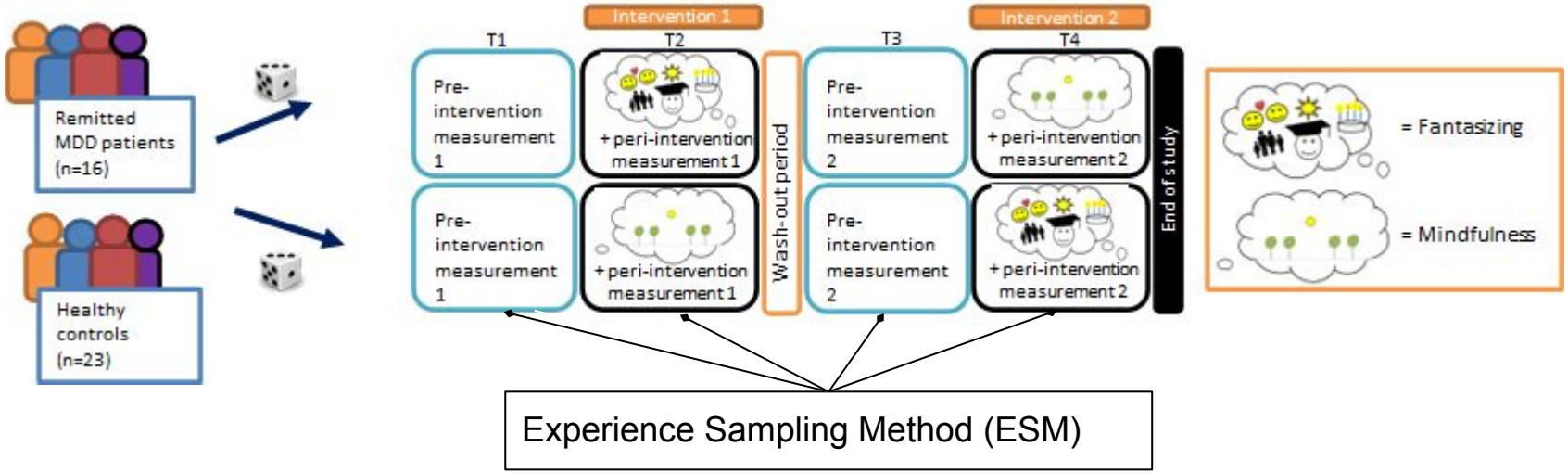

Rumination


Negative Affect
Irritation
Restlessness
Anxiety
Sadness
Hjartson et al., 2021
Rumination


Negative Affect
Irritation
Restlessness
Anxiety
Sadness
Positive Affect
Energy
Wakefulness
Satisfaction
Hjartson et al., 2021
Rumination
Hjartson et al., 2021


Negative Affect
Irritation
Restlessness
Anxiety
Sadness
Diener & Emmons, 1984
Positive Affect
Energy
Wakefulness
Satisfaction
Hjartson et al., 2021
Rumination
Hjartson et al., 2021

Data Collection



Network analysis consists of three stages

Adapted from Borsboom et al., 2021

First, we choose the variables we want to investigate

Rumination
- 1: Rumination

PositiveAffect
- 2: Energy
- 3: Wakefulness
- 4: Satisfaction

NegativeAffect
- 5: Sadness
- 6: Irritation
- 7: Anxiety
- 8: Restlessness

Events
- 9: EventUnpleasantness
- 10: EventPleasantness

Other
- 11: Distraction

Every variable is represented by a **node**

Rumination
- 1: Rumination

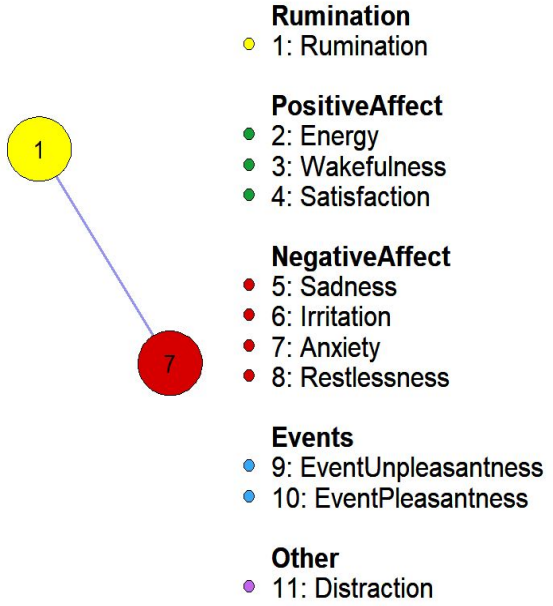
PositiveAffect
- 2: Energy
- 3: Wakefulness
- 4: Satisfaction

NegativeAffect
- 5: Sadness
- 6: Irritation
- 7: Anxiety
- 8: Restlessness

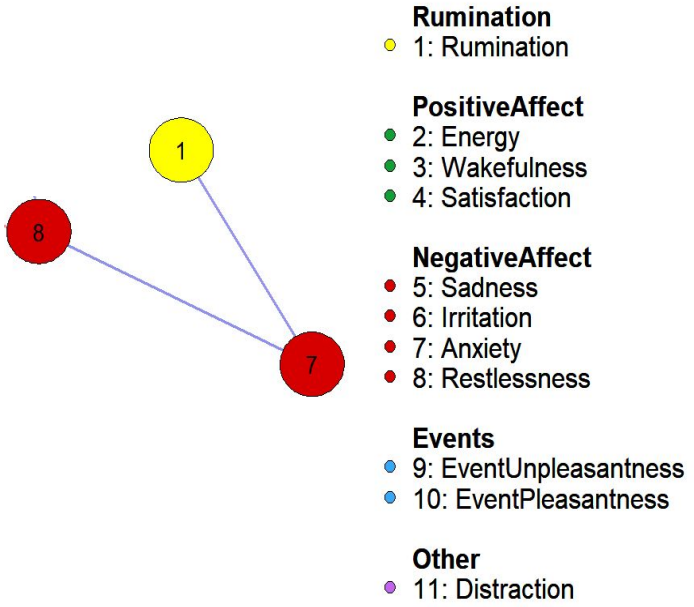
Events
- 9: EventUnpleasantness
- 10: EventPleasantness

Other
- 11: Distraction

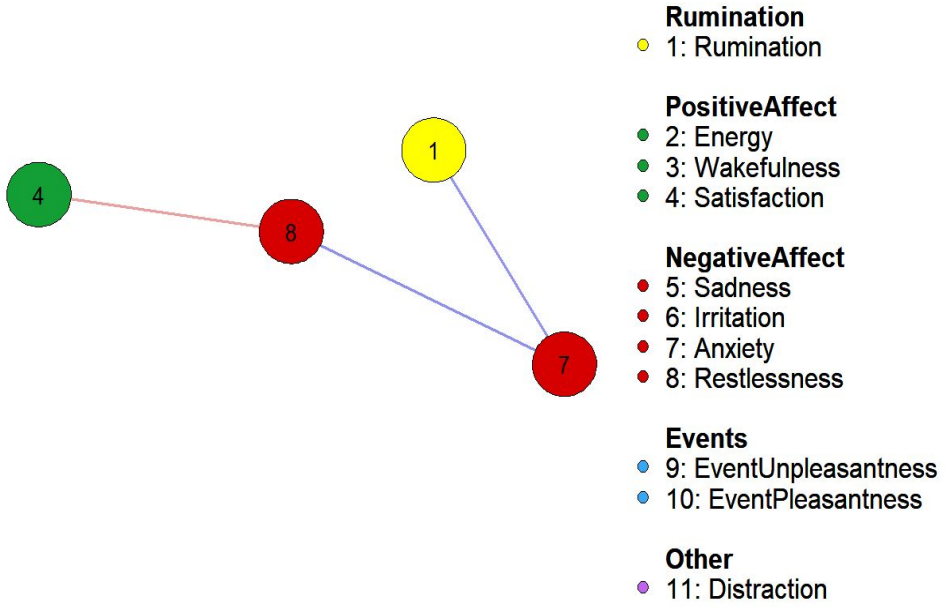
Relationships between nodes are represented by **edges**



These relationships can be **positive**…



… or **negative**


1
4
8
7
Rumination
1: Rumination
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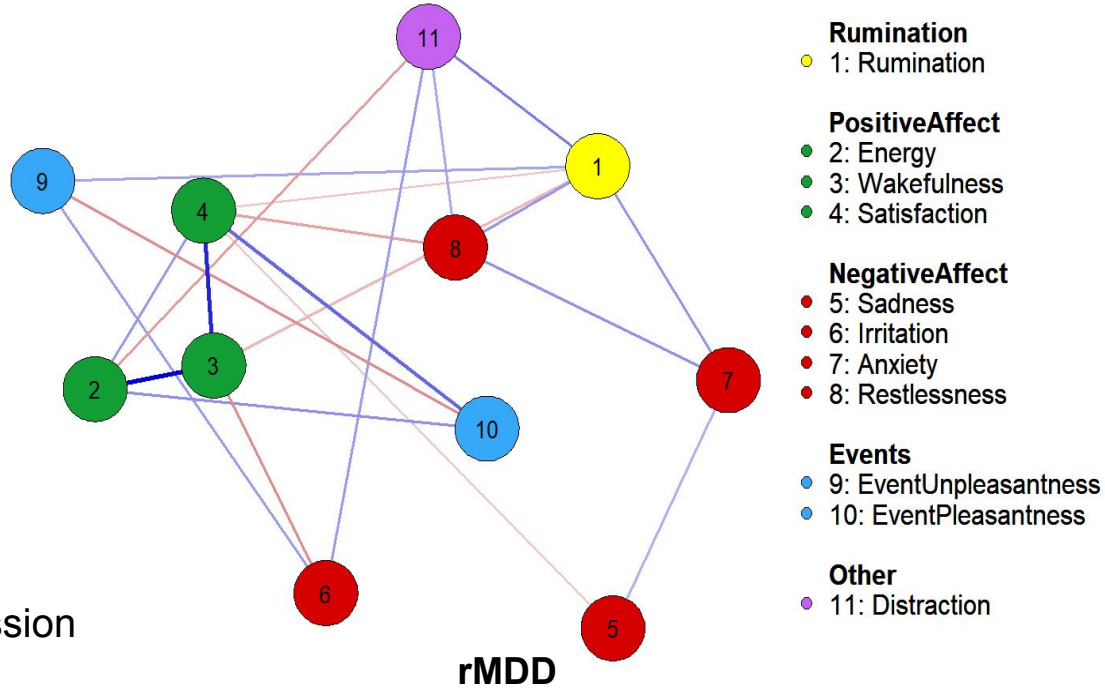
We estimate all relationships and build the full network*

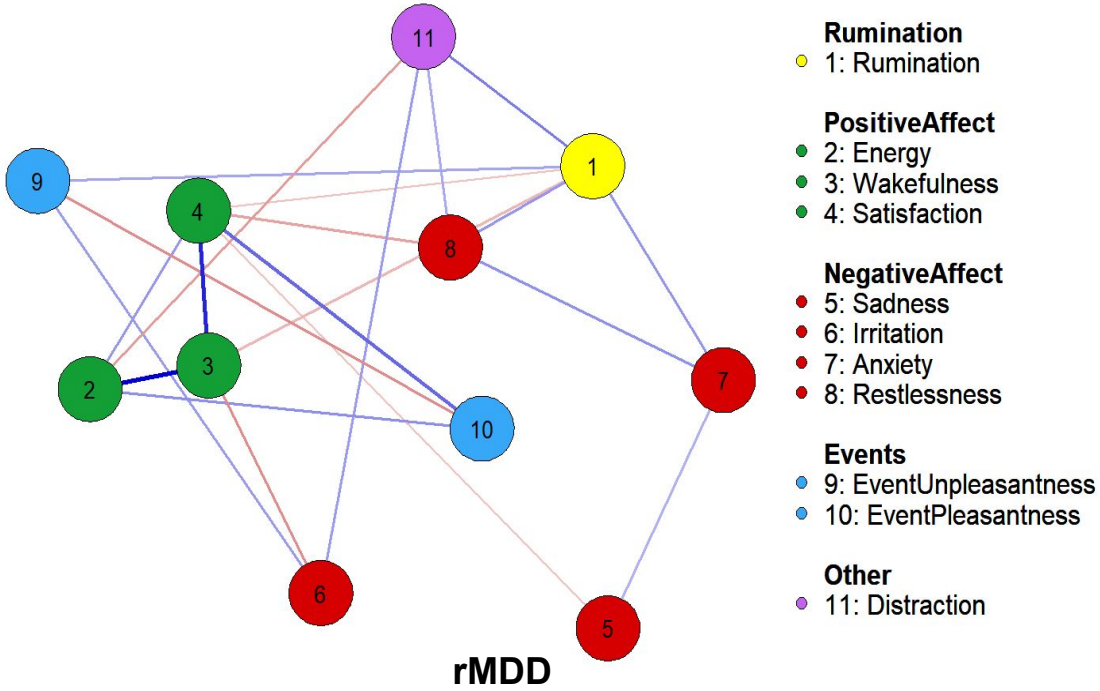


rMDD

* We used Multi-Level Vector Autoregression (mlVAR, Epskamp et al, 2018)

Then we describe the network statistically

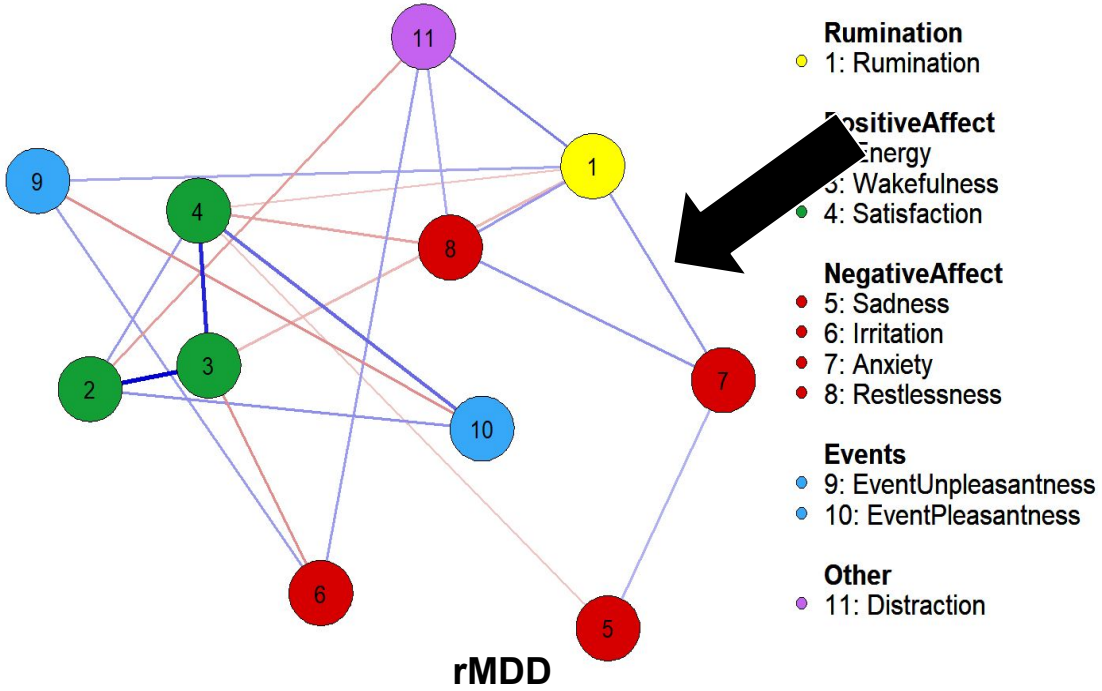
Network Statistics



How strong is the relationship between rumination and anxiety?

