

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

Clemens Kaiser, s4460065

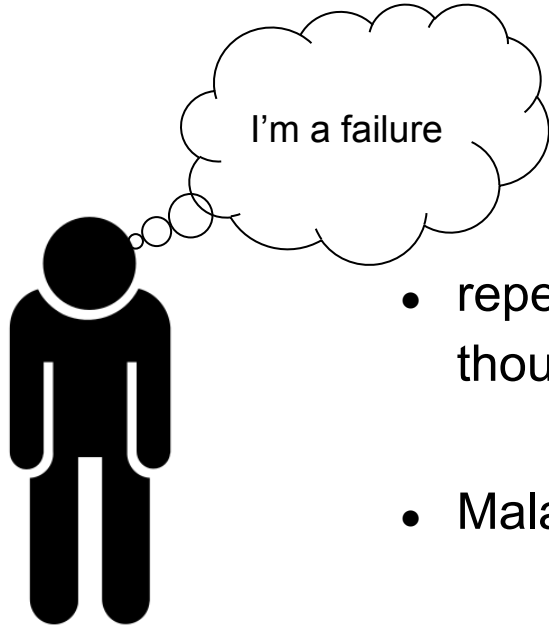
Supervisors: Marieke van Vugt
 Marlijn Besten

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)

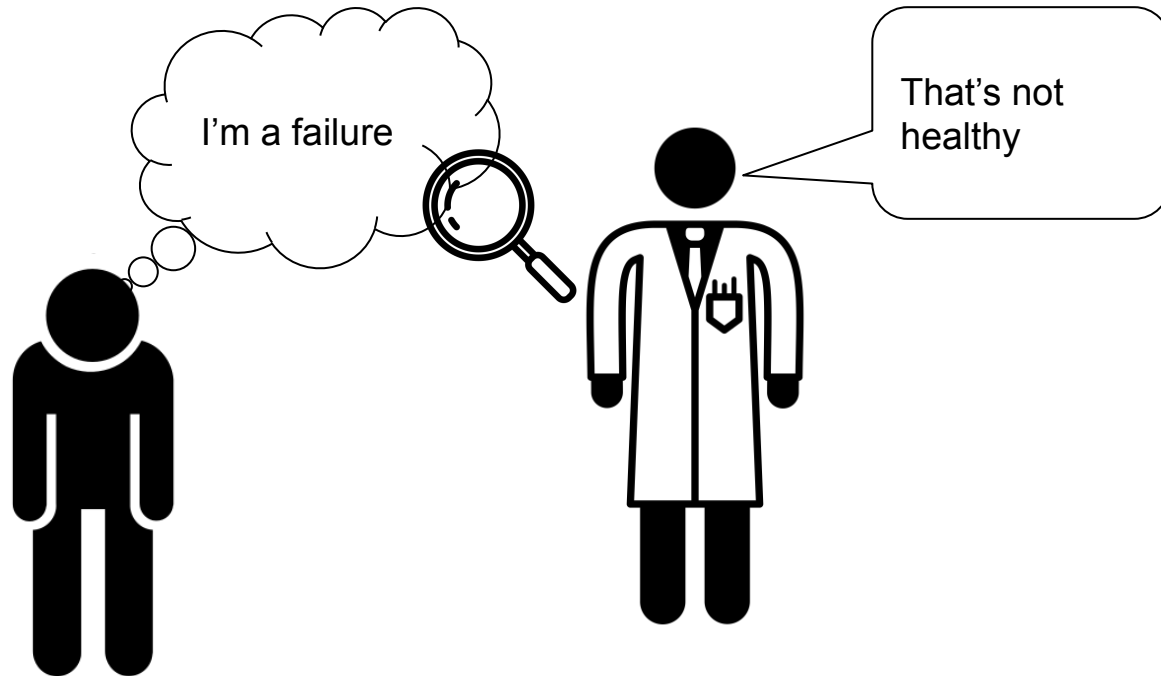


... and **rumination** plays a central role in it



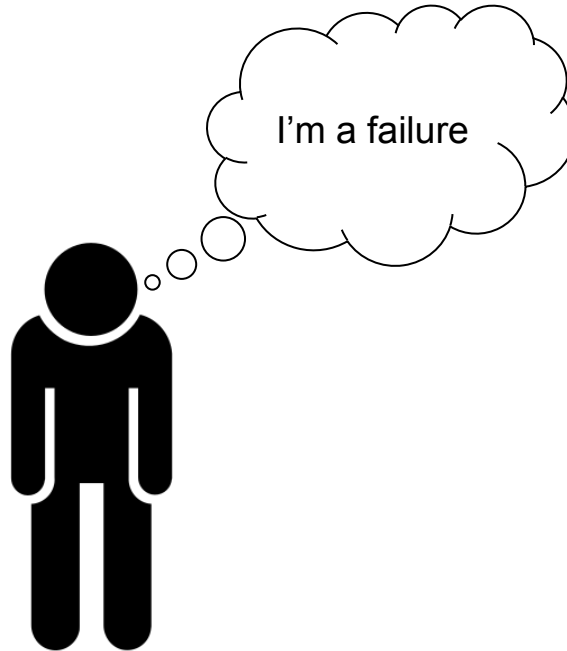
- repetitive, uncontrolled stream of negatively-valenced thoughts and memories that follow a common theme
- Maladaptive form of self-reflection

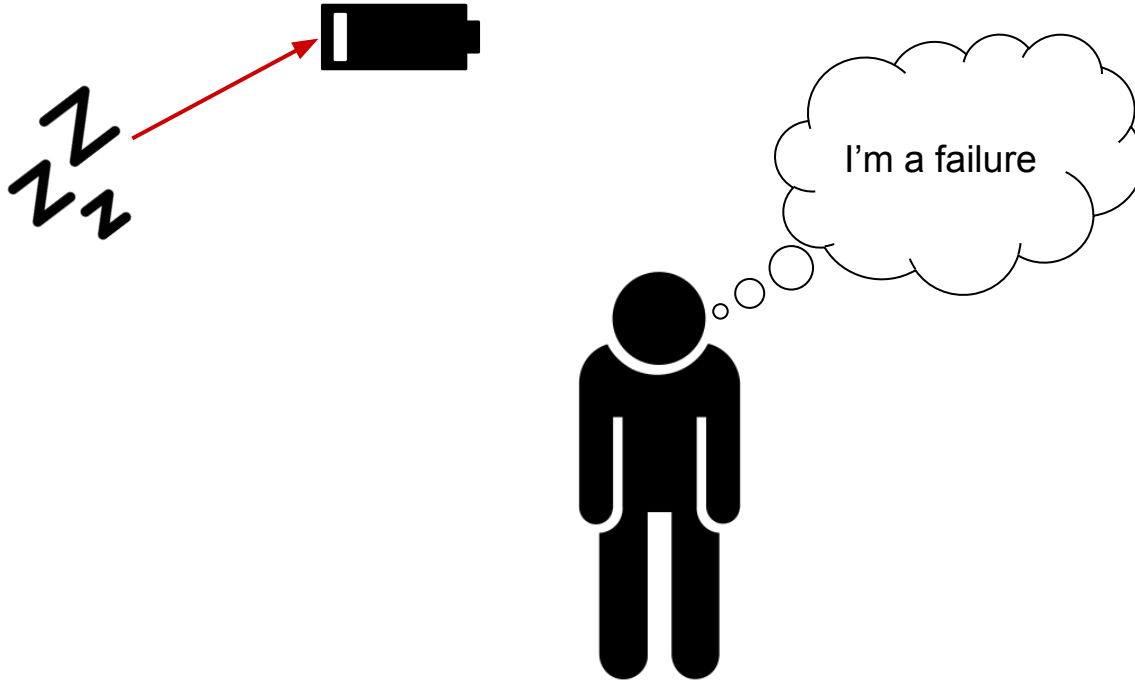
So, we need to investigate rumination!

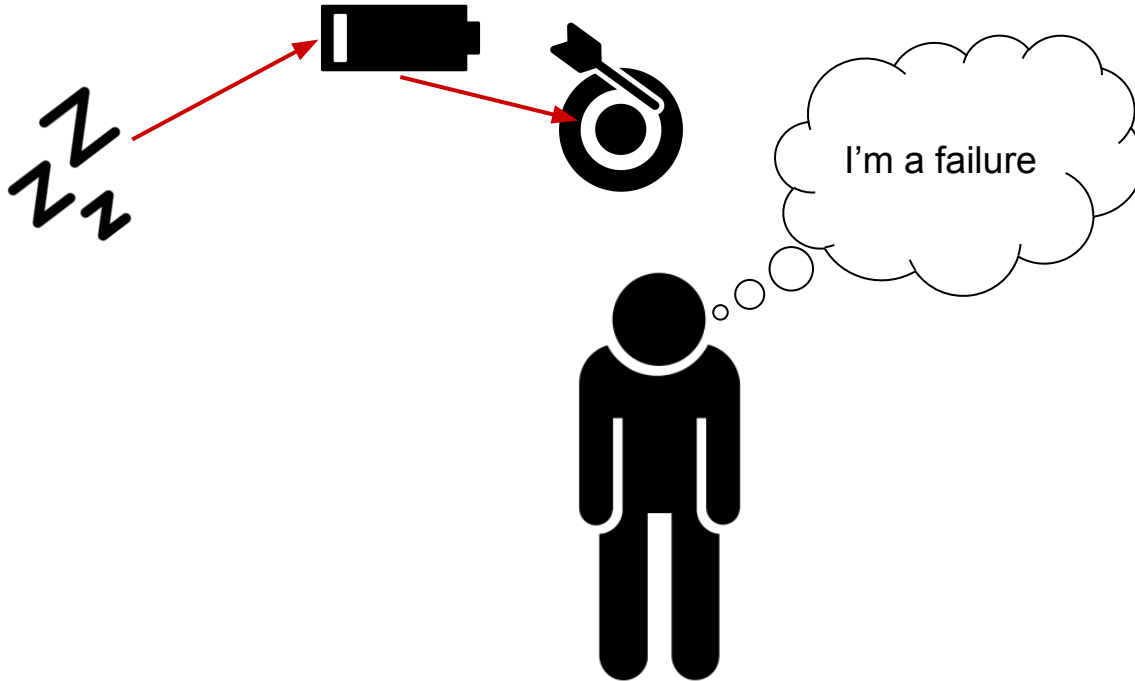


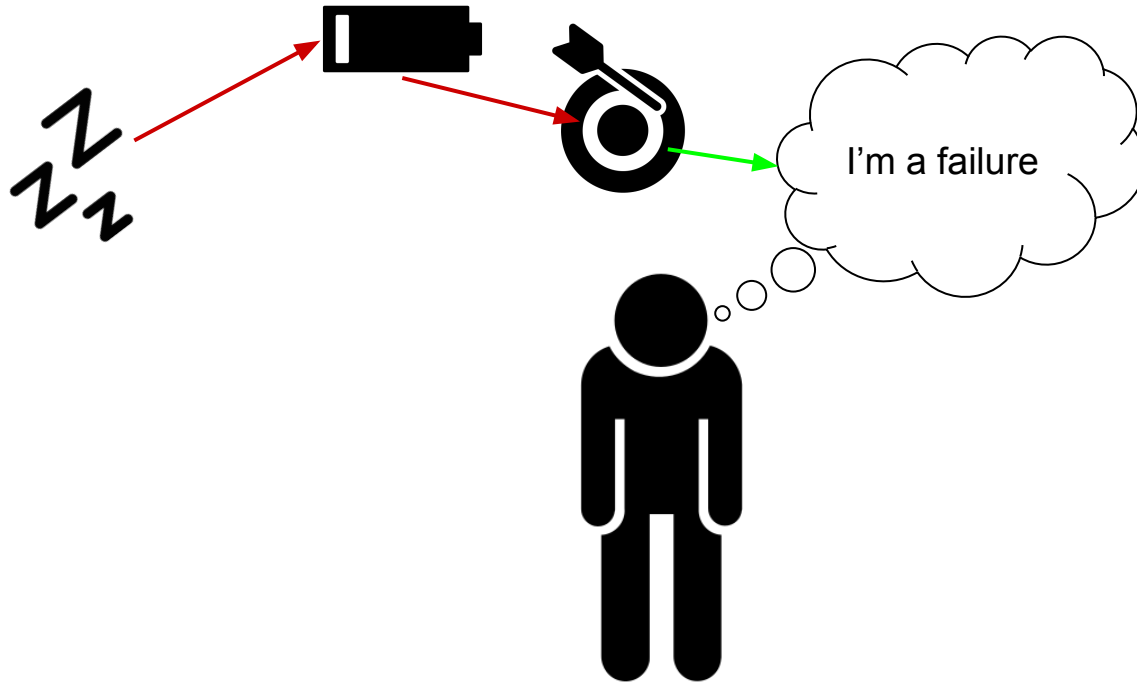
But... what if we're missing something?