Network Statistics

Edge Weights

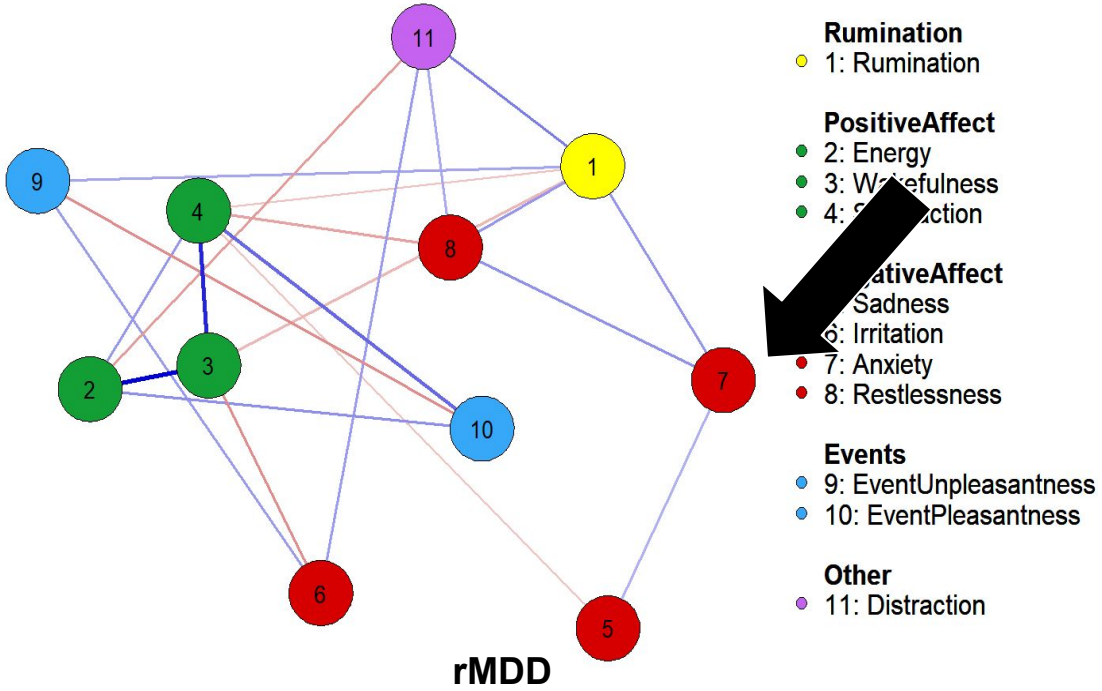


How much influence does anxiety have on other variables?

Network Statistics

Edge Weights

Strength

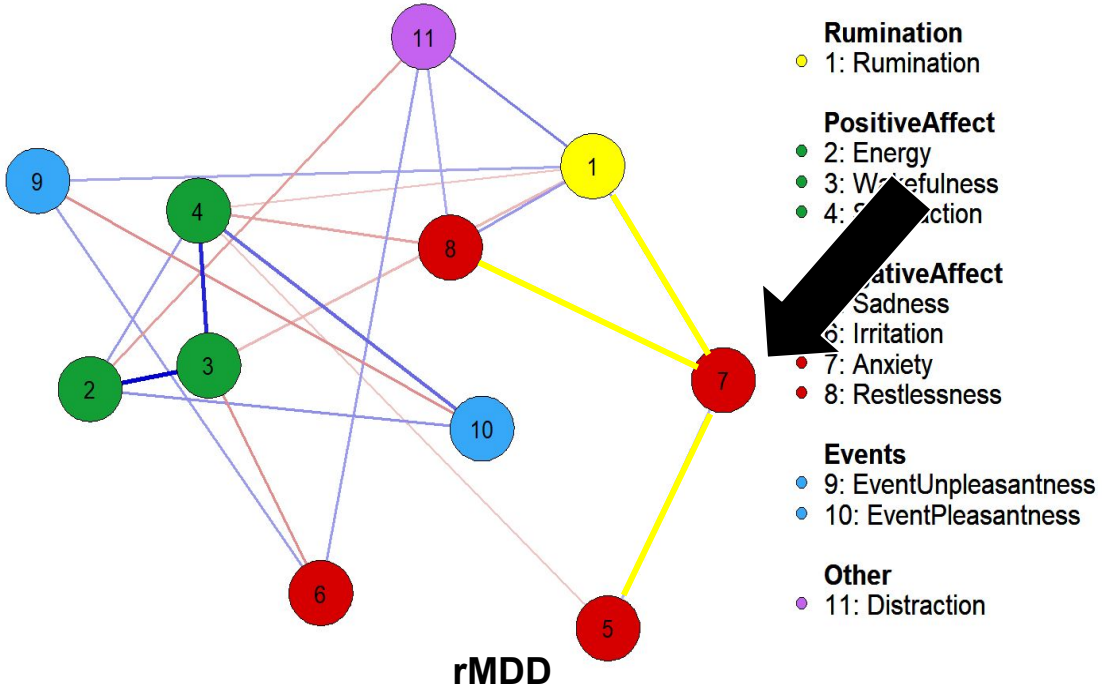


How much influence does anxiety have on other variables?

Network Statistics

Edge Weights

Strength



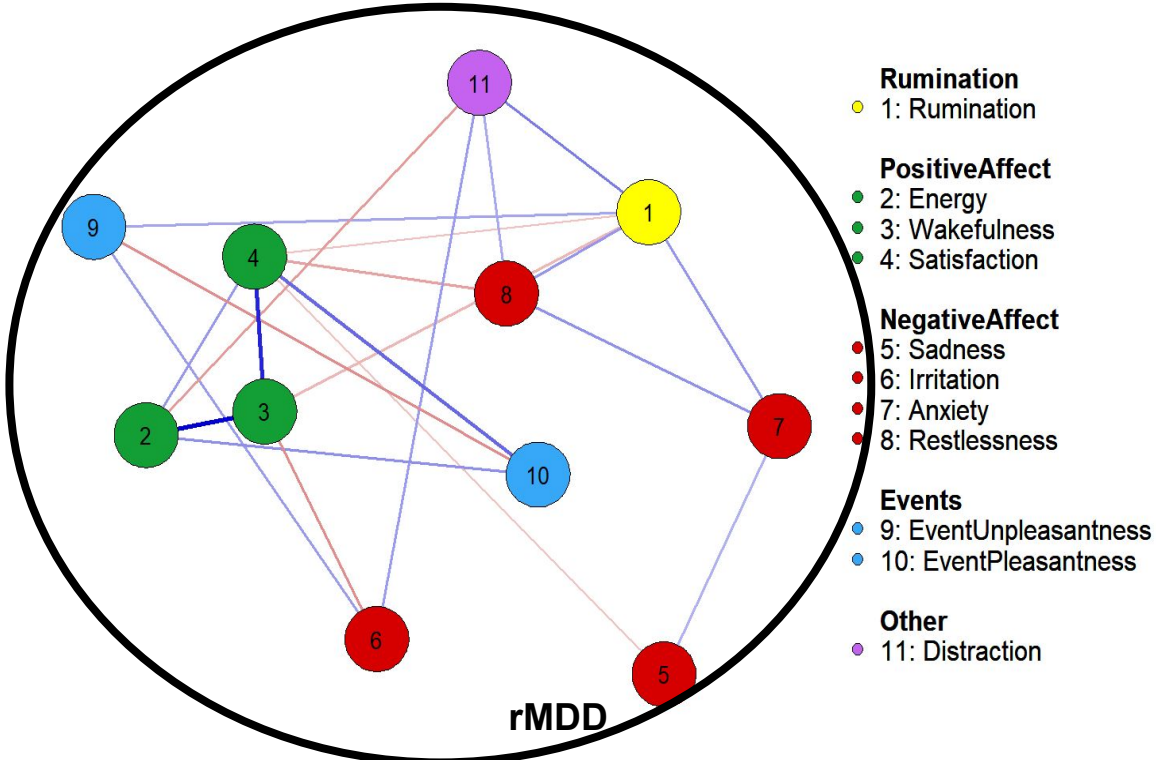
How densely connected is the network globally?

Network Statistics

Edge Weights

Strength

Global Strength



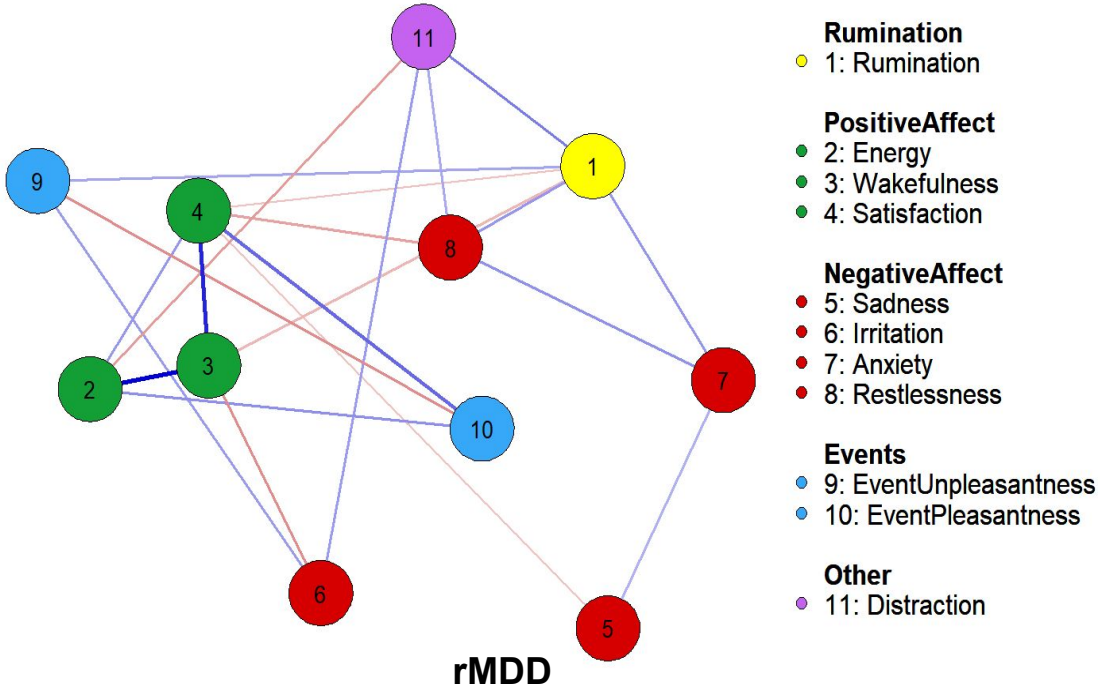
… but can we trust this network?

Network Statistics

Edge Weights

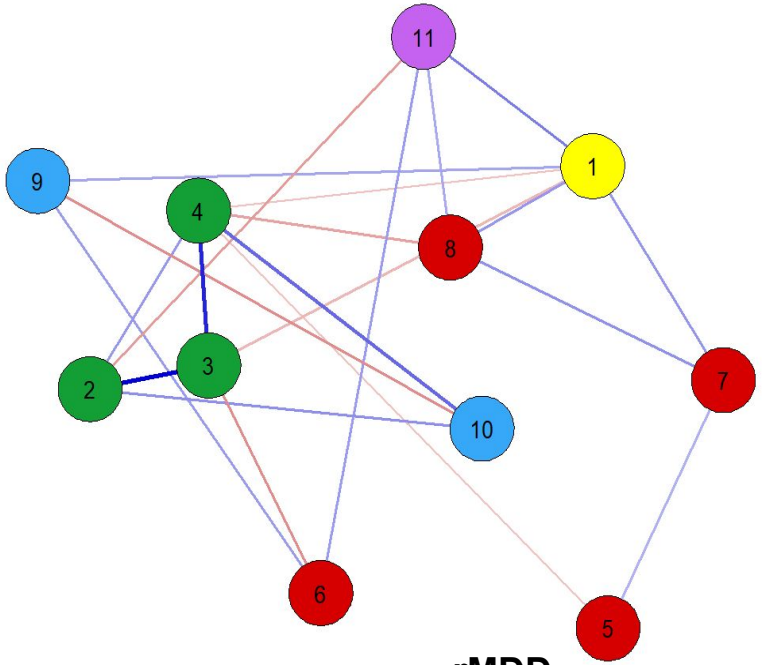
Strength

Global Strength



Using **permutations**, we can calculate p-values

Subject	Time	Rumination	Sadness	Anxiety	Satisfaction
s1	1	33	27	23	15
s1	2	12	74	67	20
s1	3	22	1	9	78
		Rumination	Sadness	Anxiety	Satisfaction
s2	1	32	34	12	53
s2	2	67	75	32	11
s2	3	84	82	13	5
		Rumination	Sadness	Anxiety	Satisfaction
s3	1	89	19	62	49
s3	2	54	14	31	47
s3	3	58	12	21	10



We **shuffle** the node labels per subject…

Subject	Time	Anxiety	Satisfaction	Rumination	Sadness
s1	1	33	27	23	15
s1	2	12	74	67	20
s1	3	22	1	9	78
		Sadness	Rumination	Satisfaction	Anxiety
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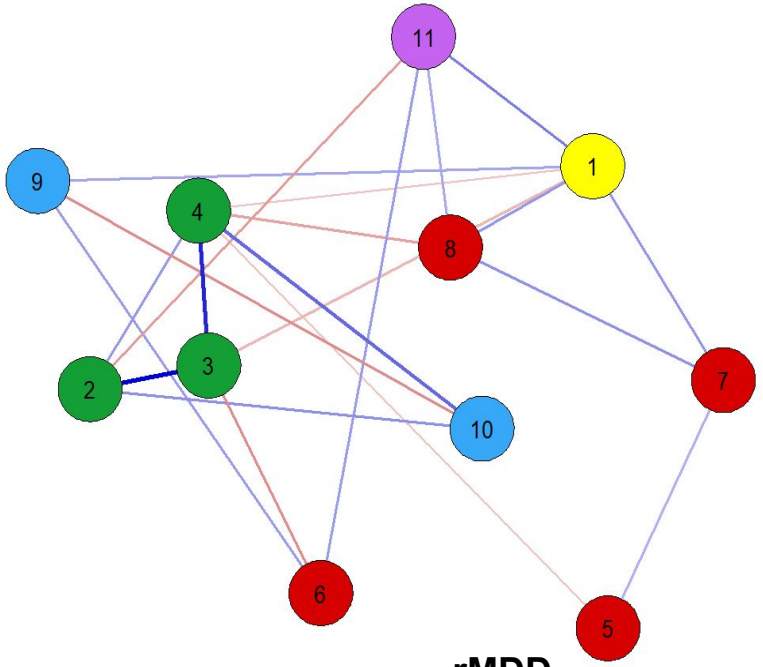

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- 11: Distraction

… **estimate a new network** and re-calculate all the statistics

Subject	Time	Anxiety	Satisfaction	Rumination	Sadness
s1	1	33	27	23	15
s1	2	12	74	67	20
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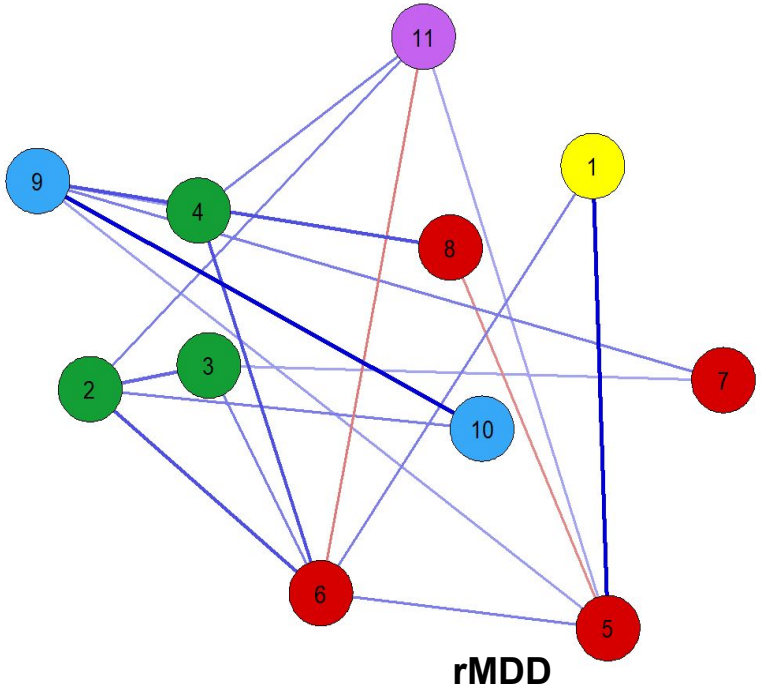
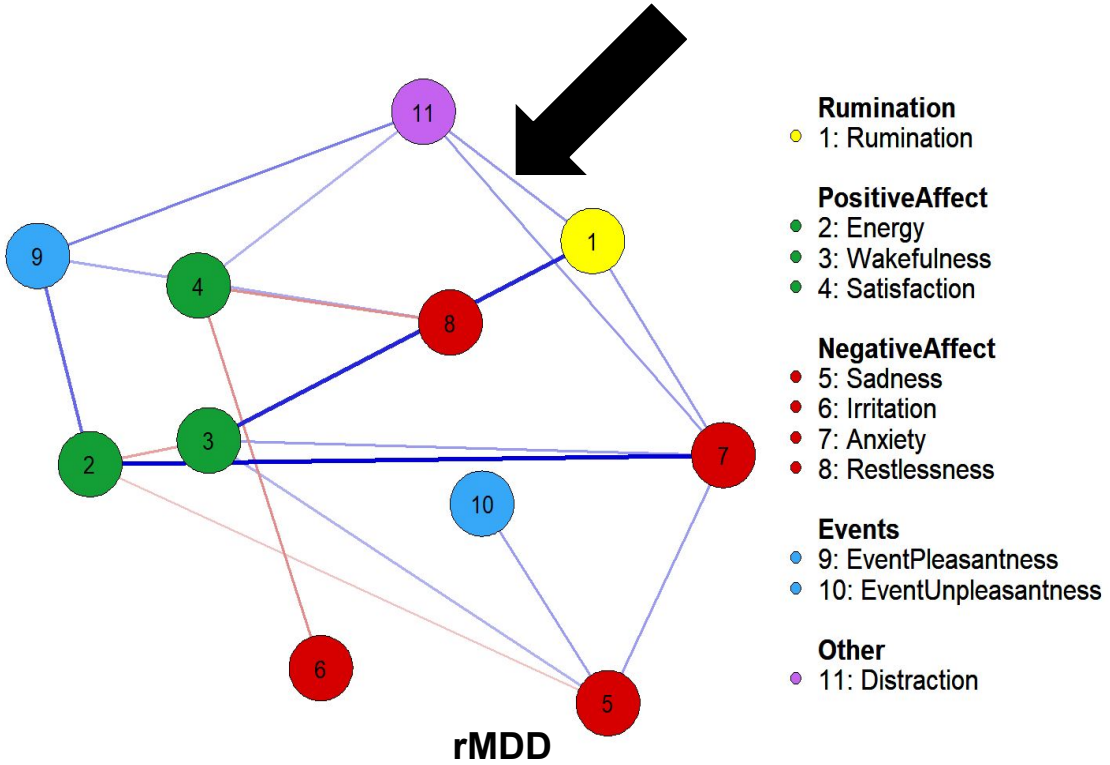
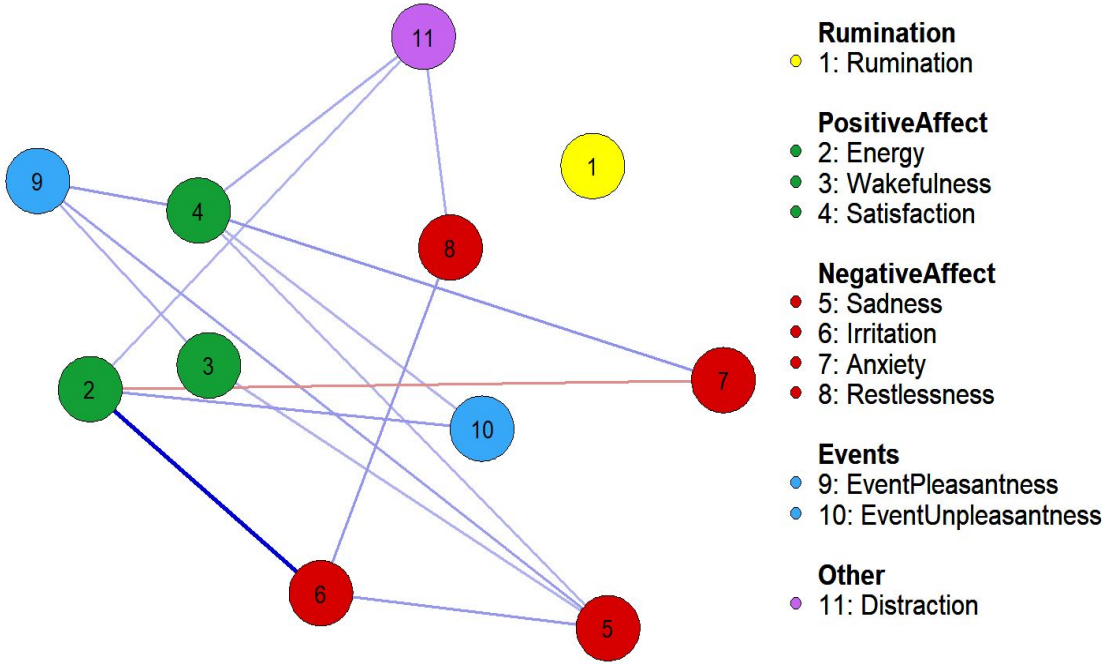


Repeating it 1000x…



Repeating it 1000x…

Edge Weight
Rumination - Distraction



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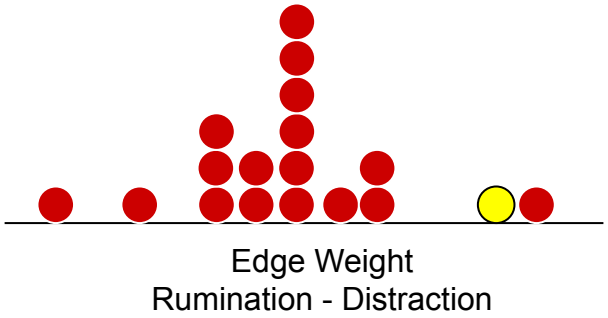
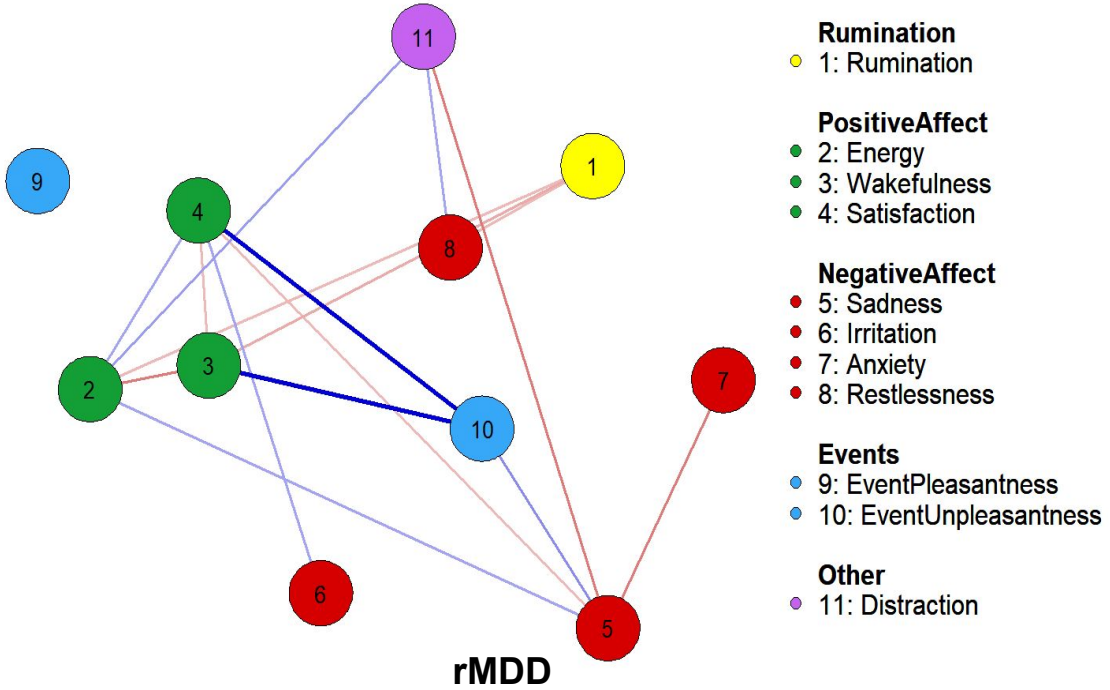
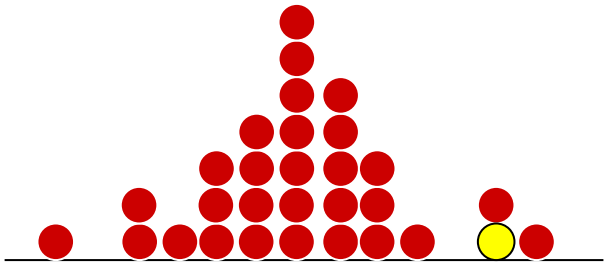


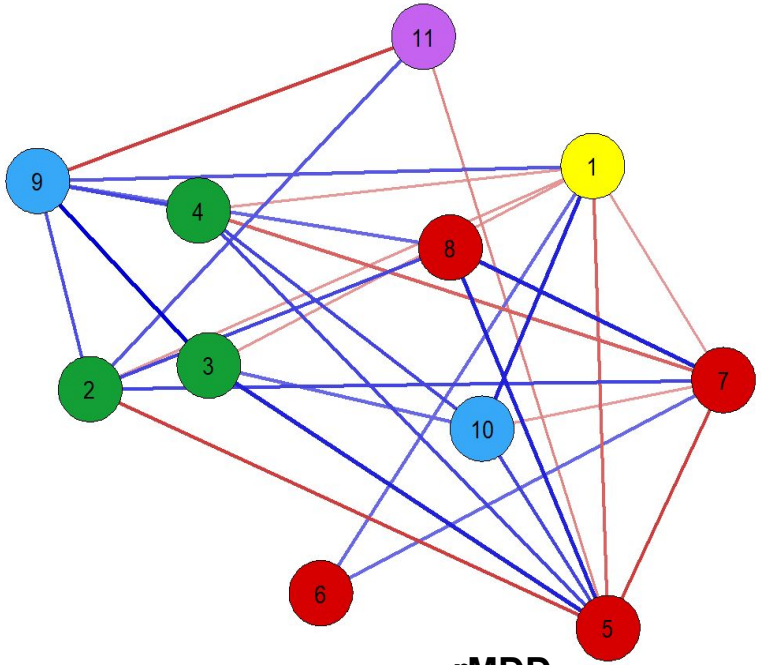
Edge Weight
Rumination - Distraction



Repeating it 1000x…



Edge Weight
Rumination - Distraction



rMDD

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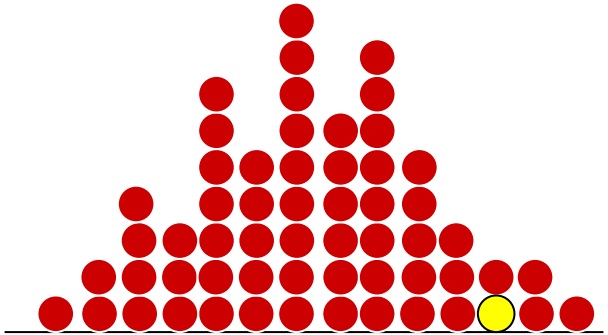
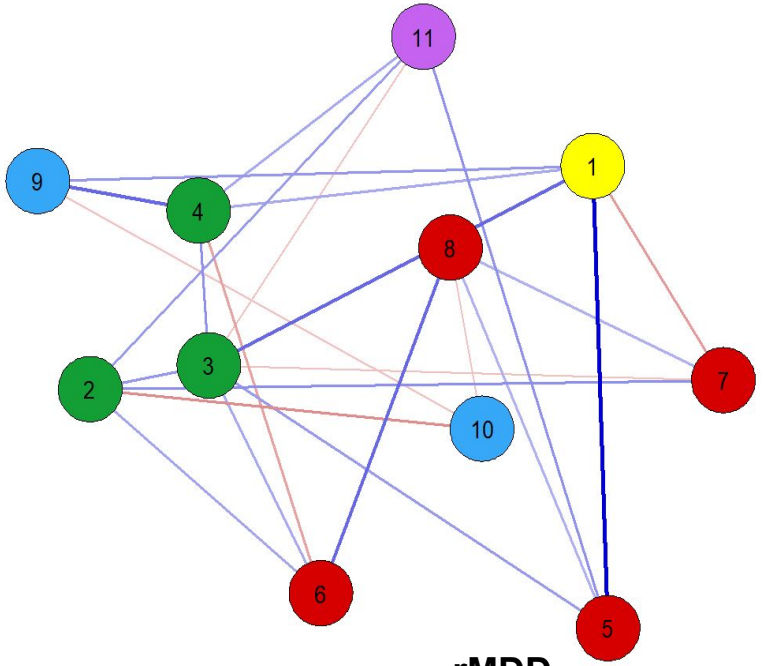
Other
- 11: Distraction

Repeating it 1000x, we **approximate** the relevant **distributions**



Edge Weight
Rumination - Distraction



rMDD

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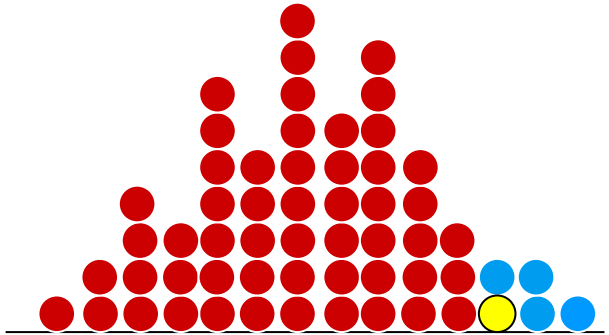
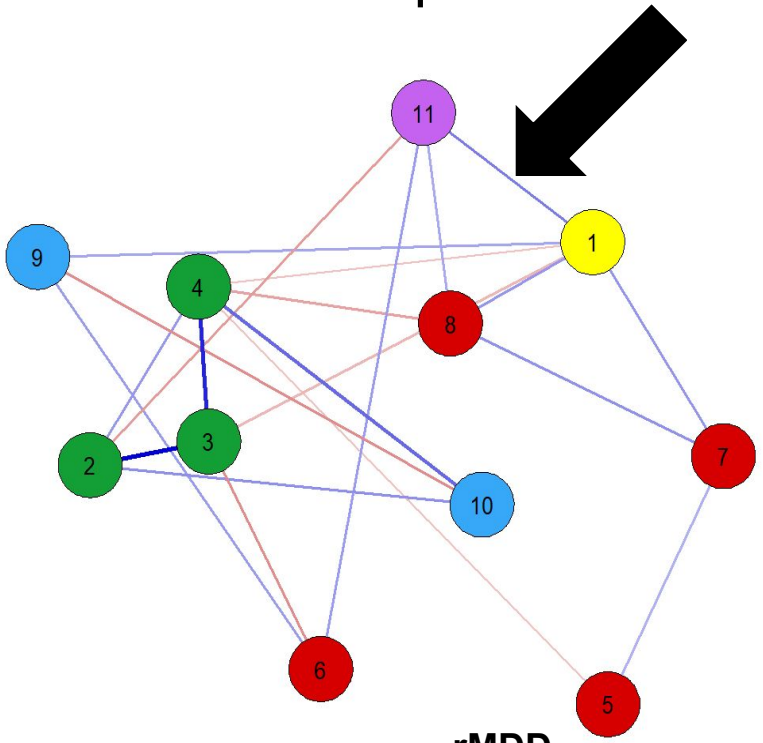
How many values are greater than or equal to the actual value?