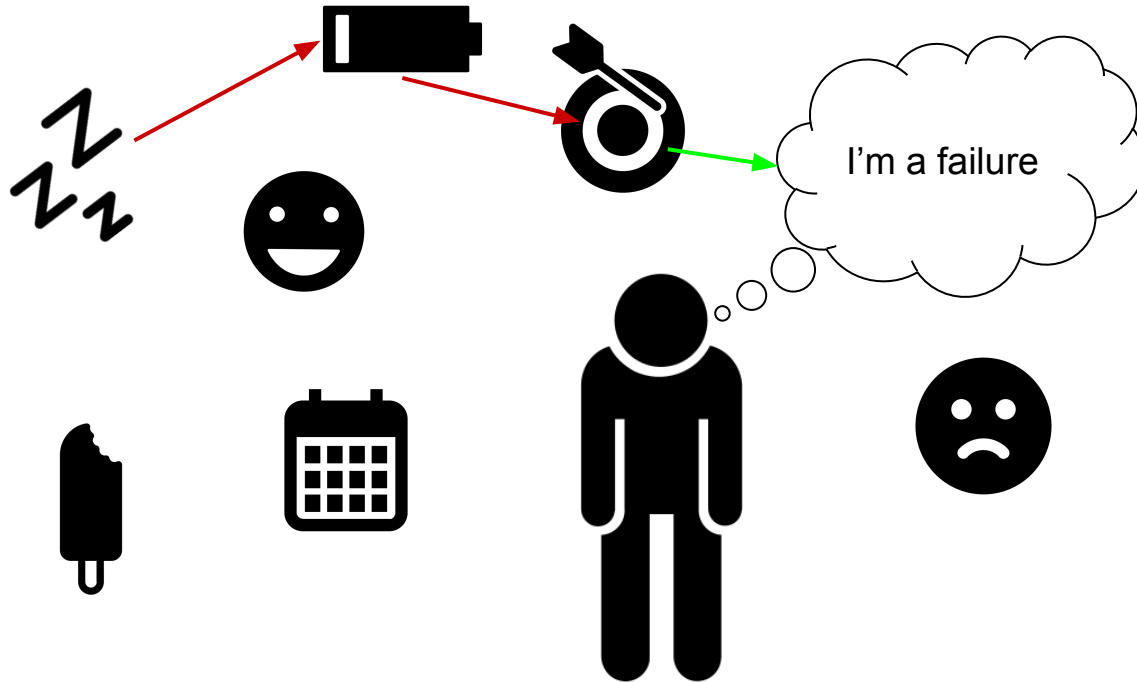


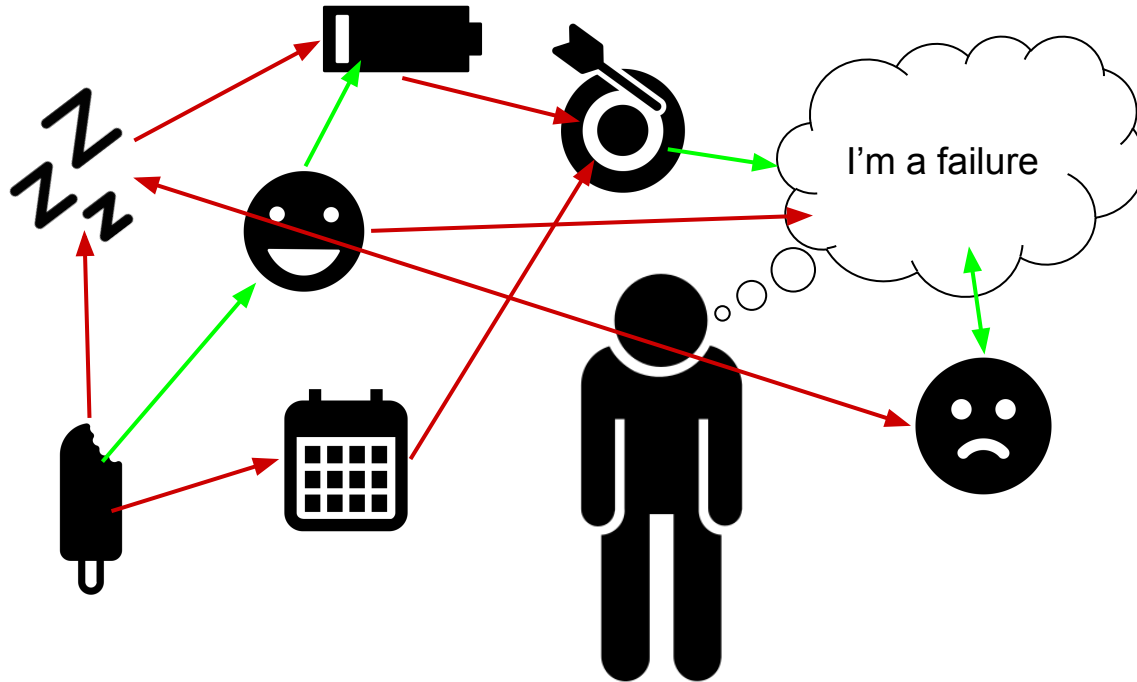




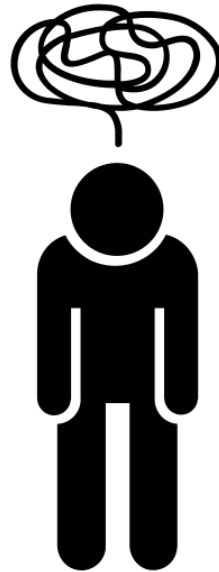






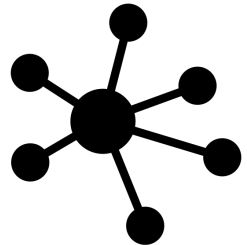


Maybe we cannot look at just one factor in isolation



Network analysis aims to explore systems holistically

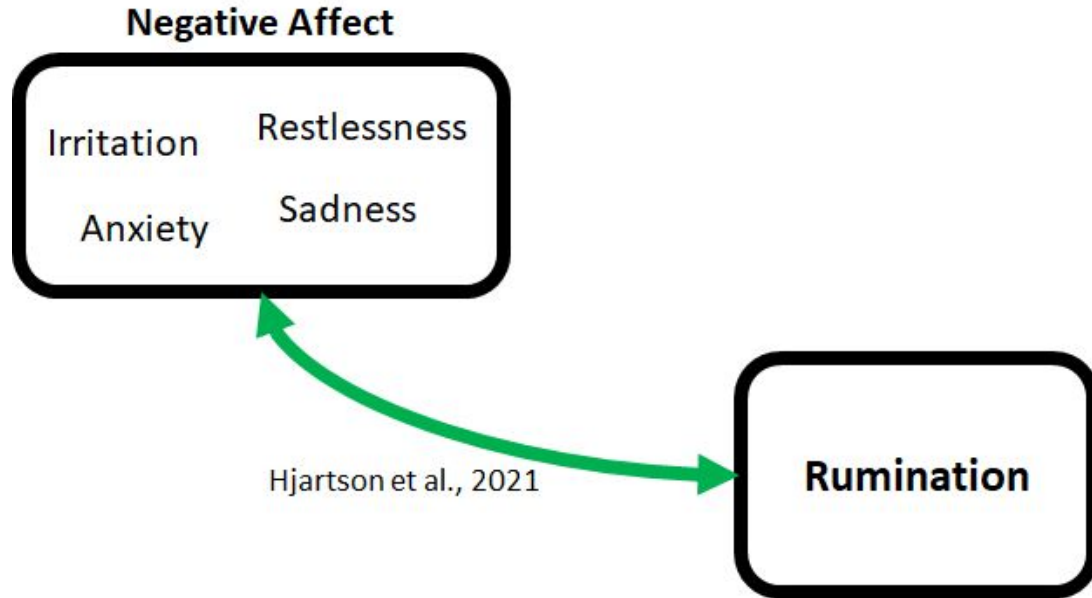
- Analytical framework to *explore* interdependent interactions of multiple entities as one integrated system.
- In psychopathology: a reaction to perceived shortcomings of current diagnostic approach (see Borsboom & Cramer, 2013)

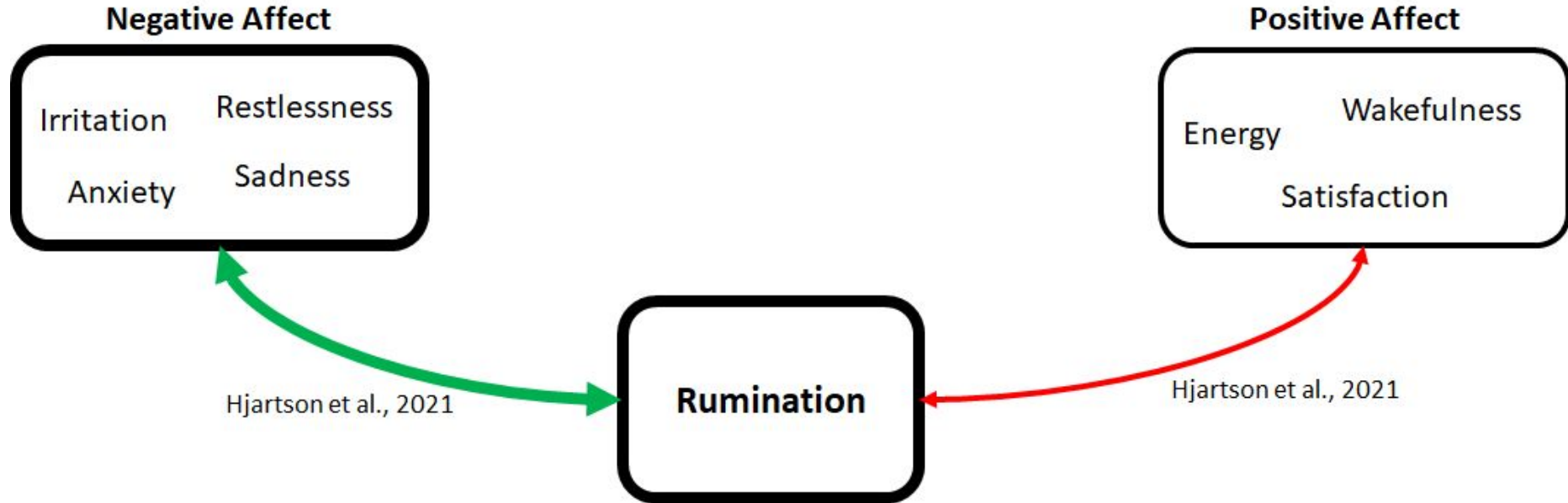


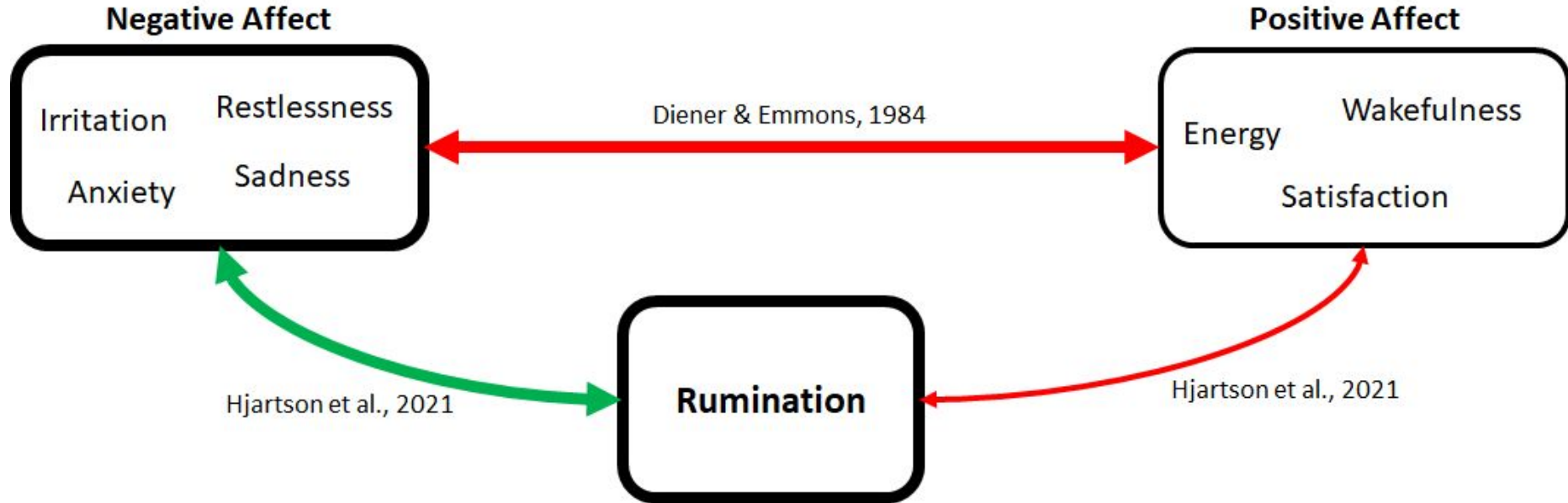
Research Question 1

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?