Less than **2.5 %**



Edge Weight
Rumination - Distraction



rMDD

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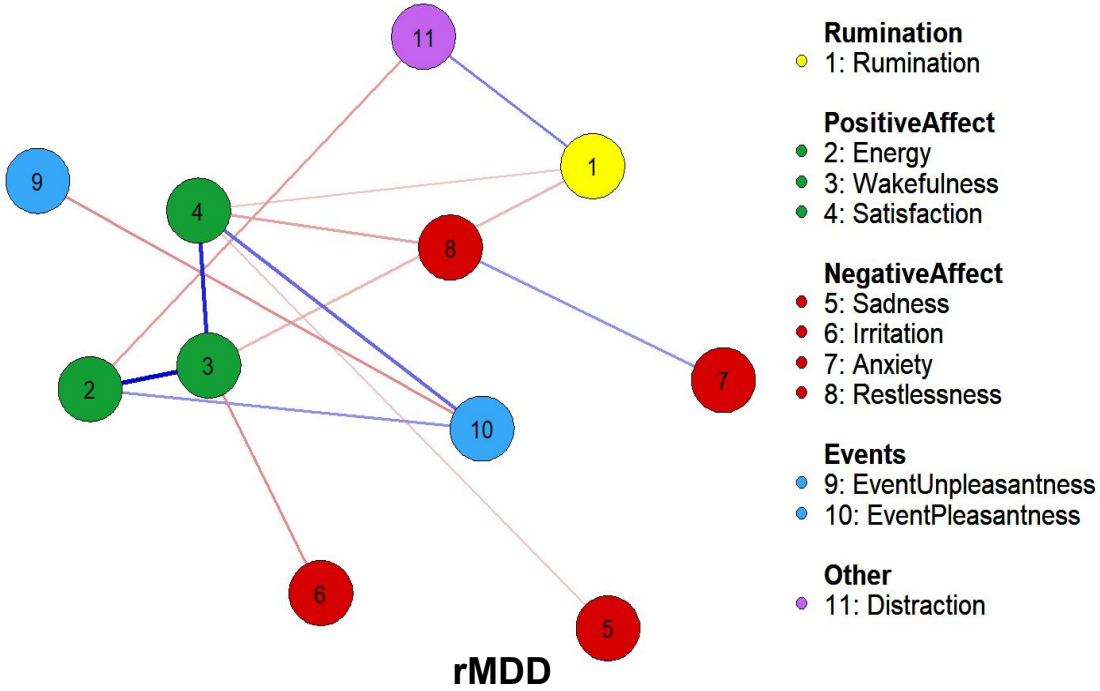
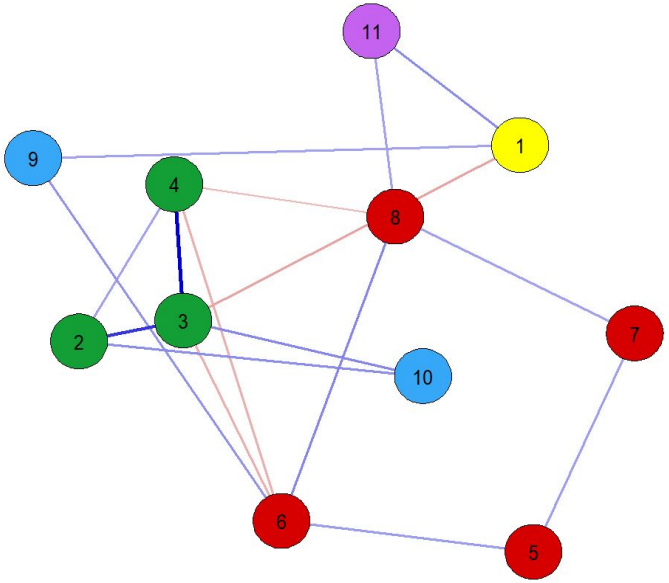
- 11: Distraction

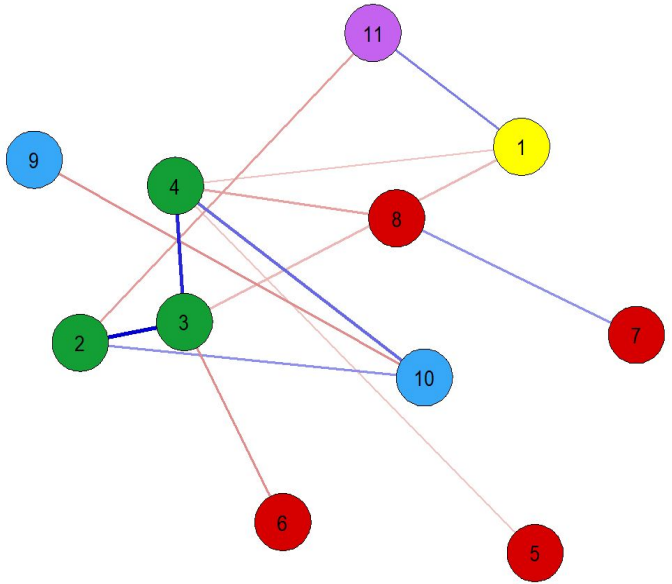
Some edges were not statistically significant



We can also apply permutations to compare two networks



HC (n=38)



rMDD (n=21)

Rumination
1: Rumination

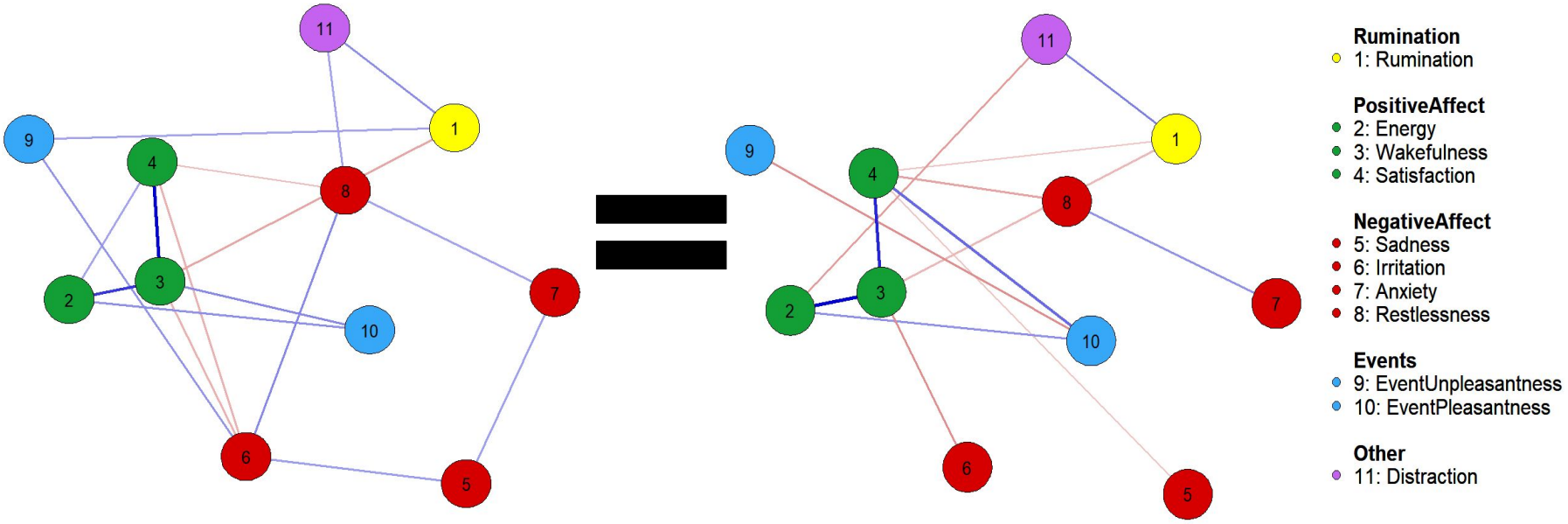
PositiveAffect
2: Energy
3: Wakefulness
4: Satisfaction

NegativeAffect
5: Sadness
6: Irritation
7: Anxiety
8: Restlessness

Events
9: EventUnpleasantness
10: EventPleasantness

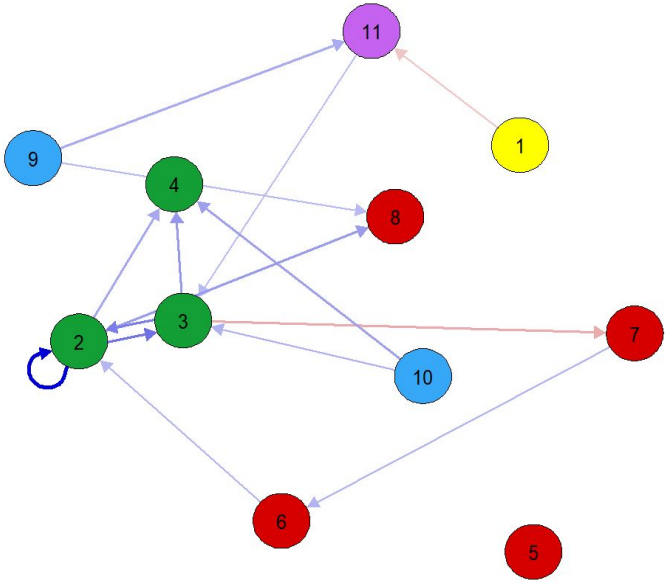
Other
11: Distraction

No statistically significant differences were found

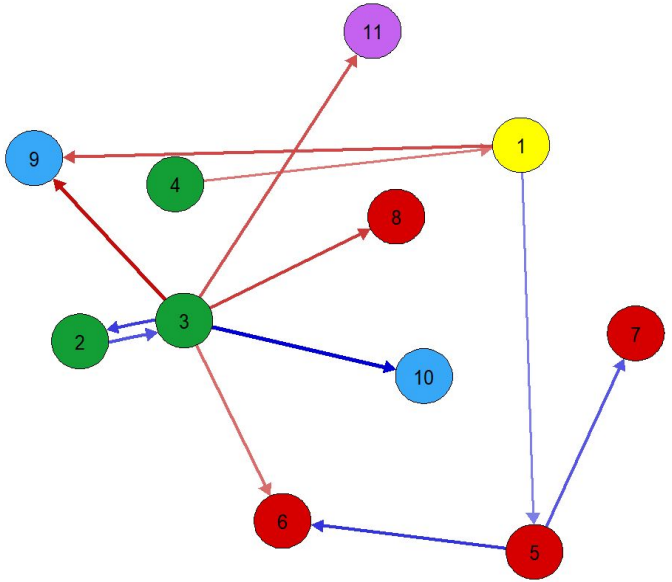


HC (n=38) **rMDD (n=21)**

How about the temporal relationships?



HC (n=38)



rMDD (n=21)

Rumination
- 1: Rumination

PositiveAffect
- 2: Energy
- 3: Wakefulness
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NegativeAffect
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Events
- 9: EventUnpleasantness
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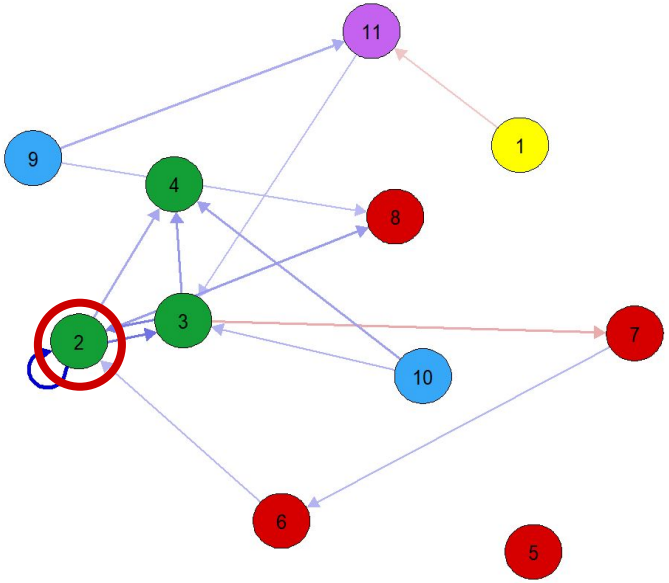
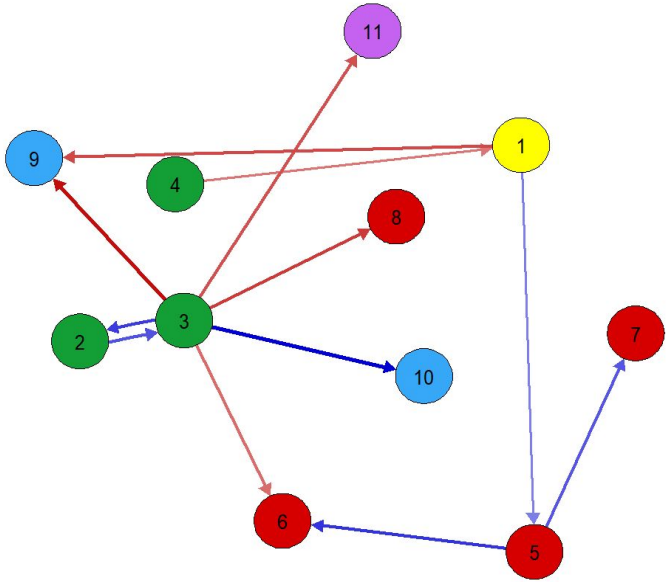
Other
- 11: Distraction

Satisfaction is more severely **influenced** in the HC network …



HC (n=38)



rMDD (n=21)