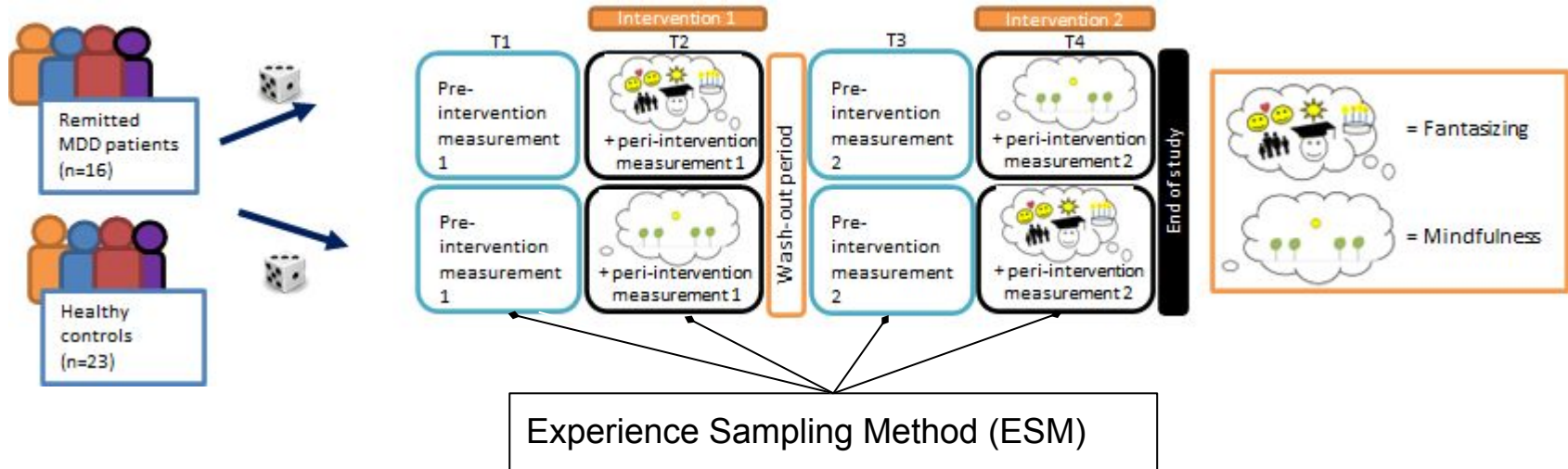
Rumination








Data Collection



Network analysis consists of three stages

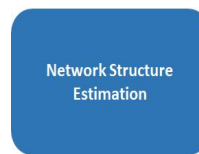


```
graph LR; A[Network Structure Estimation] --> B[Network Description]; B --> C[Stability Analysis];
```

Network Structure
Estimation

Network Description

Stability Analysis



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

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Events

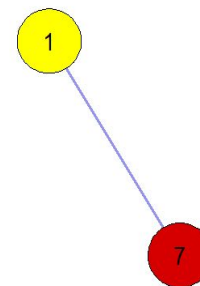
- 9: EventUnpleasantness
- 10: EventPleasantness

Other

- 11: Distraction



Relationships between nodes are represented by **edges**

**Rumination**

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PositiveAffect

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- 4: Satisfaction

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Events

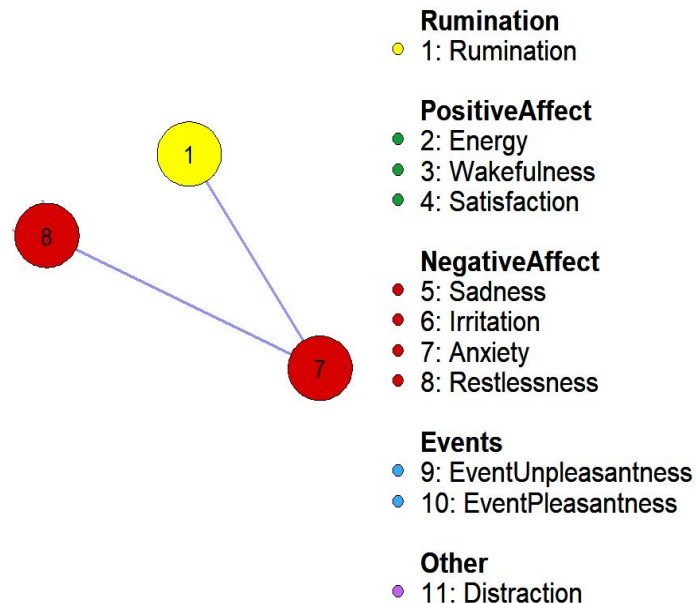
- 9: EventUnpleasantness
- 10: EventPleasantness

Other

- 11: Distraction

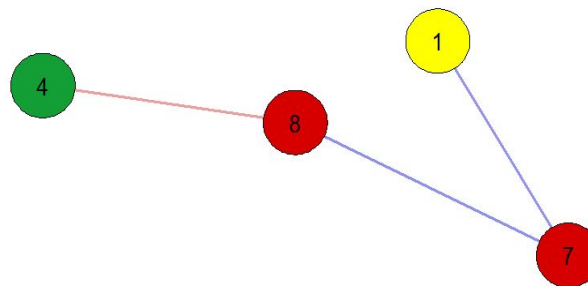


These relationships can be **positive**...





... or negative

**Rumination**

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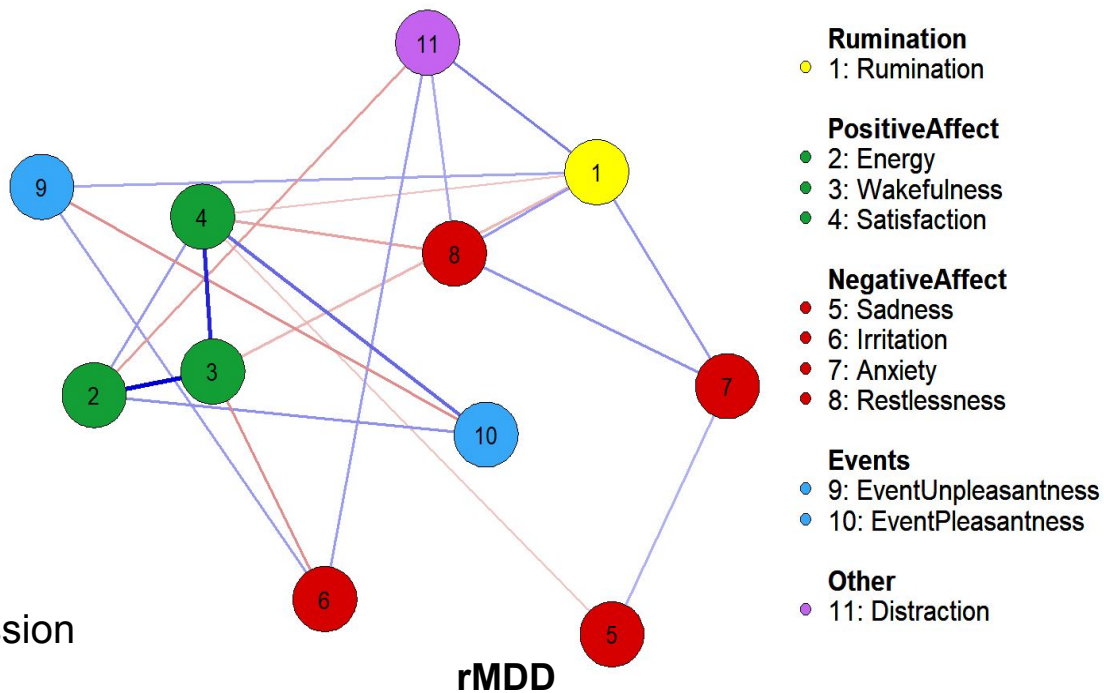
- 9: EventUnpleasantness
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We estimate all relationships and build the full network*

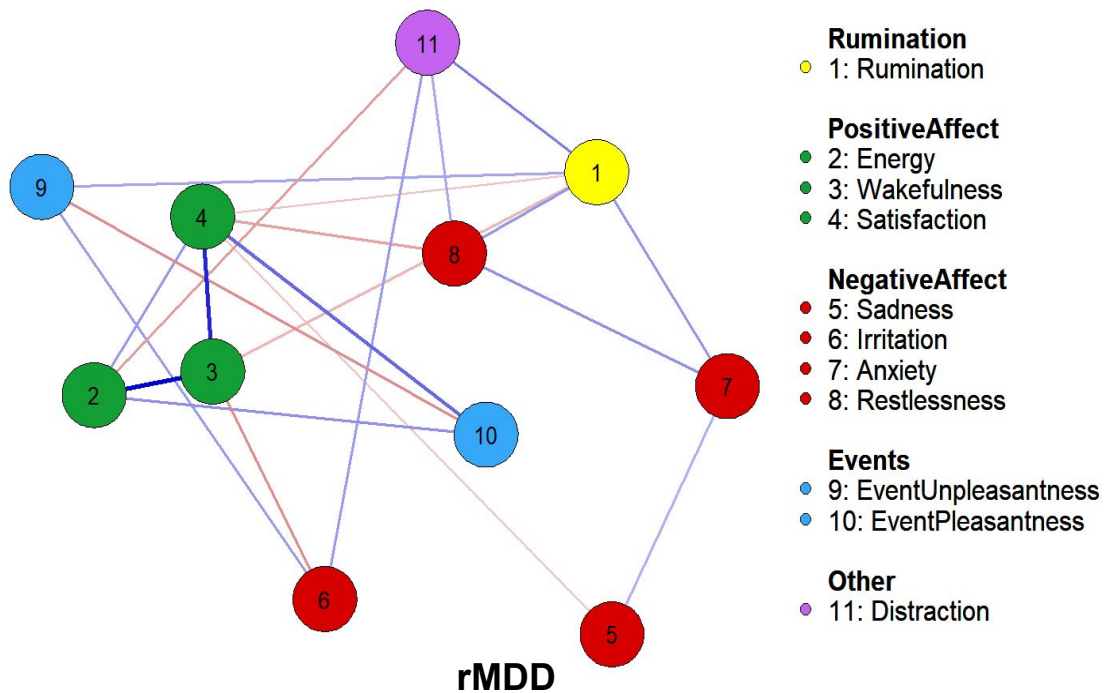


* We used Multi-Level Vector Autoregression (mIVAR, Epskamp et al, 2018)



Then we describe the network statistically

Network Statistics

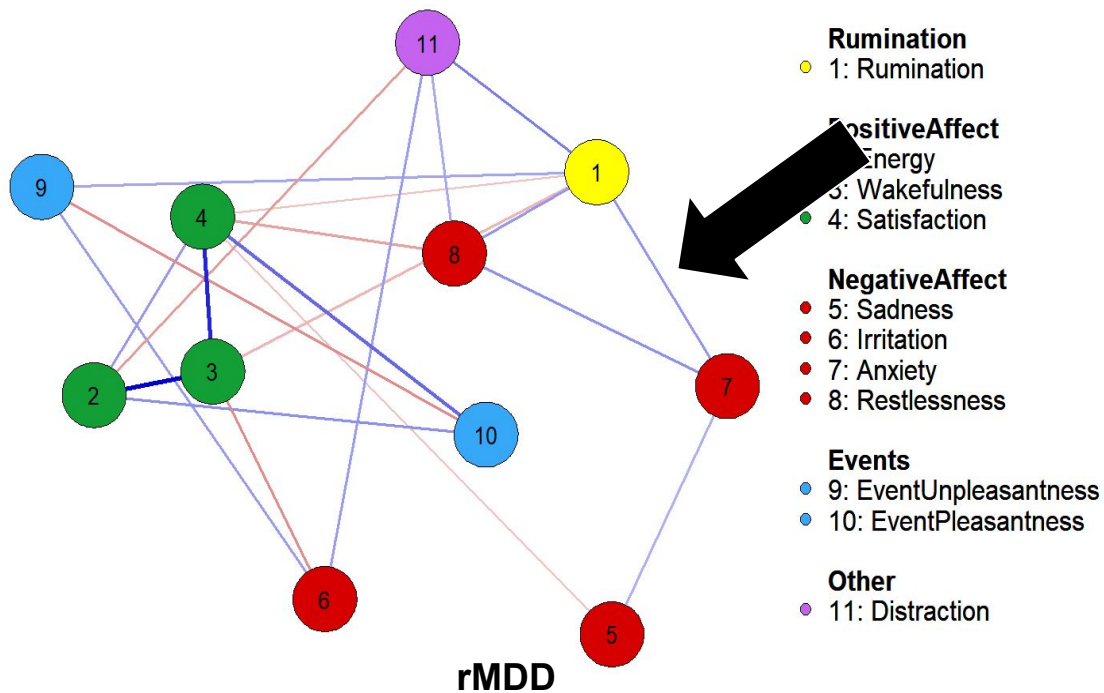




How strong is the relationship between rumination and anxiety?

Network Statistics

Edge Weights



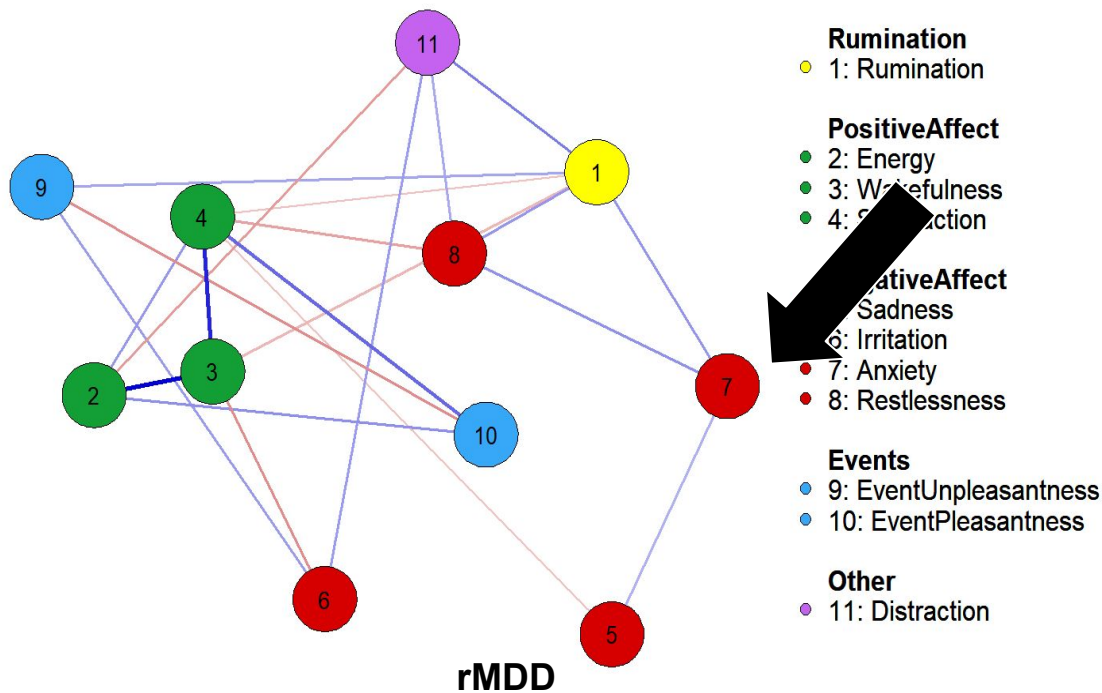


How much influence does rumination have on other variables?

Network Statistics

Edge Weights

Strength



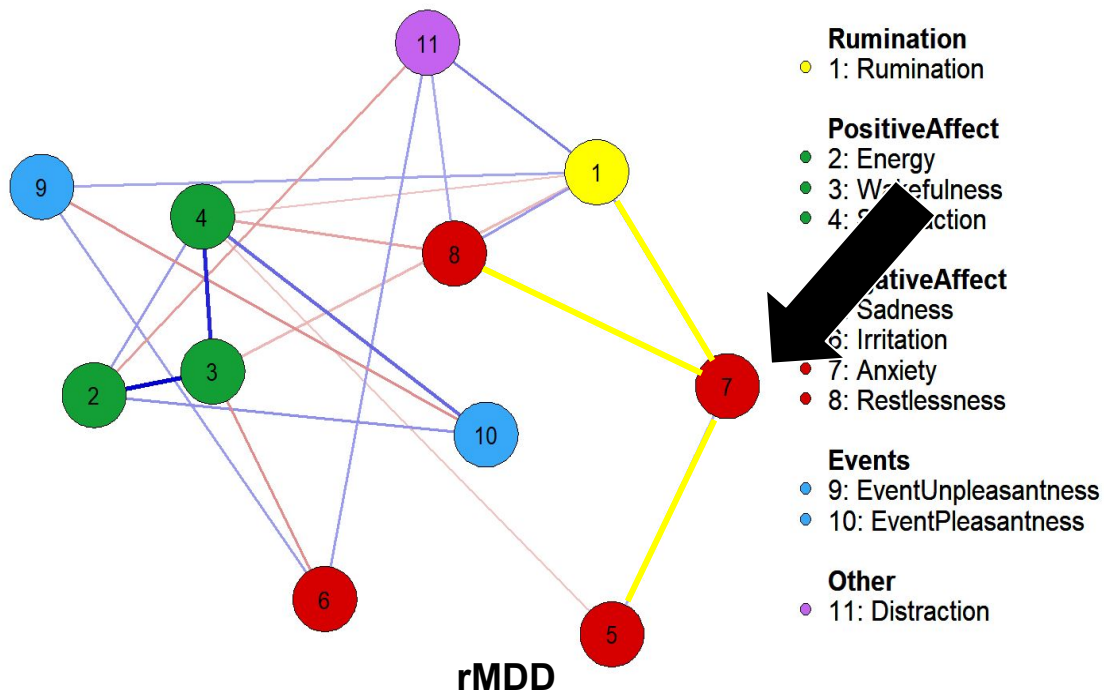


How much influence does rumination have on other variables?

Network Statistics

Edge Weights

Strength





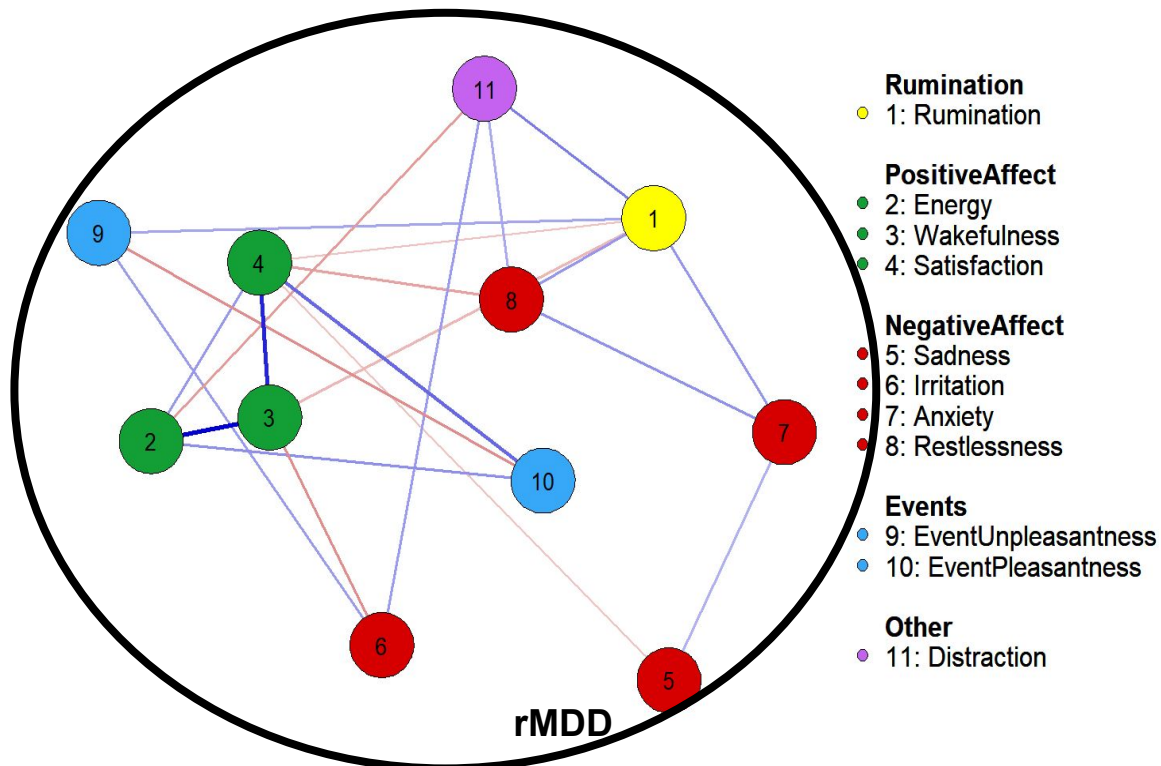
How densely connected is the network globally?

Network Statistics

Edge Weights

Strength

Global Strength





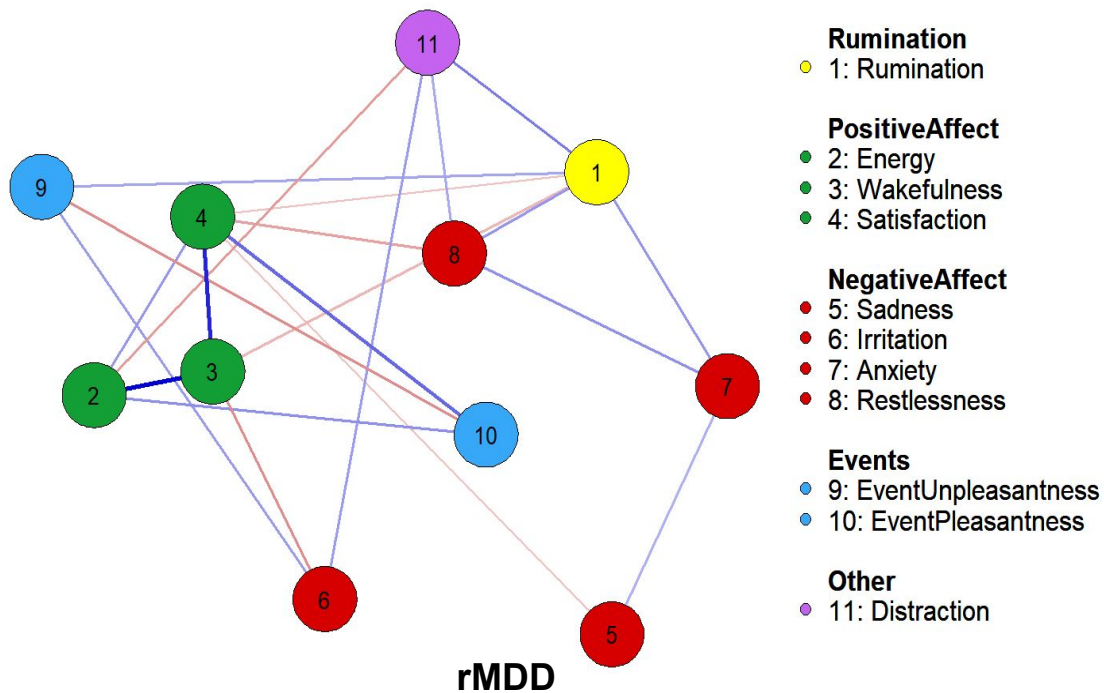
... but can we trust this network?

Network Statistics

Edge Weights

Strength

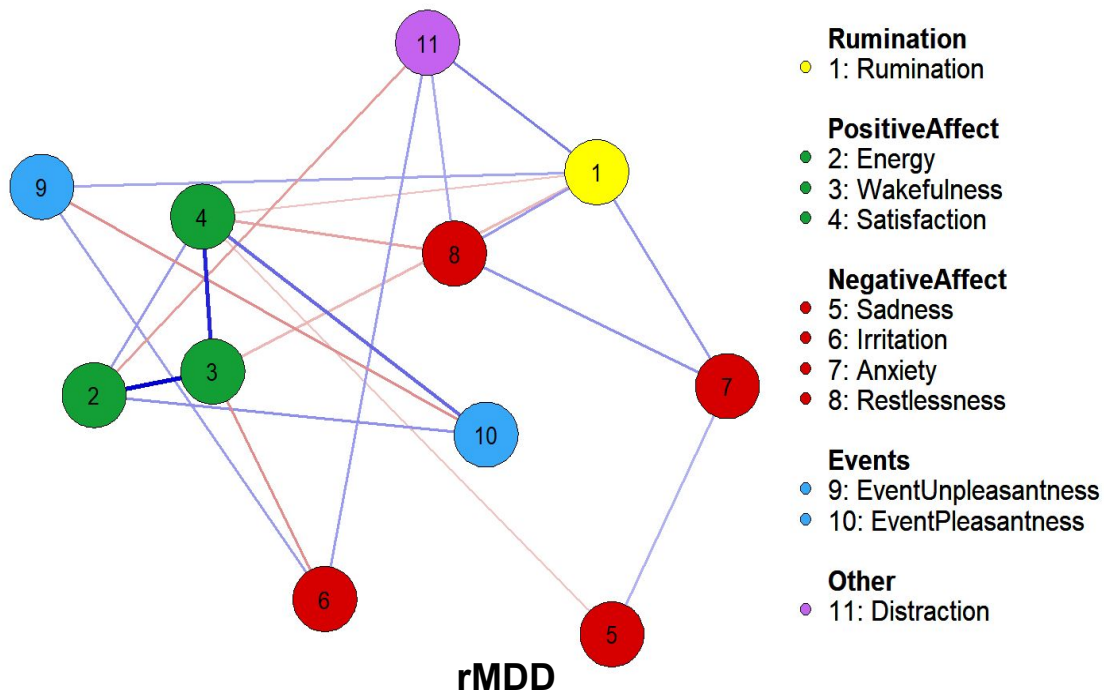
Global Strength





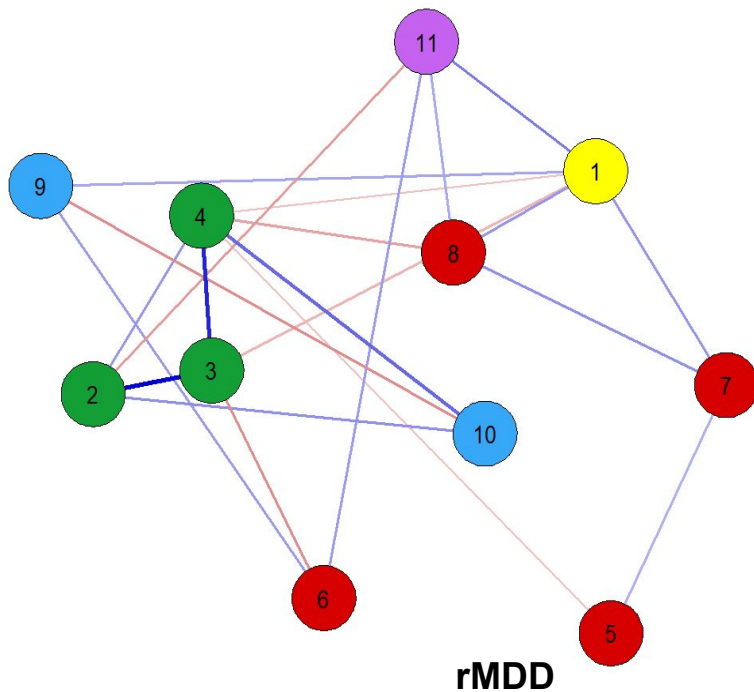
Using **permutations**, we can calculate p-values

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
s2	1	32	34	12	53
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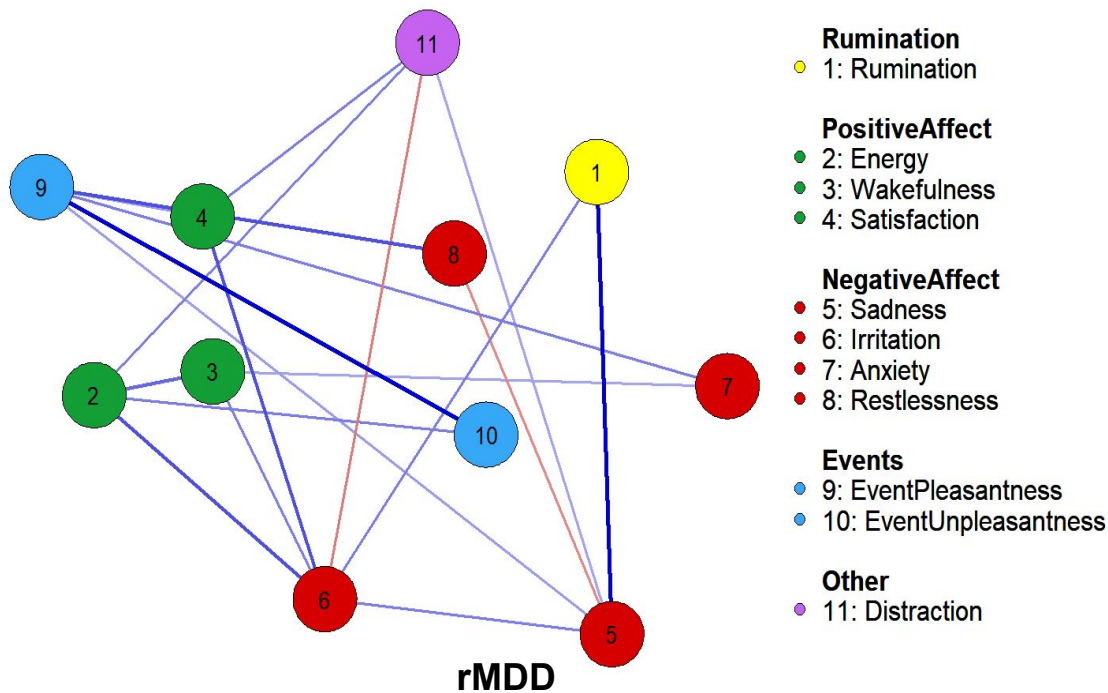
Other