Rumination
1: Rumination

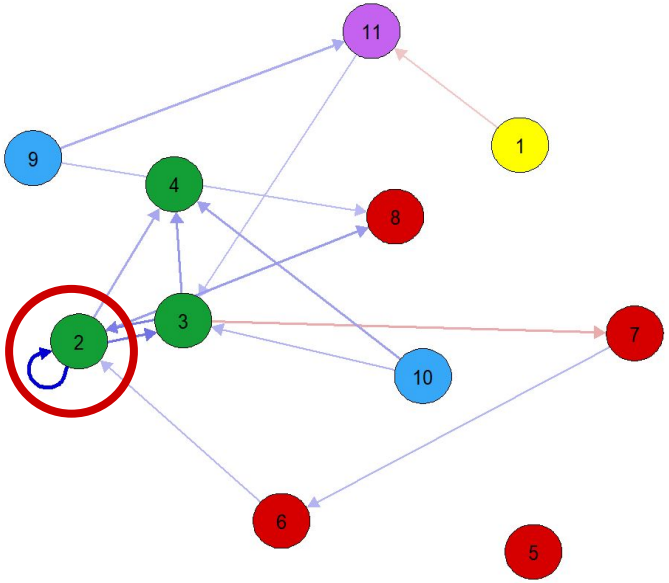
PositiveAffect
2: Energy
3: Wakefulness
4: Satisfaction

NegativeAffect
5: Sadness
6: Irritation
7: Anxiety
8: Restlessness

Events
9: EventUnpleasantness
10: EventPleasantness

Other
11: Distraction

… and **reinforces itself** more strongly



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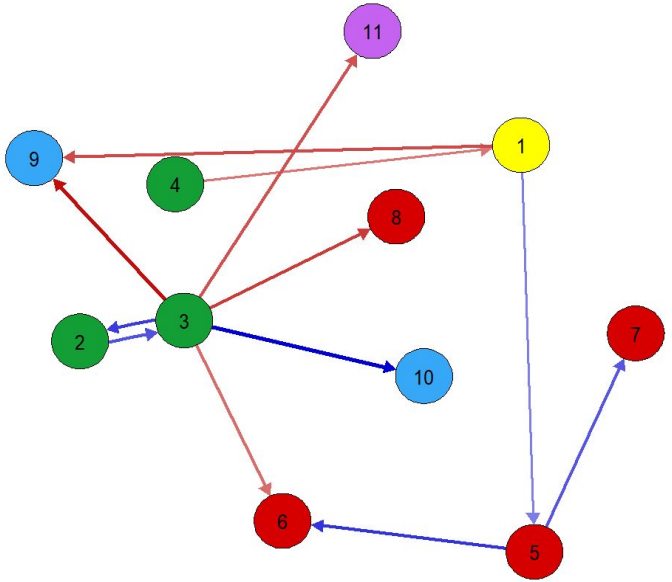

rMDD (n=21)

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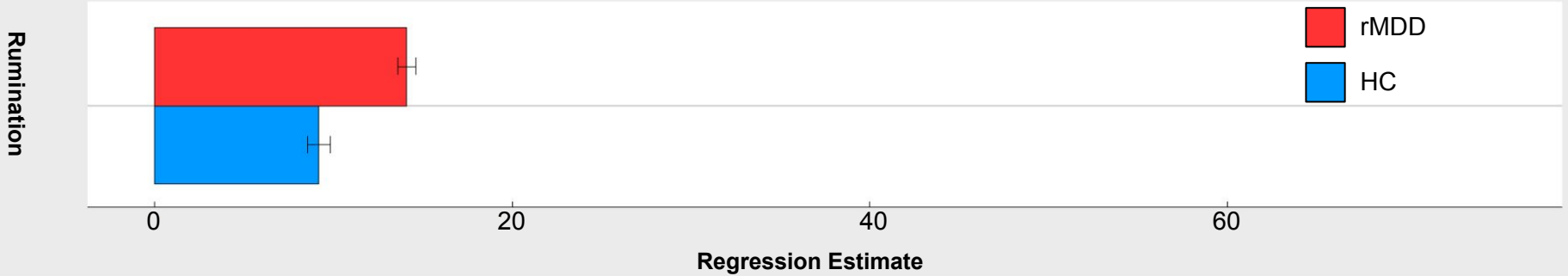
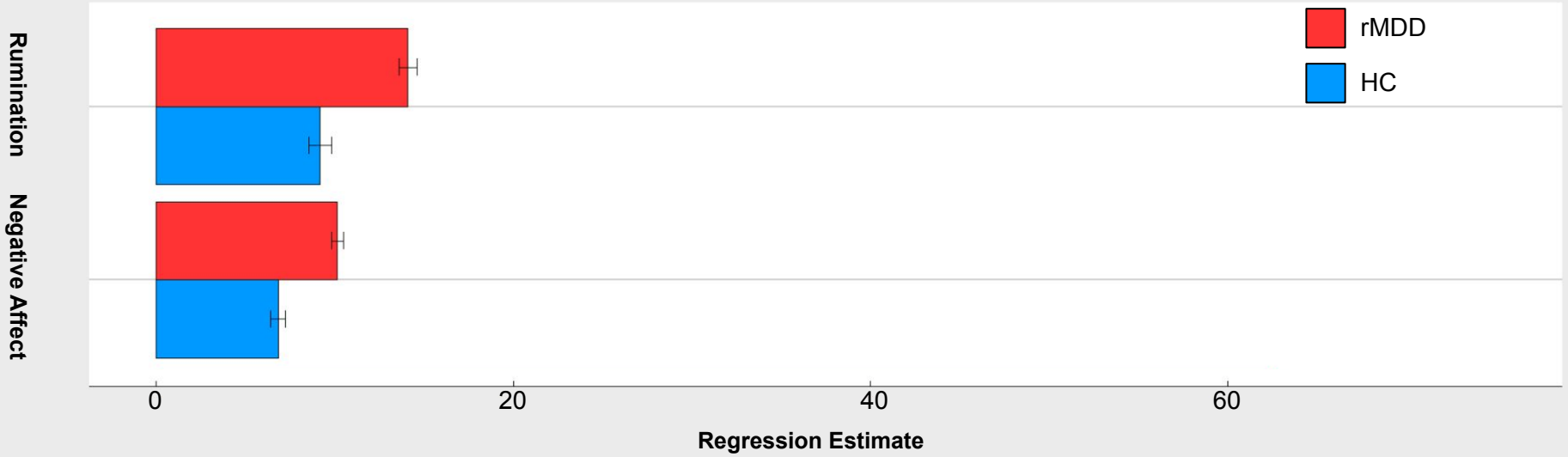
11: Distraction

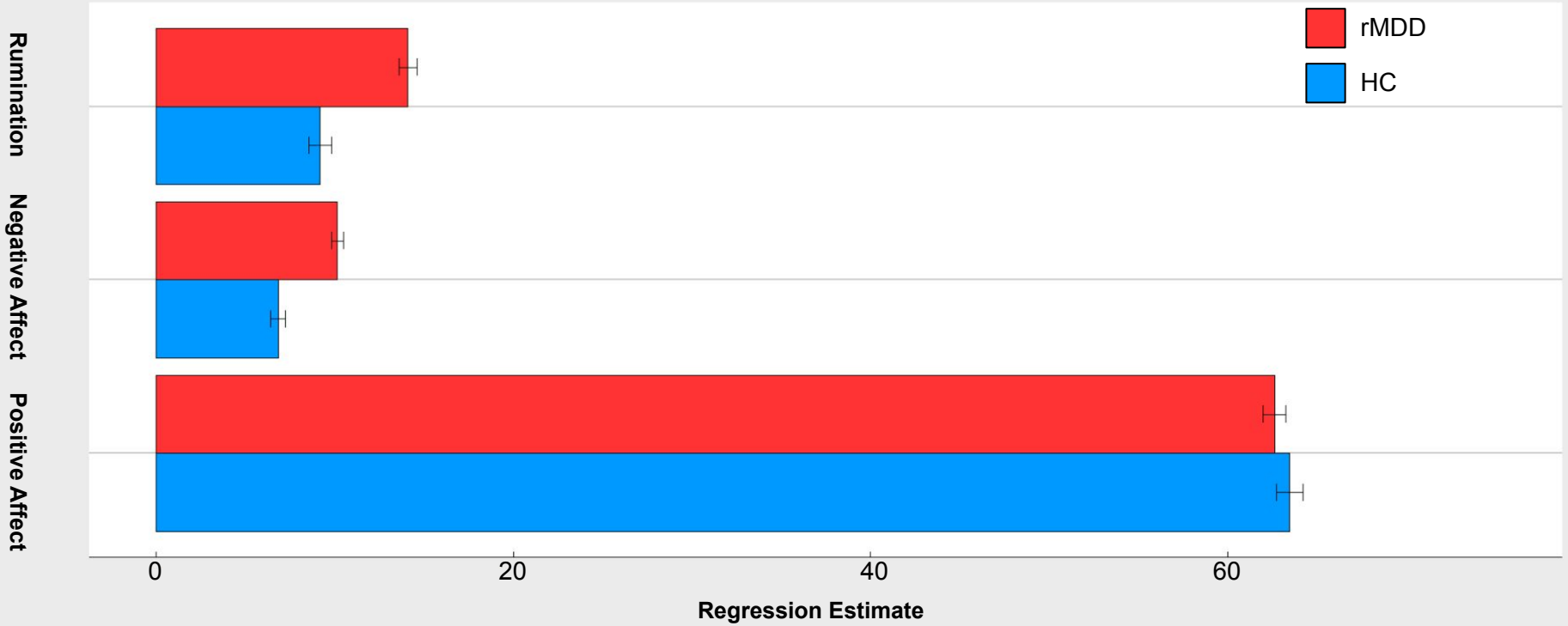
Remitted MDD participants report significantly more rumination…



… and negative affect



There is no significant difference in positive affect



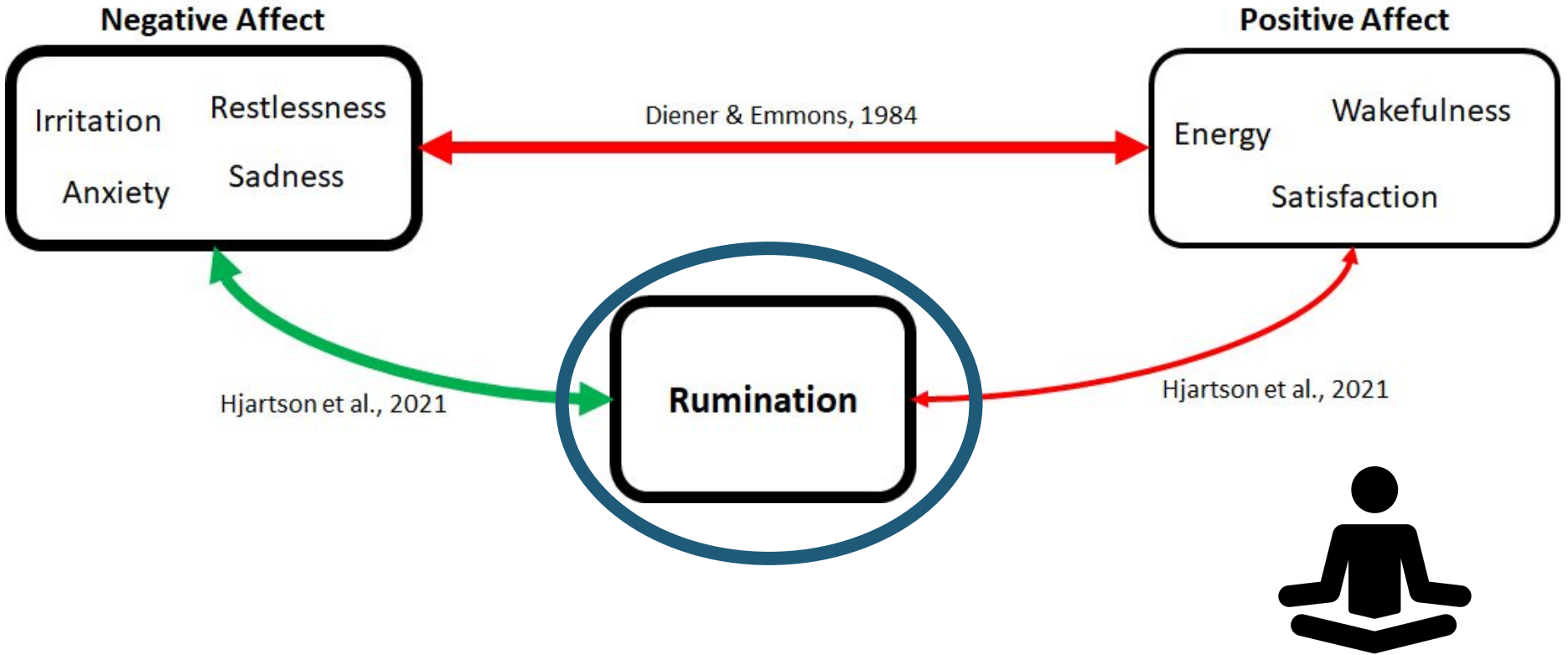
Two intervention might target **rumination** more directly

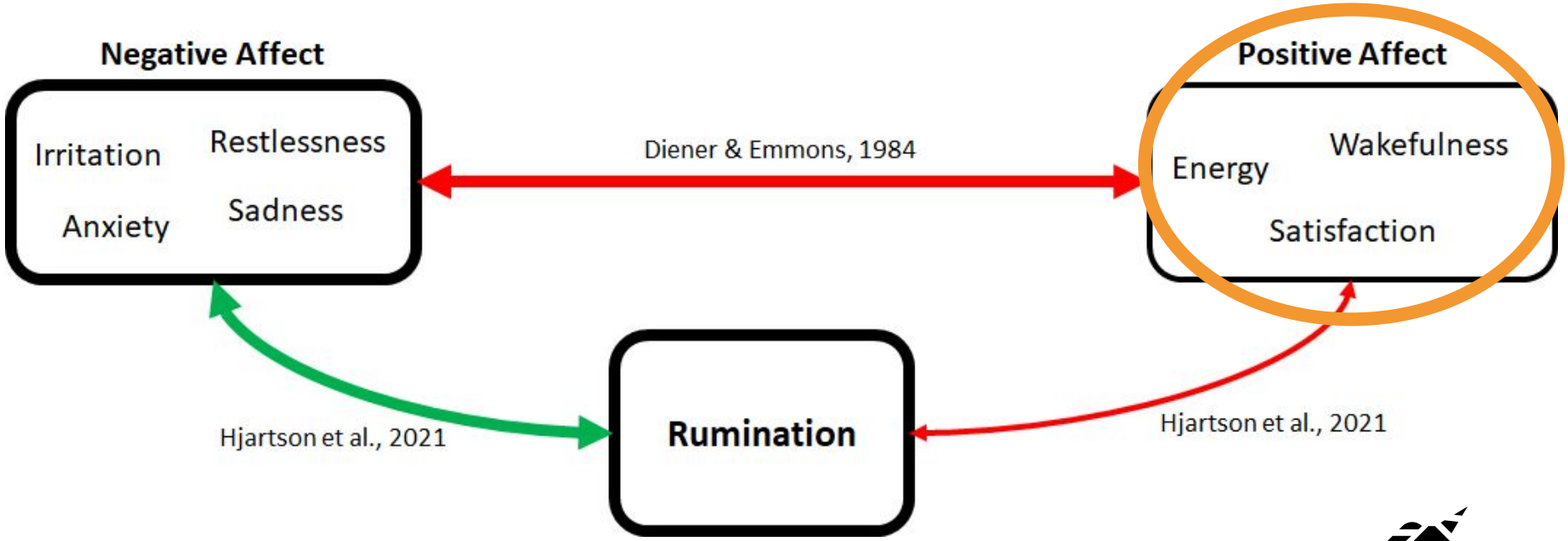
- **Mindfulness**
  - Reduces dysfunctional emotion regulation strategies such as rumination (Guendelman et al., 2017)

- **Positive Fantasizing**
  - Improves regulation of content of positive cognition and of positive affect (van Tol et al., 2021)

Research Question 2

What are the effects of mindfulness and fantasizing on the network of symptoms of MDD in general and on rumination in particular?