- 11: Distraction



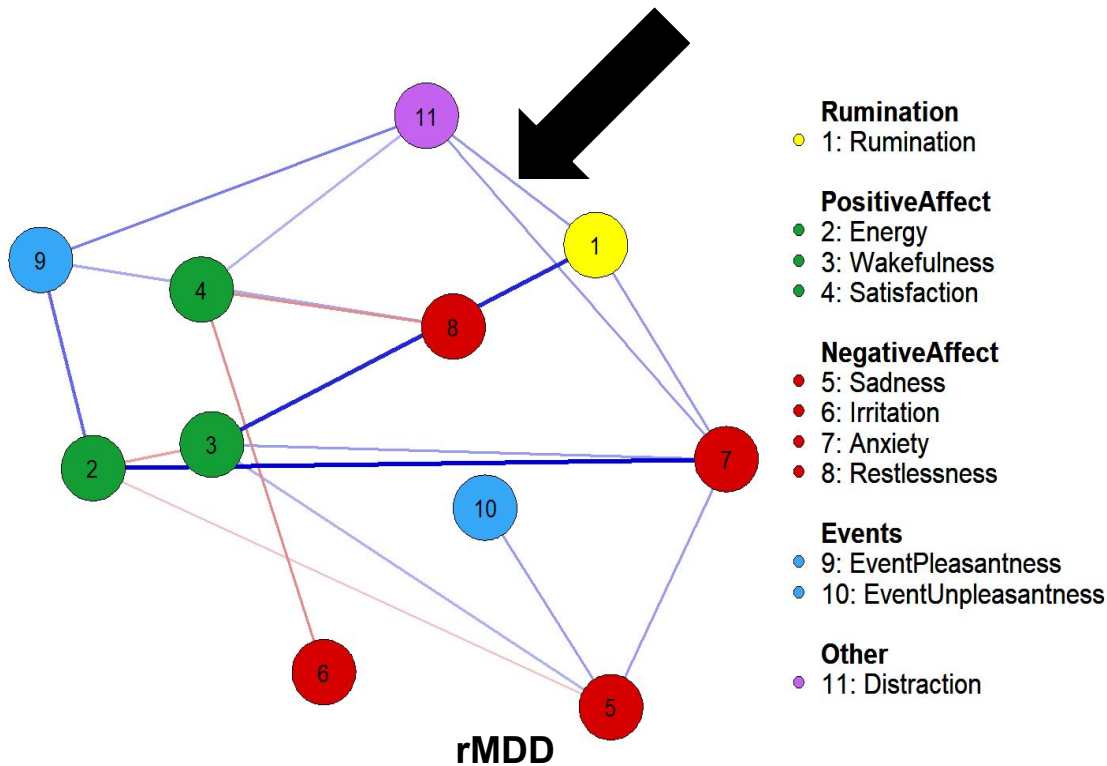
... estimate a new network and re-calculate all the statistics

Subject	Time	Anxiety	Satisfaction	Rumination	Sadness
s1	1	33	27	23	15
s1	2	12	74	67	20
s1	3	22	1	9	78
		Sadness	Rumination	Satisfaction	Anxiety
s2	1	32	34	12	53
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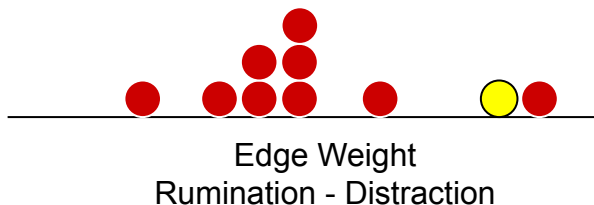
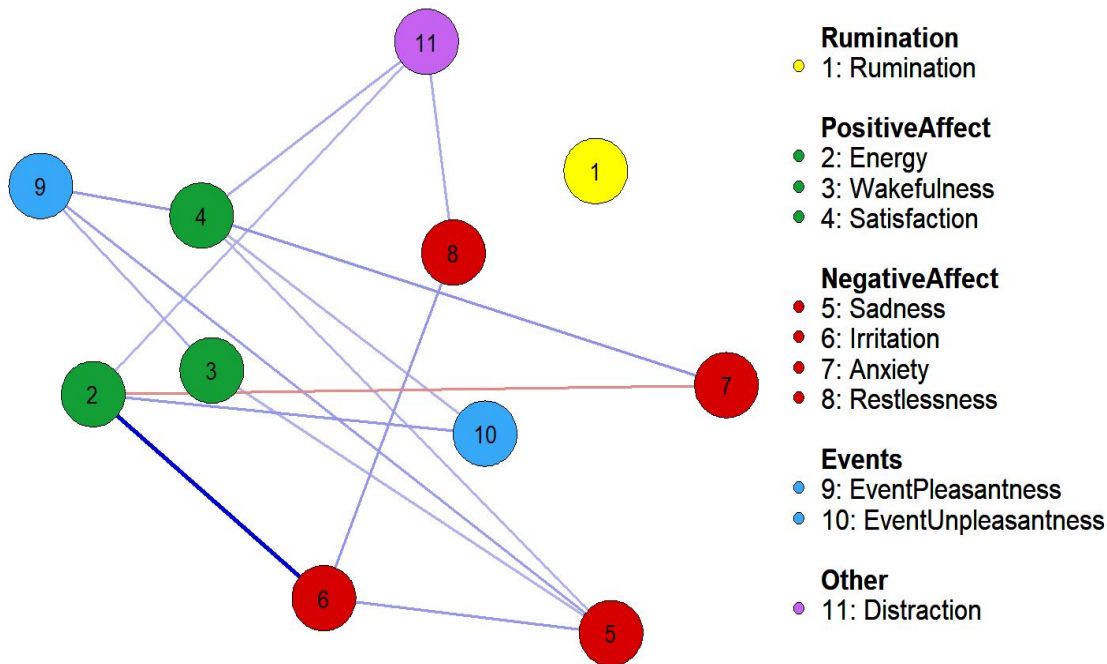
Repeating it 1000x...



Edge Weight
Rumination - Distraction

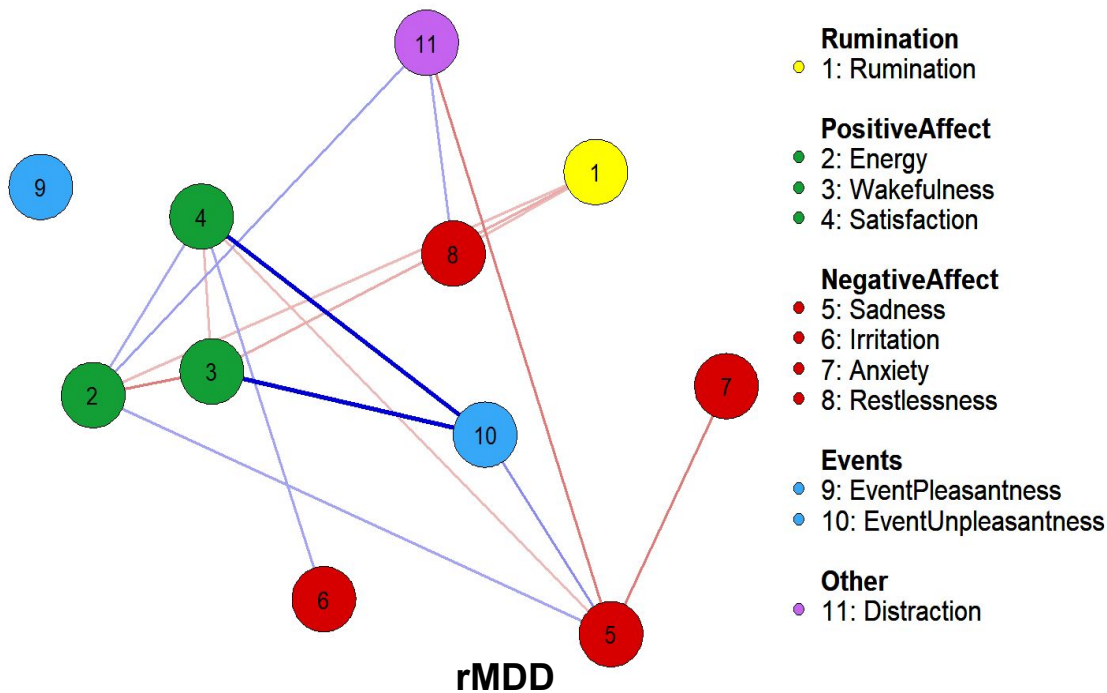
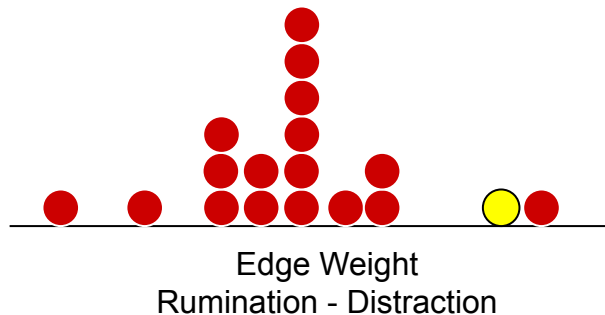


Repeating it 1000x...



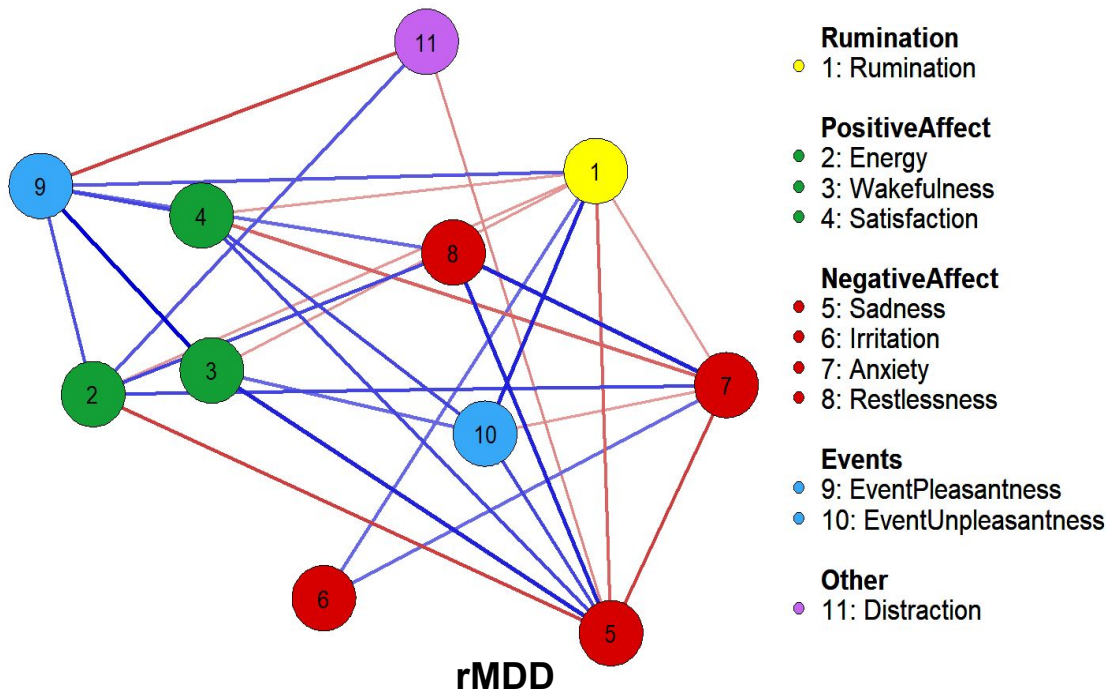
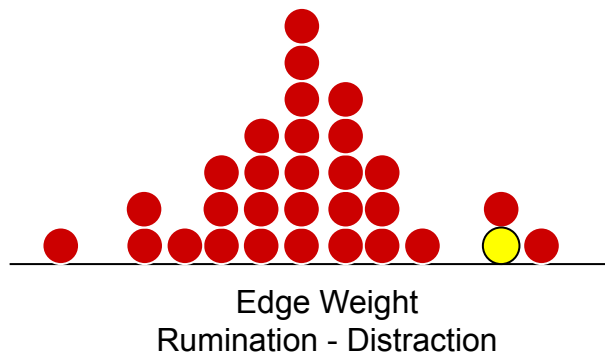


Repeating it 1000x...



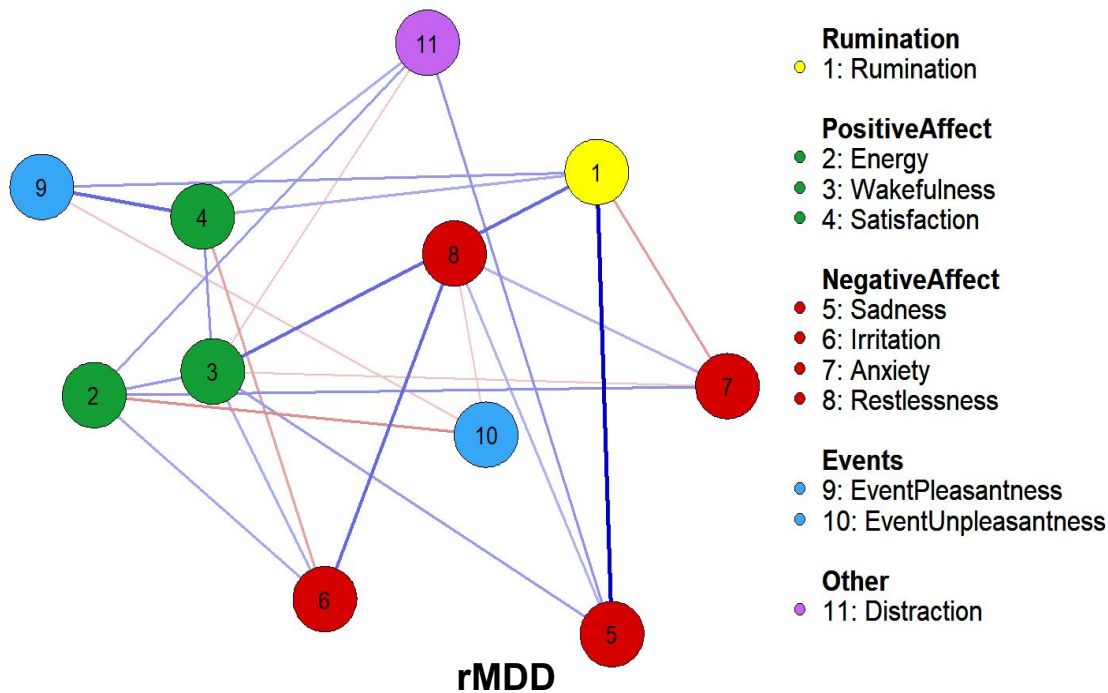
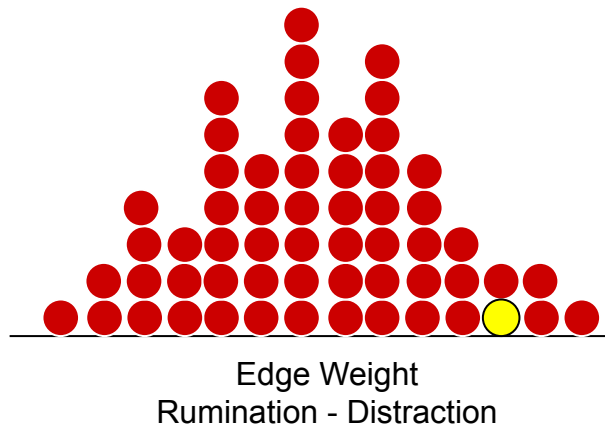


Repeating it 1000x...





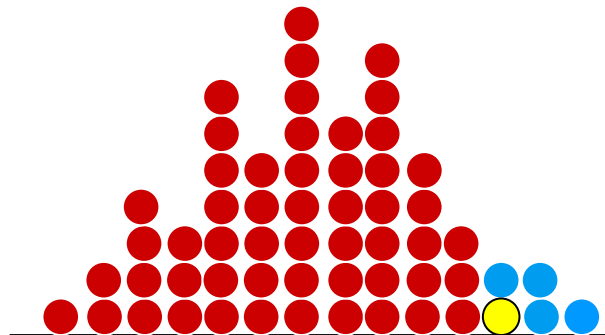
Repeating it 1000x, we **approximate** the relevant **distributions**



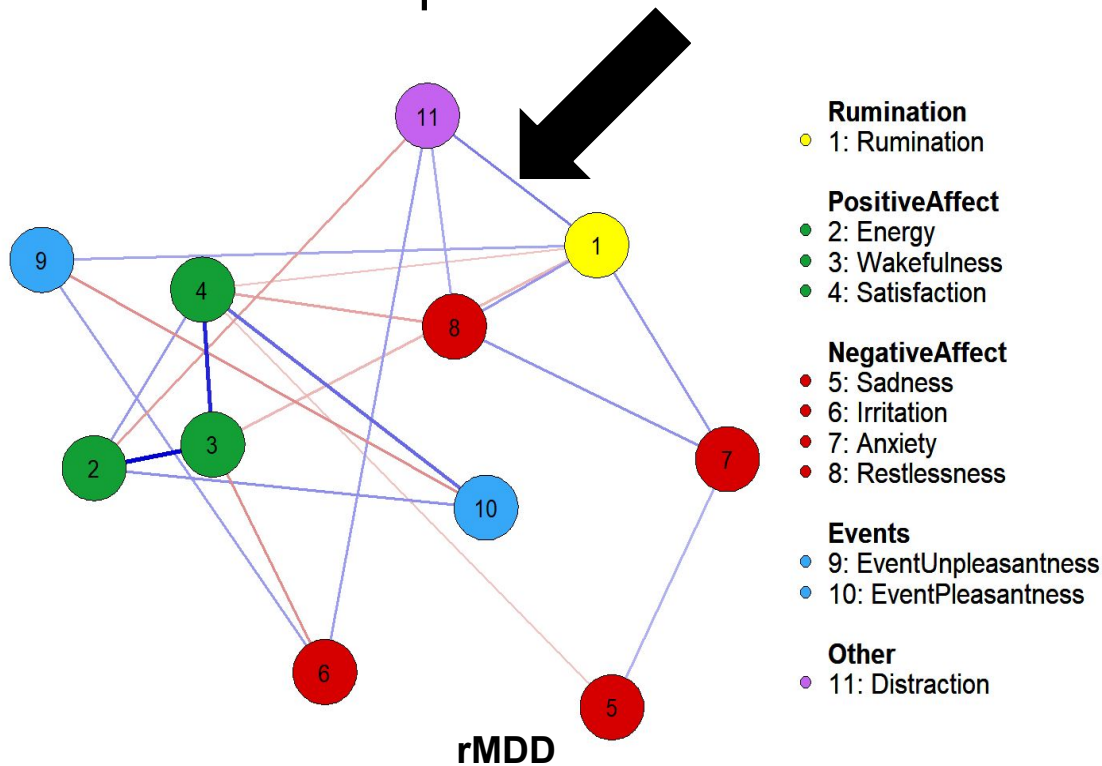


How many values are greater than or equal to the actual value?

Less than **2.5 %**

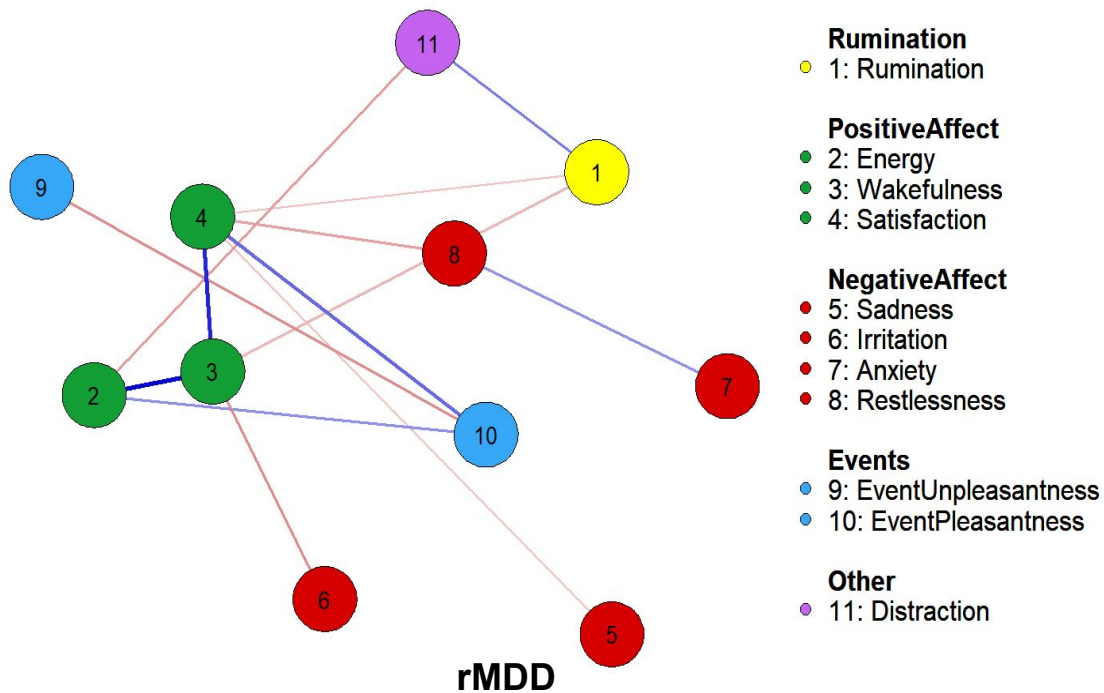


Edge Weight
Rumination - Distraction

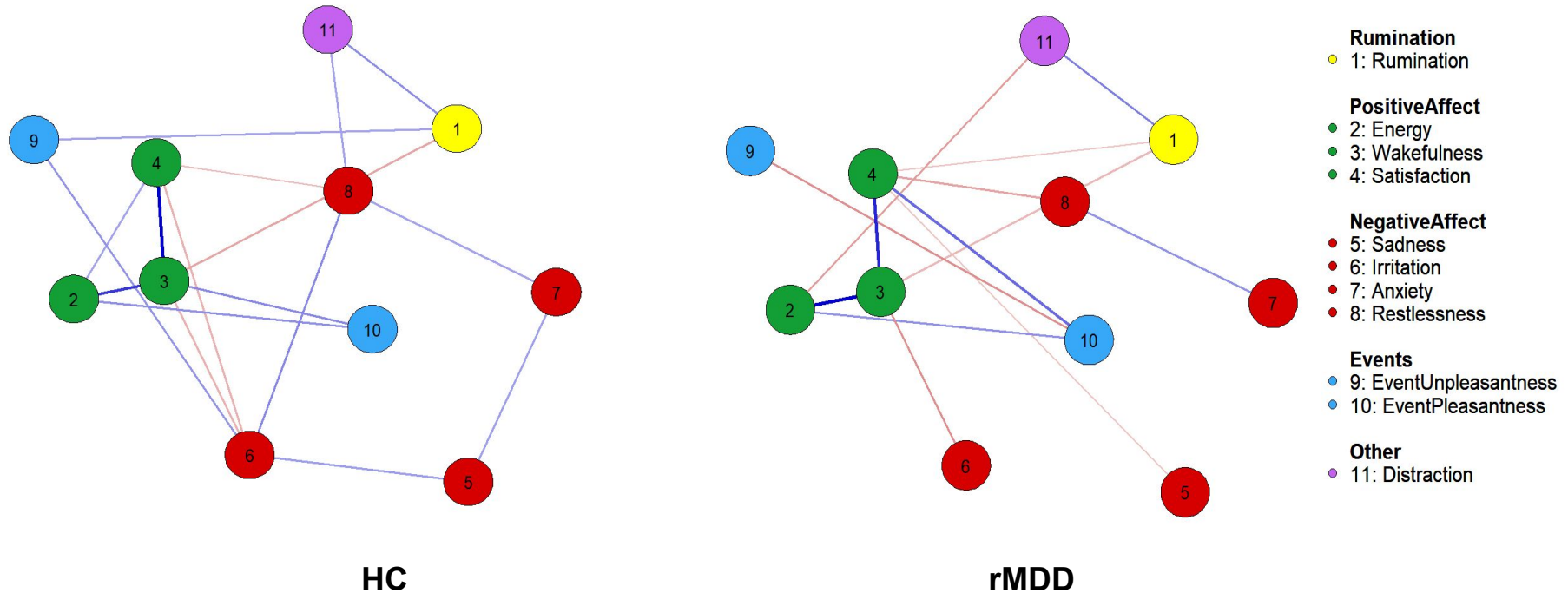




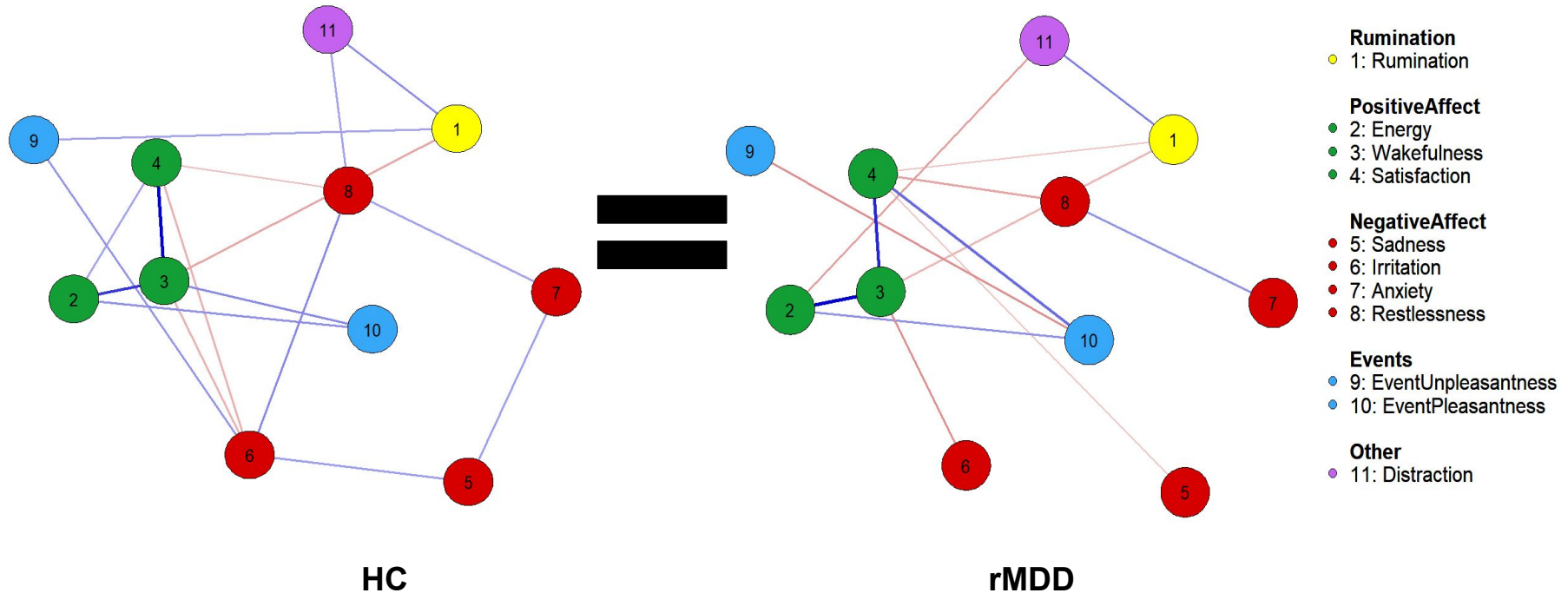
Some edges were not statistically significant