Negative Affect
Irritation
Restlessness
Anxiety
Sadness
Diener & Emmons, 1984
Positive Affect
Energy
Wakefulness
Satisfaction
Hjartson et al., 2021
Rumination
Hjartson et al., 2021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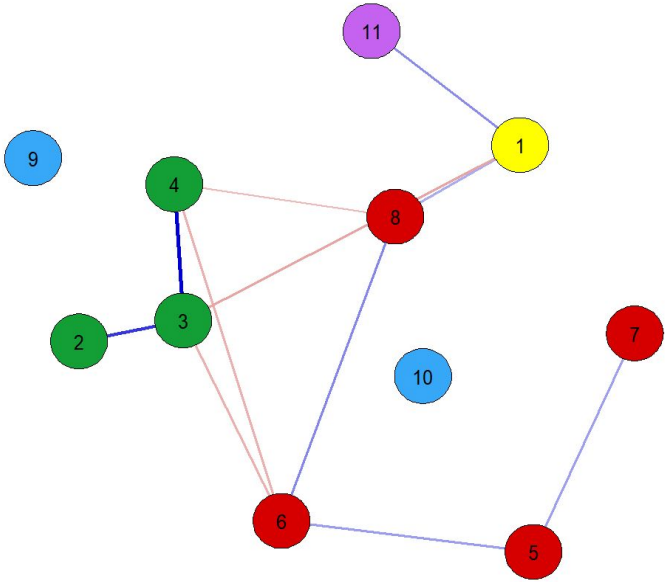
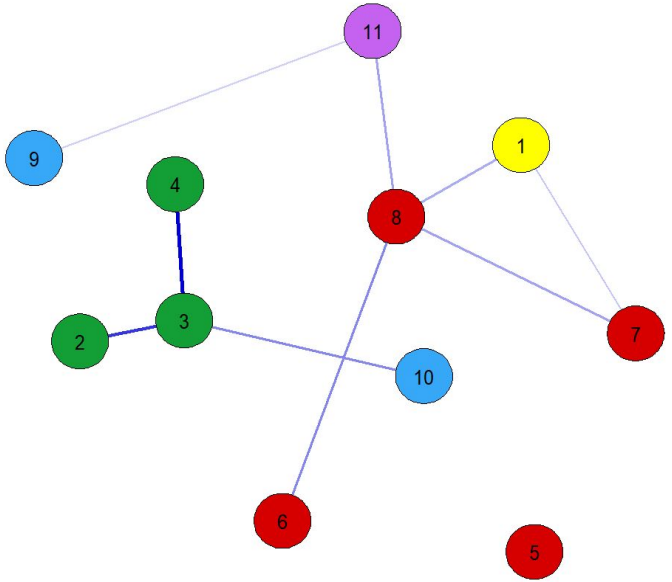
Positive Affect
Energy
Wakefulness
Satisfaction
Hjartson et al., 2021
Rumination
Hjartson et al., 2021

How does **positive fantasizing** impact the network?



at baseline (n=32)



Peri-intervention (n=31)

Rumination
1: Rumination

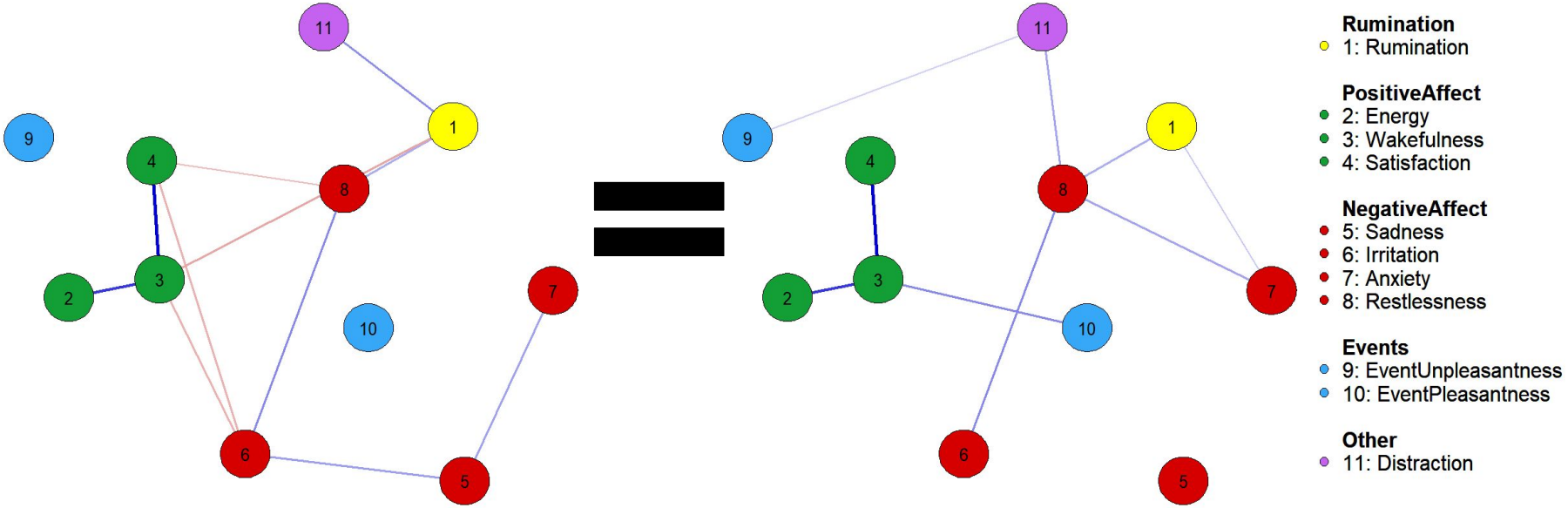
PositiveAffect
2: Energy
3: Wakefulness
4: Satisfaction

NegativeAffect
5: Sadness
6: Irritation
7: Anxiety
8: Restlessness

Events
9: EventUnpleasantness
10: EventPleasantness

Other
11: Distraction

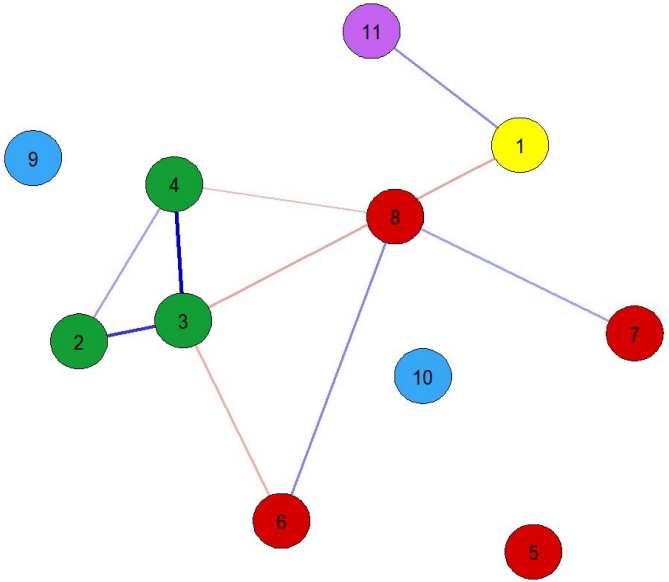
The networks do not differ from each other significantly



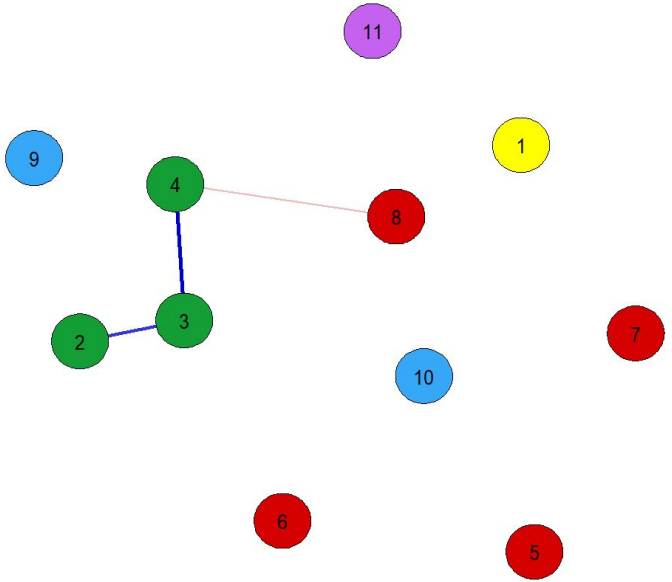
at baseline (n=32)

Peri-intervention (n=31)

What influence does **mindfulness** have on the network?



at baseline (n=27)



Peri-intervention (n=27)

Rumination
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Events
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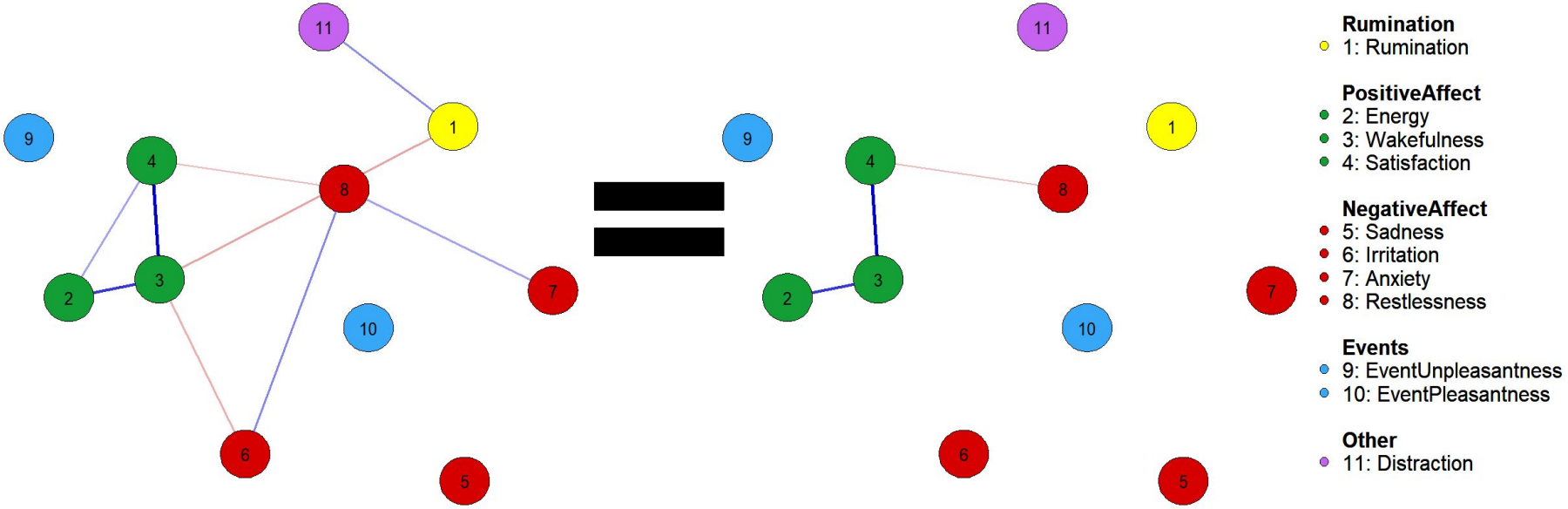
10: EventPleasantness

Other
11: Distraction

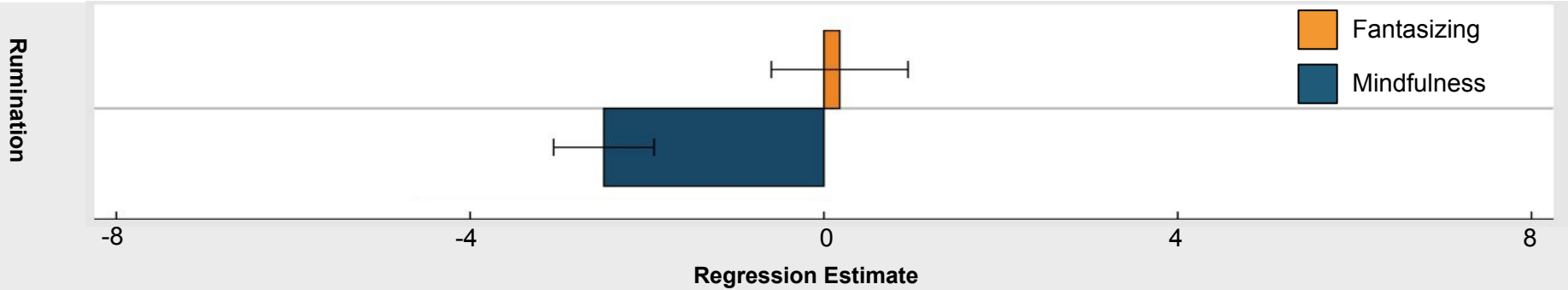
There is no statistically significant difference



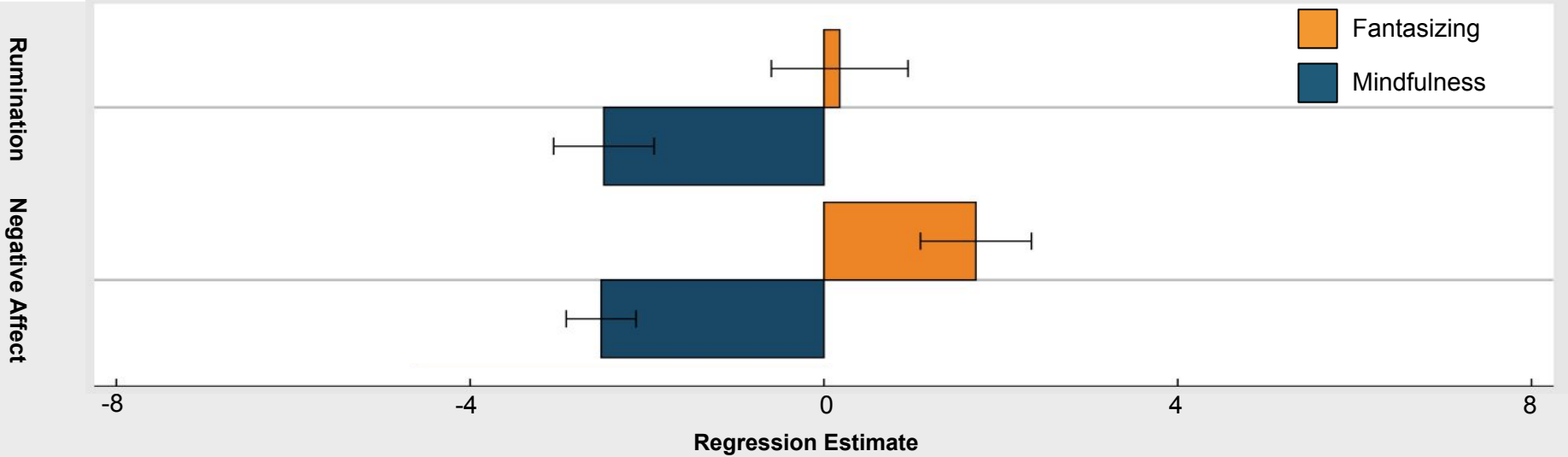
at baseline (n=27)

Peri-intervention (n=27)