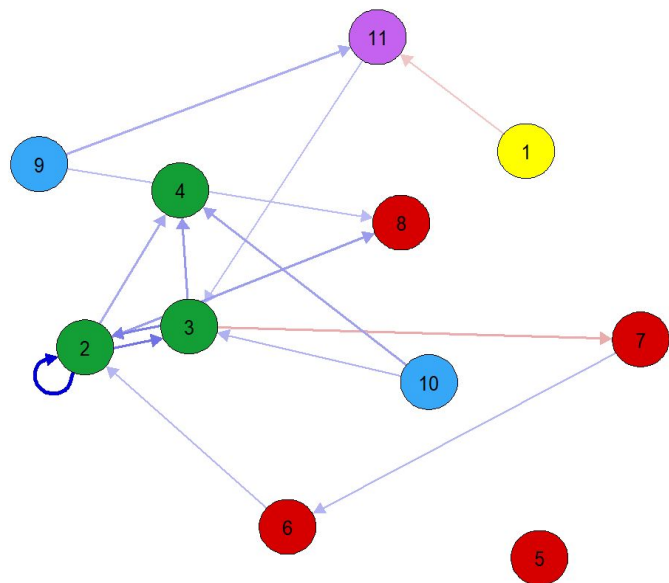
We can also apply permutations to compare two networks



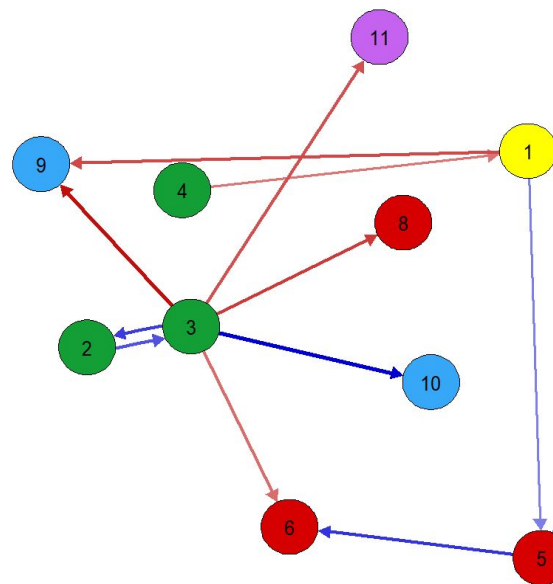
No statistically significant differences were found



How about the temporal relationships?



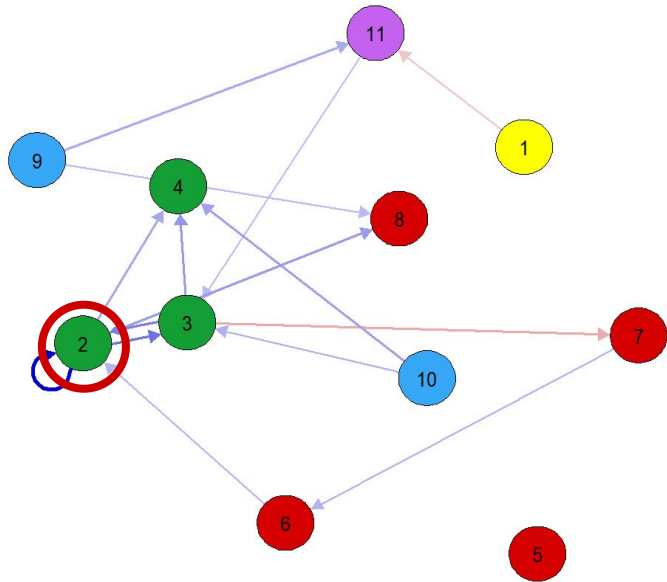
HC



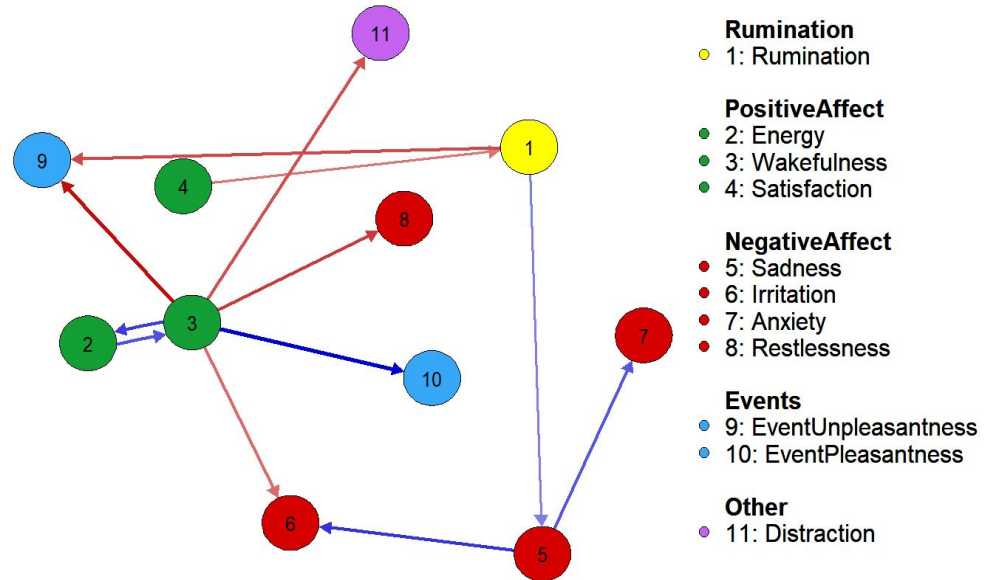
rMDD

- 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**
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Satisfaction is more severely influenced in the HC network ...



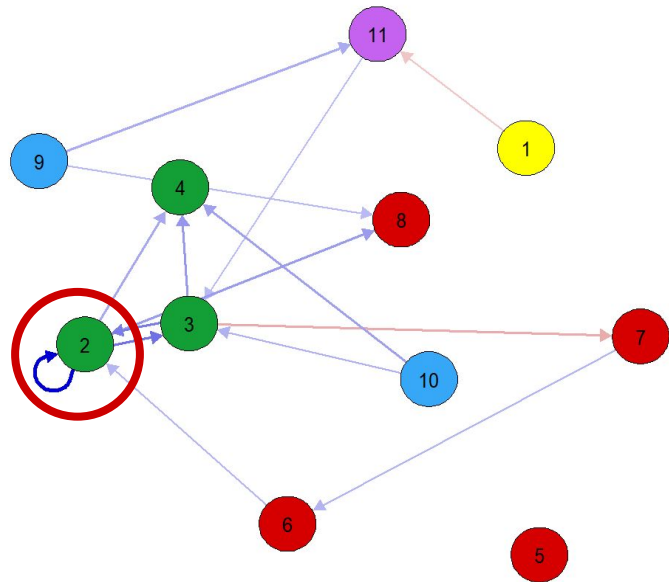
HC



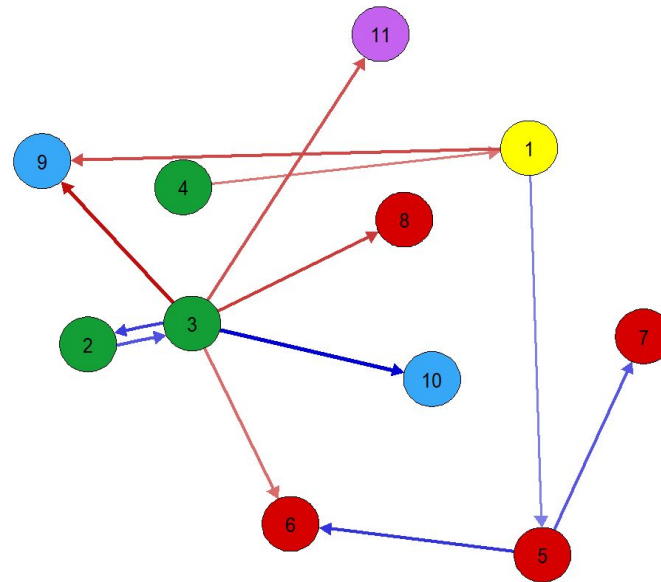
rMDD

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... and **reinforces itself** more strongly



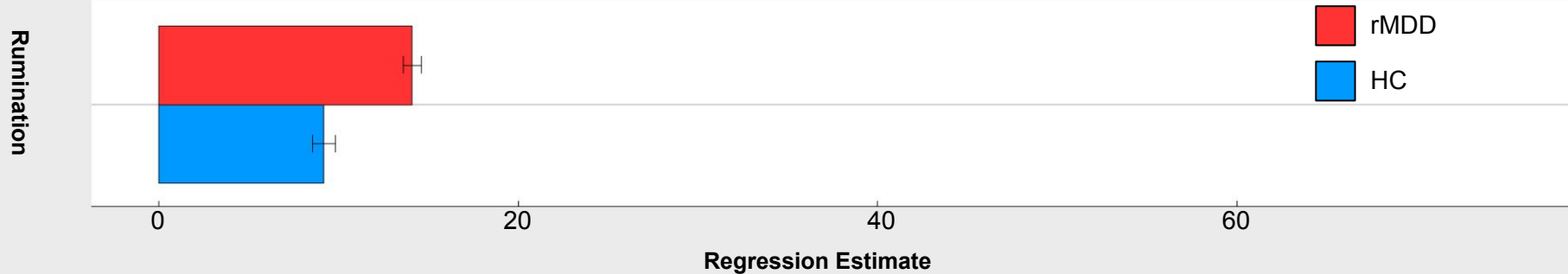
HC



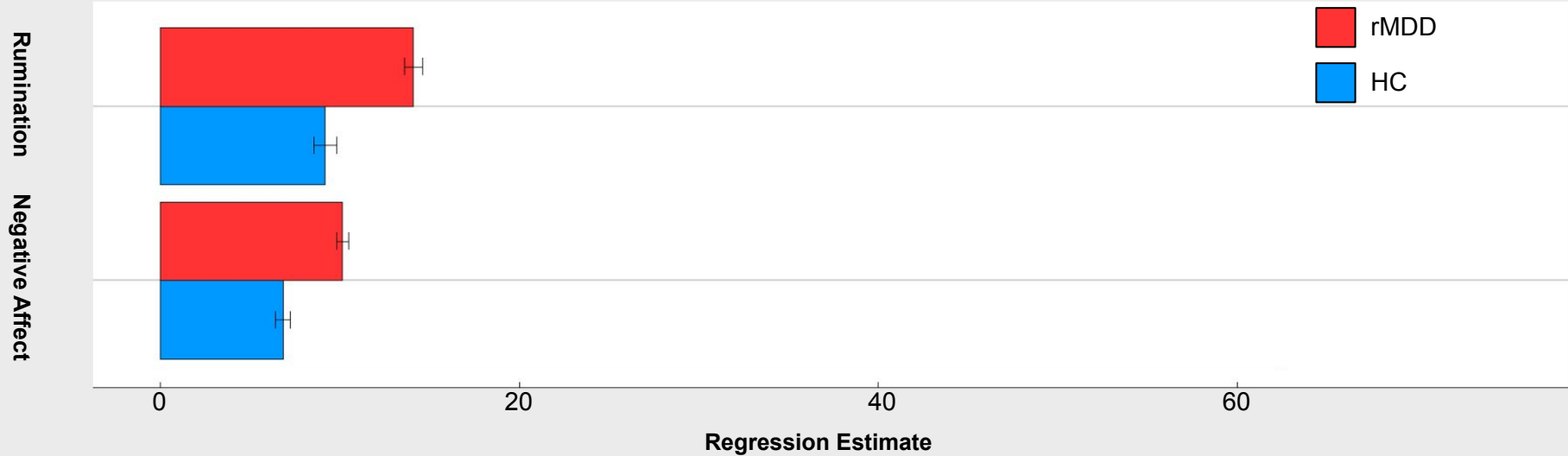
rMDD

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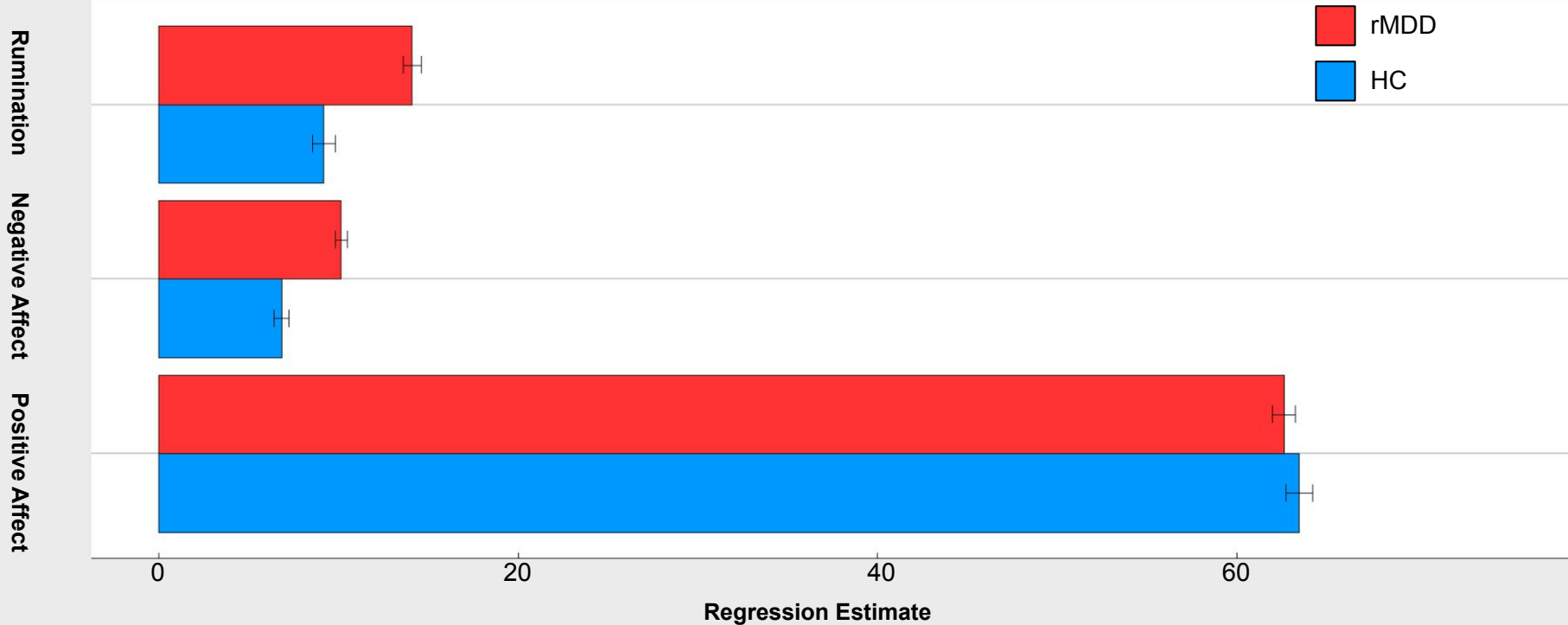
Remitted MDD participants report significantly more rumination...