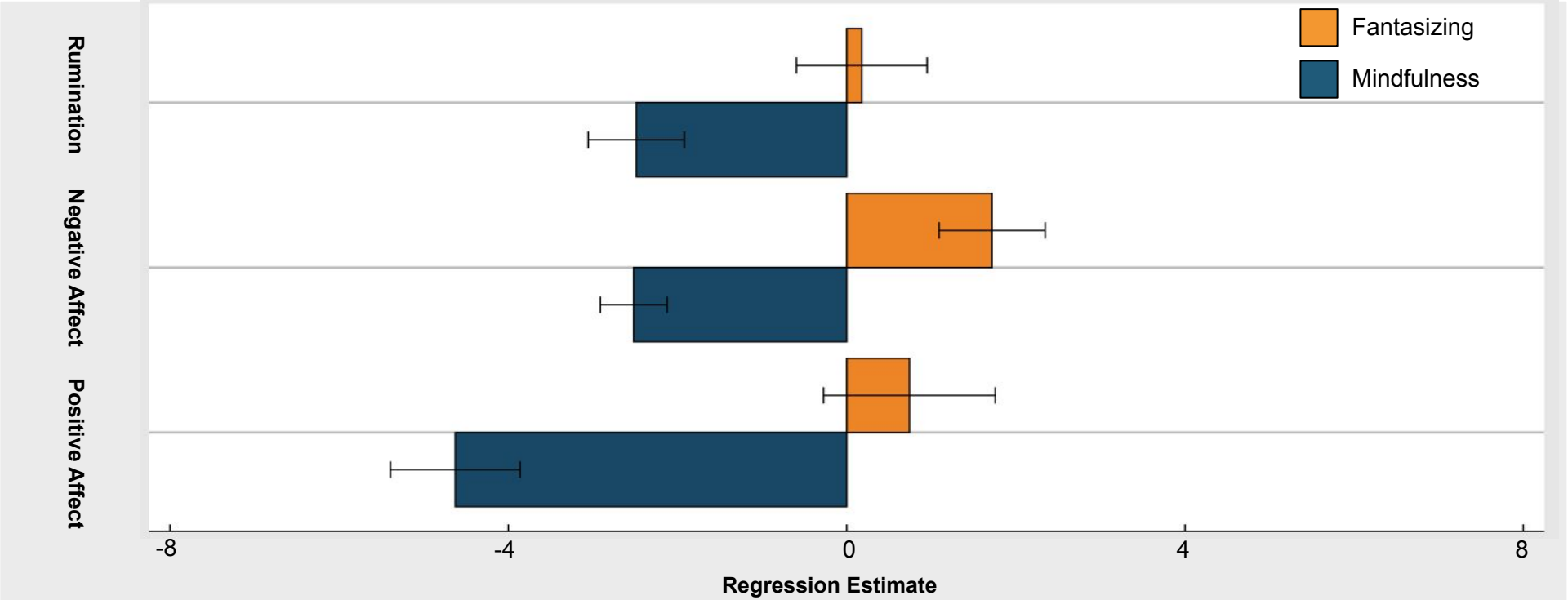
Mindfulness significantly reduces rumination…



… and negative affect…



… as well as positive affect



RQ1: How do the rMDD and HC networks differ?

- Feelings of satisfaction may be longer lasting in healthy individuals than those in remission from depression

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- Individuals in remission from depression ruminate more and experience greater negative affect

RQ2: What are the effects of mindfulness and fantasizing?

- Mindfulness more effectively lowers rumination and negative affect…
  … but also positive affect

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- No significant effects on the networks were found

RQ2: What are the effects of mindfulness and fantasizing?

- Mindfulness more effectively lowers rumination and negative affect…
  … but also positive affect
- No significant effects on the networks were found
- The effects were only tested on combined networks because the estimation algorithm requires a lot of data

Network analysis: Results need to be taken with a grain of salt

- Visual networks invite potentially fallacious post-hoc stories about connections between relationships

Network analysis: Results need to be taken with a grain of salt

- Visual networks invite potentially fallacious post-hoc stories about connections between relationships
- More research into temporal networks is needed - especially in terms of stability analysis and network comparison

Conclusion

- Individuals in remission from depression ruminate more and experience more negative affect

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- Mindfulness lowers rumination, negative affect, and positive affect

Conclusion

- Individuals in remission from depression ruminate more and experience more negative affect
- Mindfulness lowers rumination, negative affect, and positive affect
- While we did not find many significant differences between networks, the results did *hint* at potentially interesting effects (e. g., lowered influence of rumination through mindfulness)

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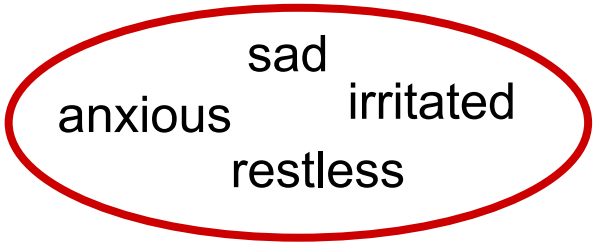
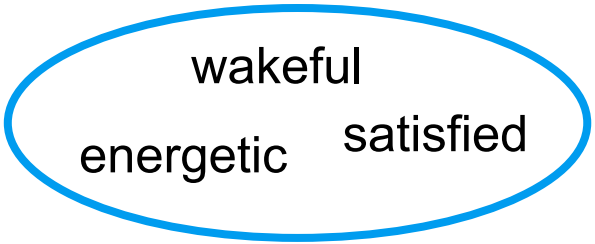
Appendix

ESM questionnaire

At the moment I feel…





distracted

At the moment I am ruminating

How pleasant was the most pleasant event since the last measurement?

How unpleasant was the most unpleasant event since the last measurement?

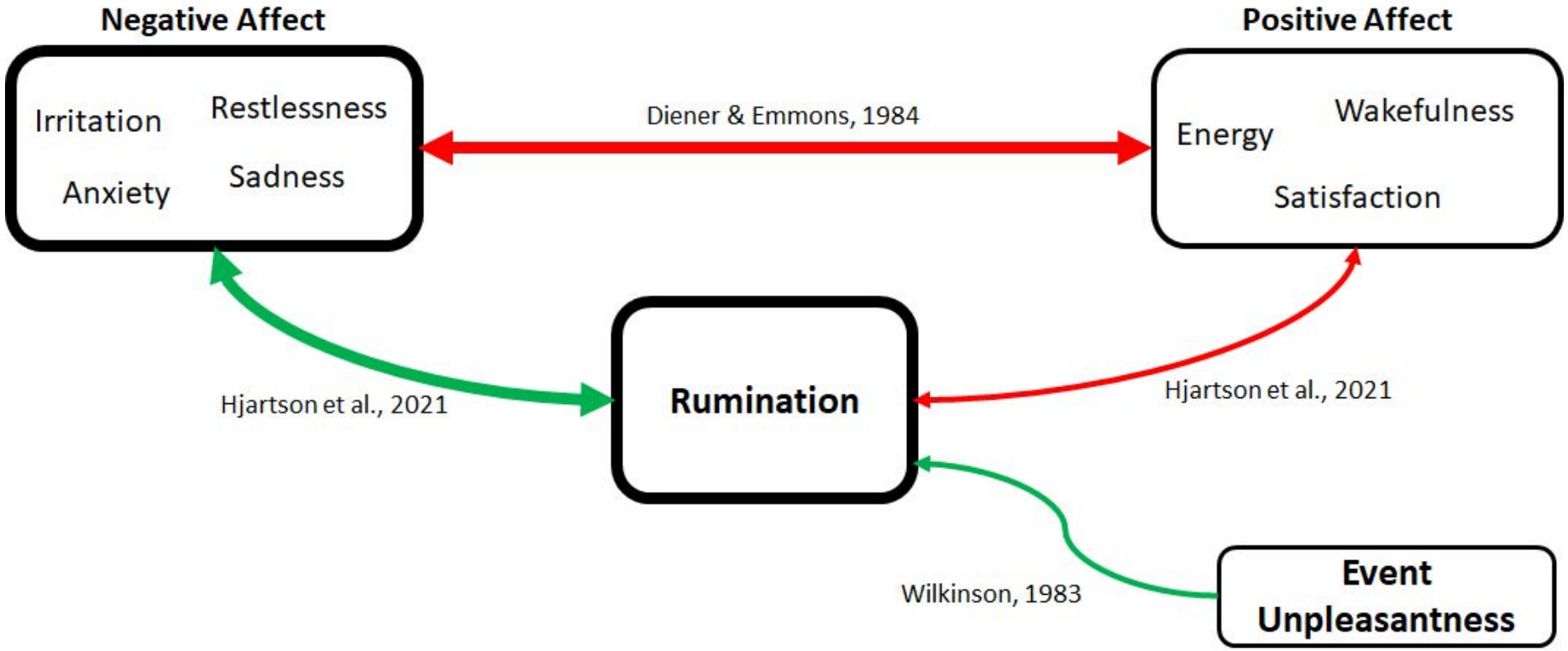
Research Questions

Question 1

How do the networks of symptoms of MDD differ between remitted MDD patients and healthy controls in general and what is the role of rumination in particular?

Question 2

What are the effects of mindfulness and fantasizing on the network of symptoms of MDD in general and on rumination in particular?


Negative Affect
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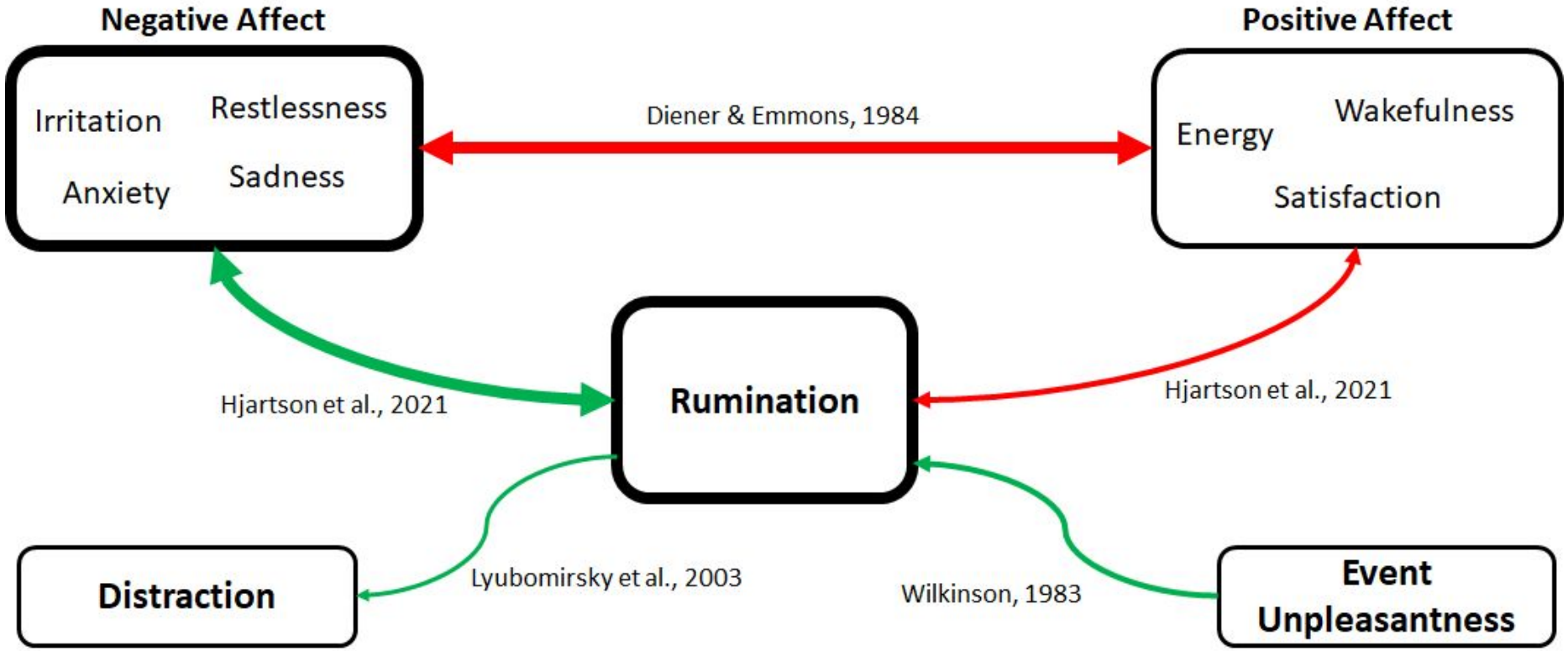
Positive Affect
Energy
Wakefulness
Satisfaction
Hjartson et al., 2021
Rumination
Hjartson et al., 2021
Wilkinson, 1983
Event Unpleasantness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Hjartson et al., 2021
Rumination
Hjartson et al., 2021
Distraction
Lyubomirsky et al., 2003
Wilkinson, 1983
Event Unpleasantness

Subquestion	Measurement
A How does mental health status interact with the variables?	Mixed-effects models
B What associations do variables show?	Mixed-effects models, edge weights
C What are the most central symptoms?	Centrality measures
D How central is rumination and what associations does it have?	Centrality measures, edge weights
E How densely connected is the network overall?	Global strength
F How strongly are PA measures interconnected?	Local strength
G How strongly are NA measures interconnected?	Local strength

Mindfulness

- Efficacy in mitigating depressive symptoms corroborated by multiple meta-analyses (for example, Hofmann et al., 2010)

- Reduces dysfunctional emotion regulation strategies such as rumination (Guendelman et al., 2017)

… **positive fantasizing** may improve regulation of **positive affect**

- A main constituent of Preventive Cognitive Therapy
- Shown to prevent the recurrence of depressive episodes and mitigate depressive symptoms (Bockting et al., 2009)
- Improves regulation of positive affect and content of positive cognition (van Tol et al., 2021)

How much influence does a certain cluster of nodes have?

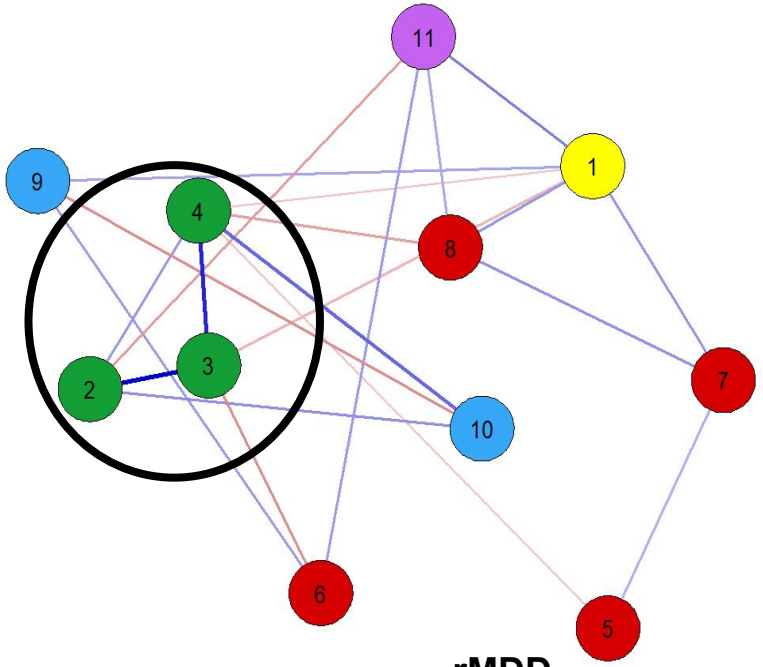
Network Statistics

Edge Weights

Strength

Positive Affect Strength

Negative Affect Strength



Some nodes failed to reach statistical significance

Stability Analysis*

Strength: **9/11 nodes**

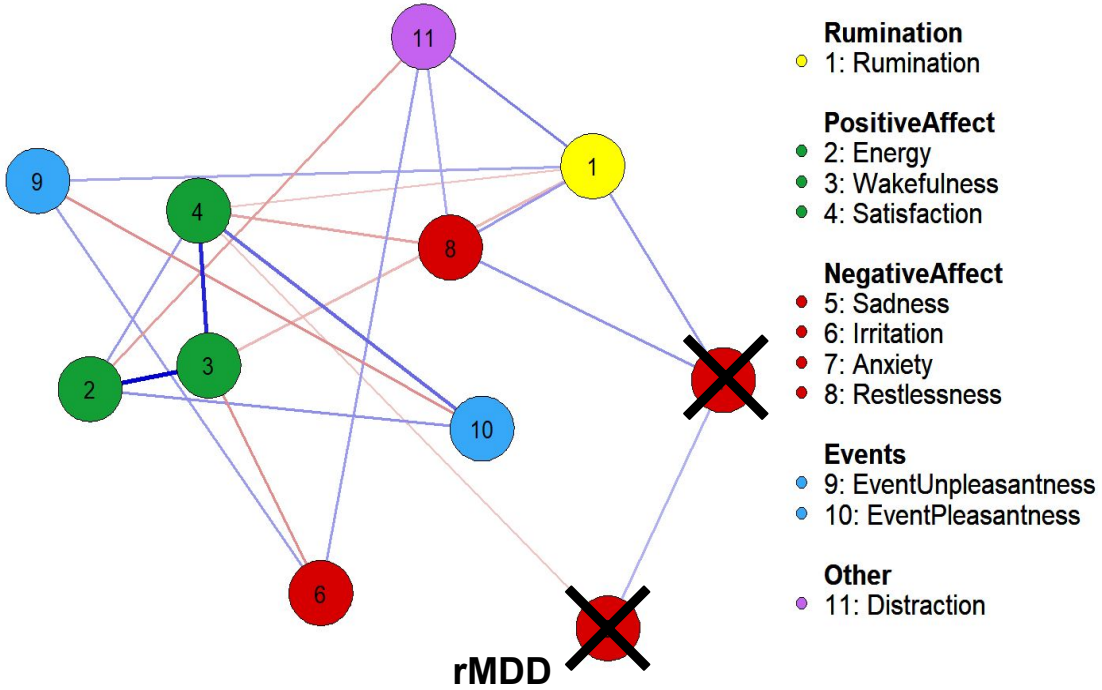
Weight:

PA Strength:

NA Strength:

Global Strength:

* alpha = 0.025

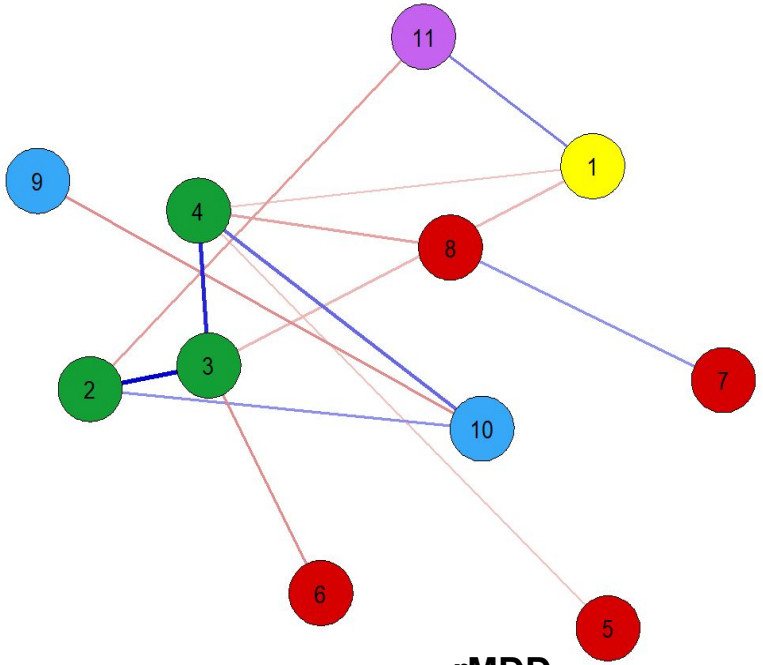


Not all edges are significant either

Stability Analysis*

Strength:	9/11 nodes
Weight:	**13/25 edges**
PA Strength:	
NA Strength:	
Global Strength:	

* alpha = 0.025

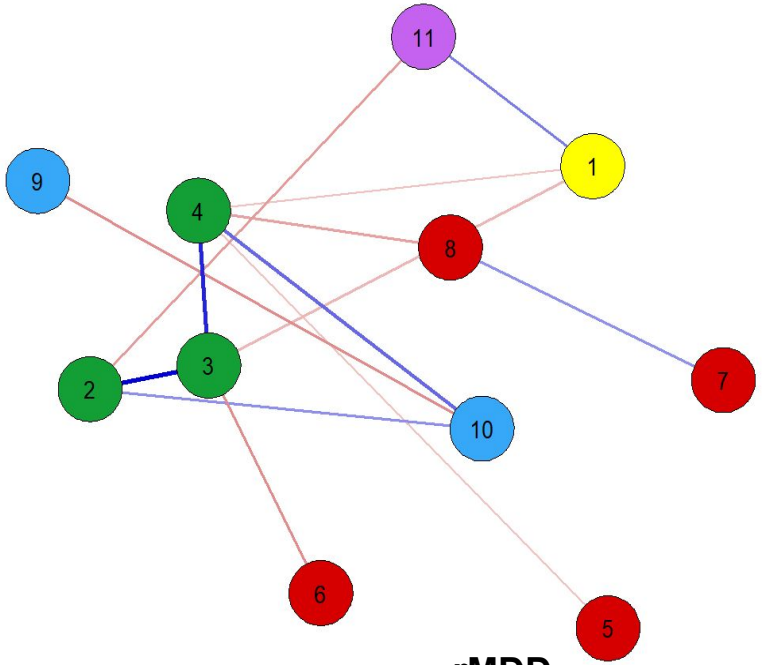


PA and NA clusters have significant influence in the network

Stability Analysis*

Strength:	9/11 nodes
Weight:	13/25 edges
PA Strength:	**1.00**
NA Strength:	**1.00**
Global Strength:	

* alpha = 0.025

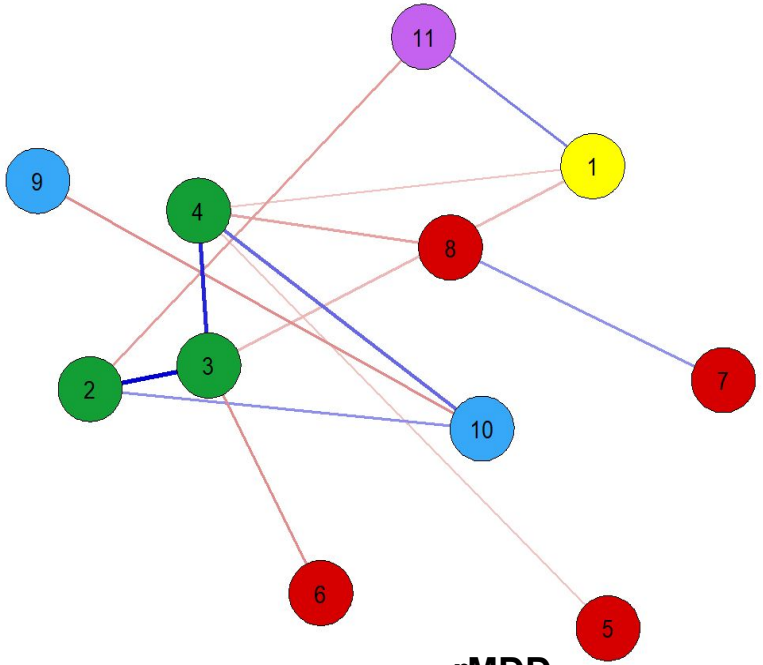


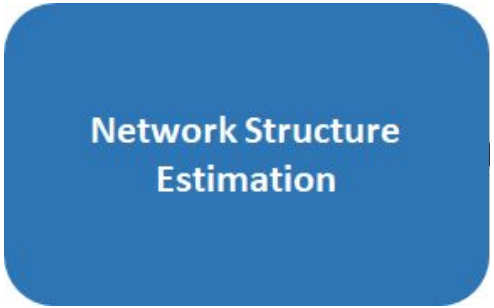
PA and NA clusters have significant influence in the network

Stability Analysis*

Strength:	9/11 nodes
Weight:	13/25 edges
PA Strength:	1.00
NA Strength:	1.00
Global Strength:	**3.08**

* alpha = 0.025





- Node Selection
- Edge Selection

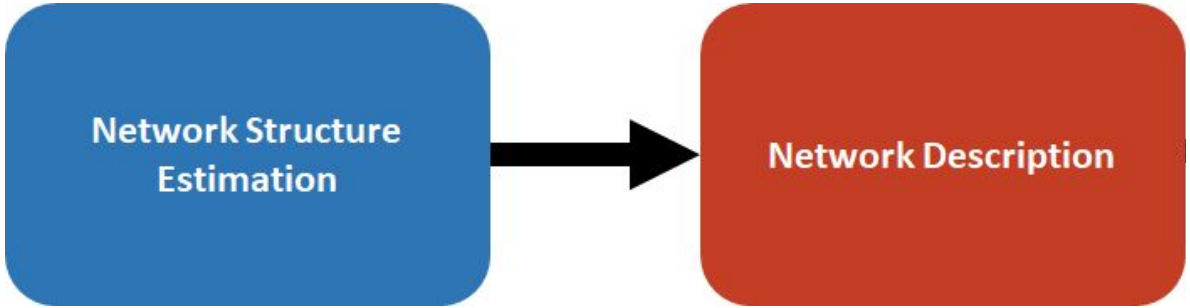
Network Structure Estimation

- Node Selection → primarily substantive considerations
- Edge Selection

Network Structure Estimation

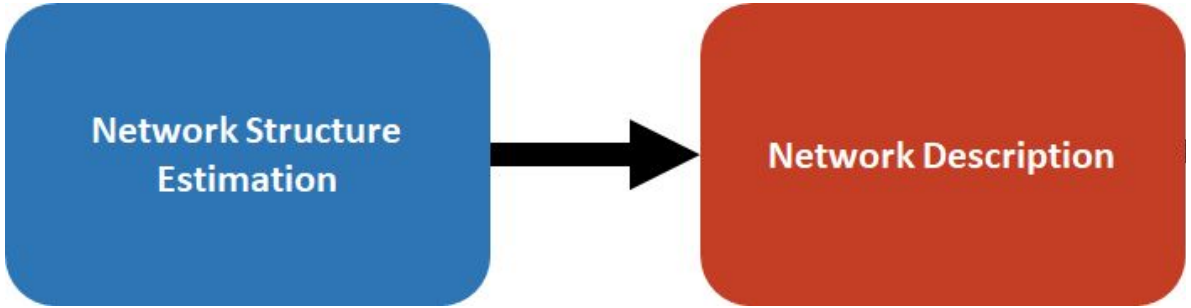
- Node Selection → primarily substantive considerations
- Edge Selection → multi-level Vector Autoregression

(mlVAR, Epskamp et al, 2018)



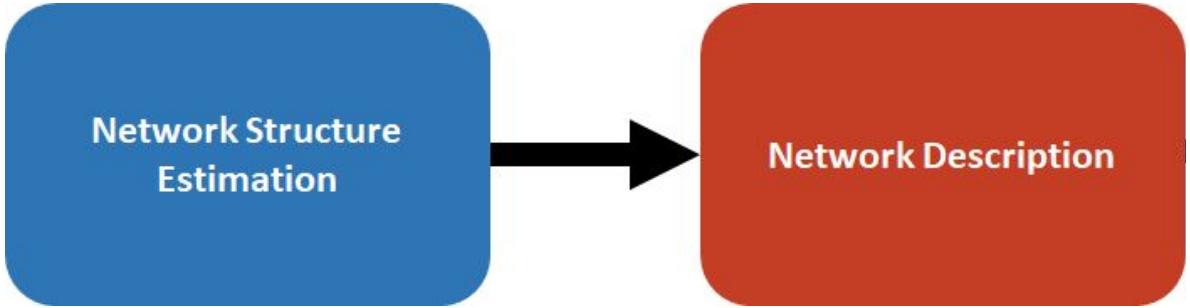
- Node Selection
- Edge Selection

- Node Centrality
- Network Topology
- Network Comparison



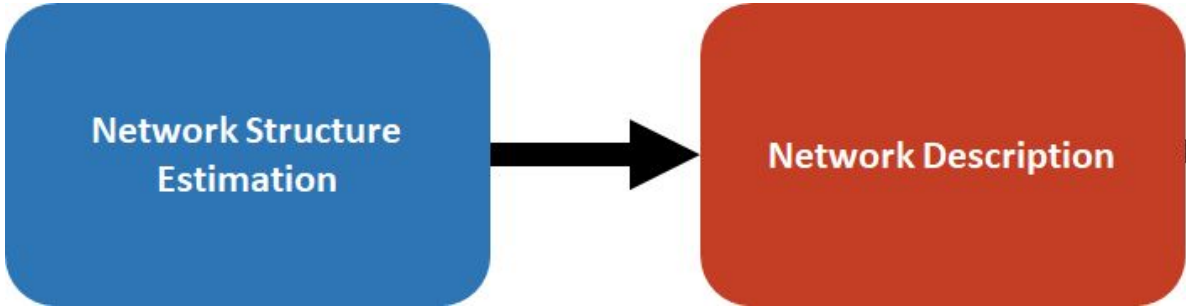
- Node Selection
- Edge Selection

- Node Centrality → Strength
- Network Topology
- Network Comparison



- Node Selection
- Edge Selection

- Node Centrality → Strength
- Network Topology → Edge Weight/Global Strength
- Network Comparison



- Node Selection
- Edge Selection

- Node Centrality → Strength
- Network Topology → Edge Weight/Global Strength
- Network Comparison → Difference Scores

- Node Selection
- Edge Selection

- Node Centrality
- Network Topology
- Network Comparison

- Node Centrality
- Network Topology
- Network Comparison

Adapted from Borsboom et al., 2021

Main Analytical Tools

- Generalized Additive Mixed Modeling (GAMM)
  - Allows separating within- and between-subject effects
  - Can capture nonlinear relationships

- Multi-level Vector Autoregression (mlVAR, Epskamp et al, 2018)
  - Temporal relationships
  - Contemporaneous relationships

Group effects

- rMDD group reported more rumination, t(1197.708)=-7.78, p<.001; small effect (d=0.45)
- rMDD group reported more negative affect, t(1169.376)=-7.97, p<.001; small effect (d=0.47)
- No significance difference in positive affect was found, t(1147.329)=0.053, p=0.958

Intervention effects

- In the fantasizing condition more rumination was reported, $t(1048.06)=4.024$, $p<.001$; small effect ($d=0.25$)

- In the fantasizing condition greater positive affect was reported, $t(1169.376)=5.415$, $p<.001$; small effect ($d=0.33$)

Baseline Network Comparison

	Controls		remitted	
	Contemp	**Temporal**	**Contemp**	**Temporal**
Global Strength	3.26	0.87	3.08	1.41
PA Strength	1.50	0.52	1.51	0.28
NA Strength	**1.32**	0.08	0.49	0.28