... 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)



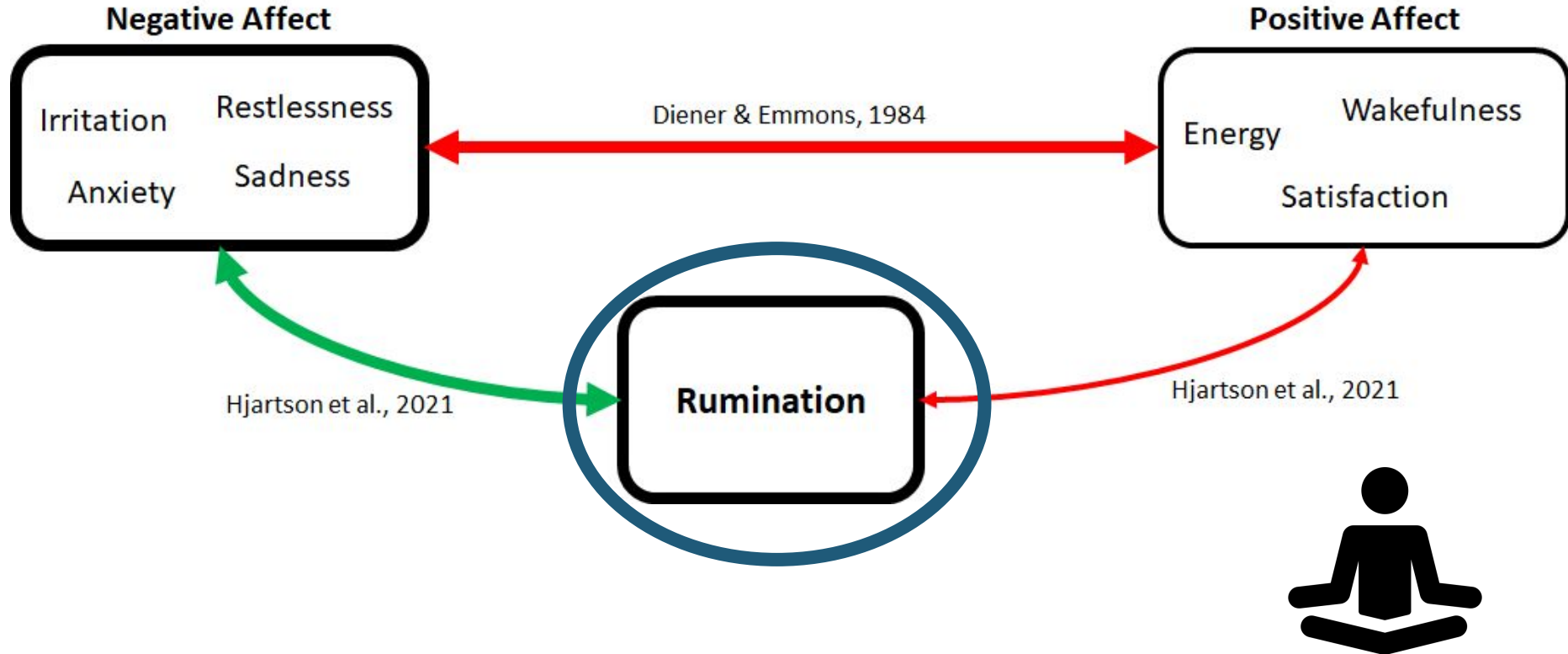
- **Positive Fantasizing**

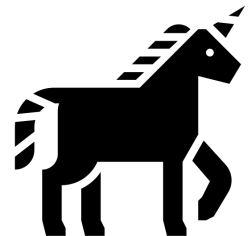
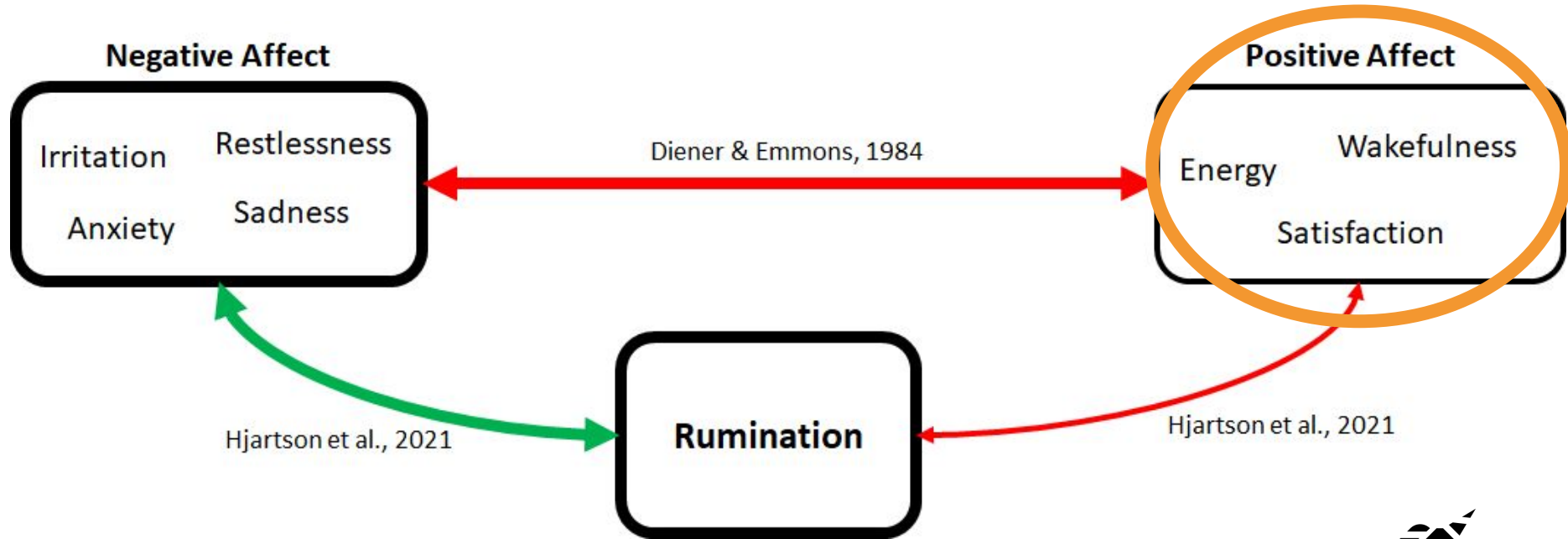
- Improves regulation of content of positive cognition and of positive affect (van Tol et al., 2021)



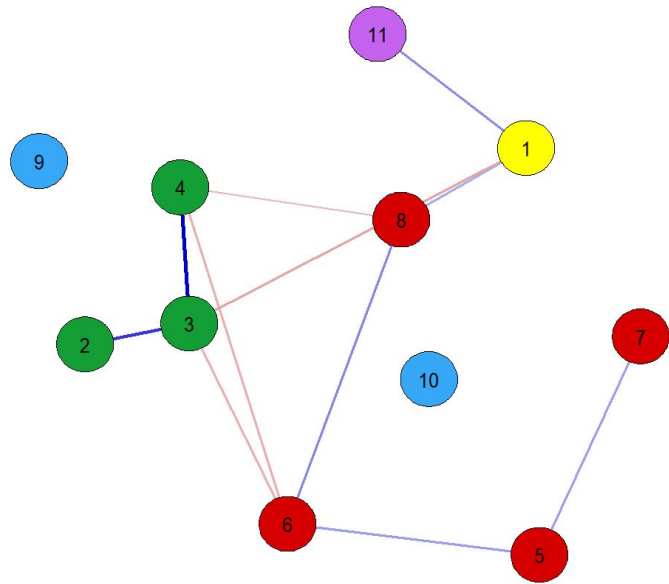
Research Question 2

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

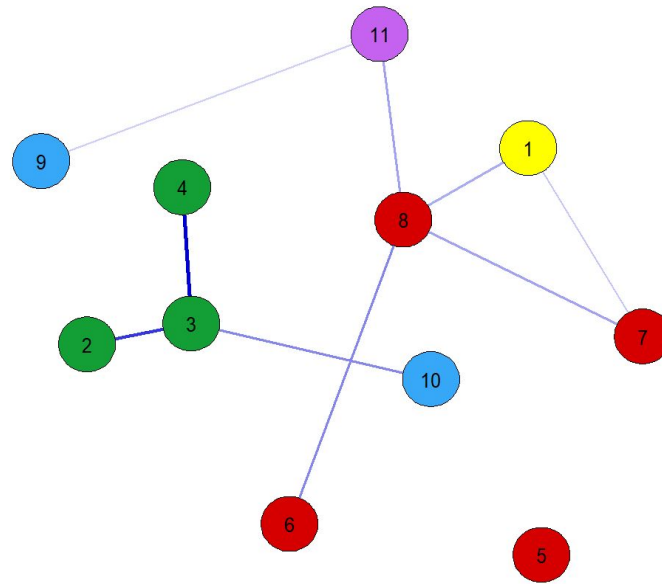




How does **positive fantasizing** impact the network?



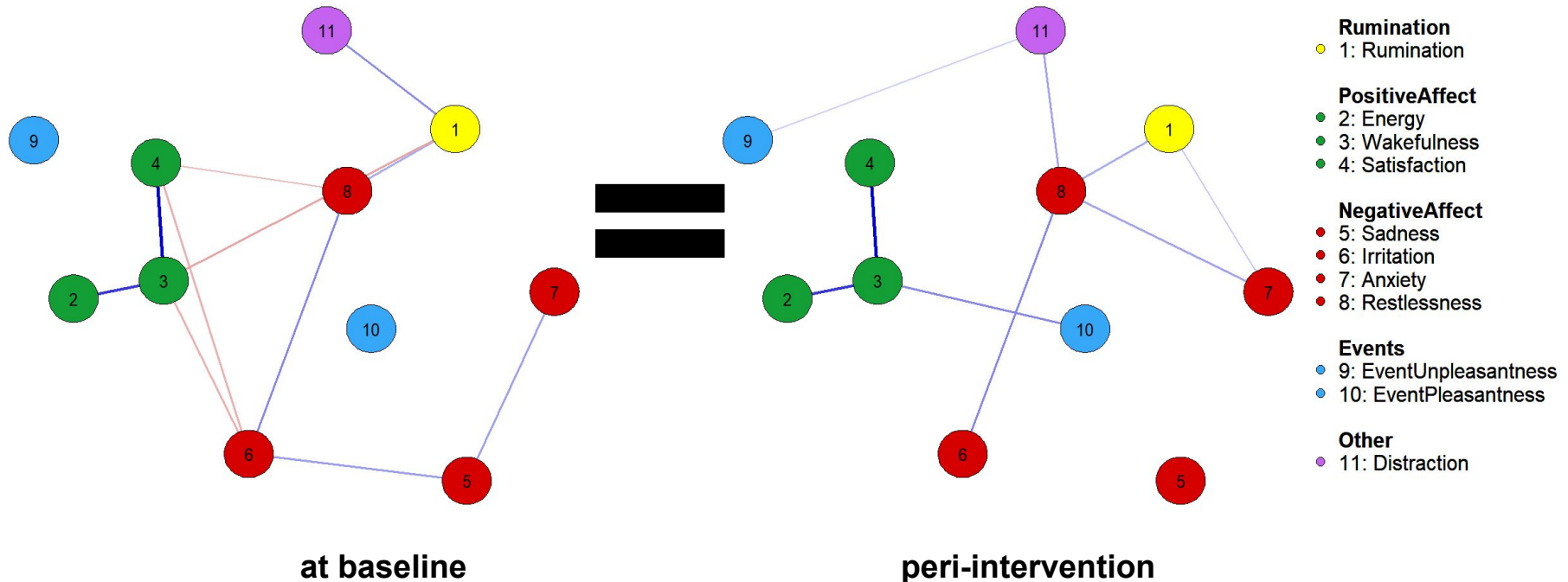
at baseline



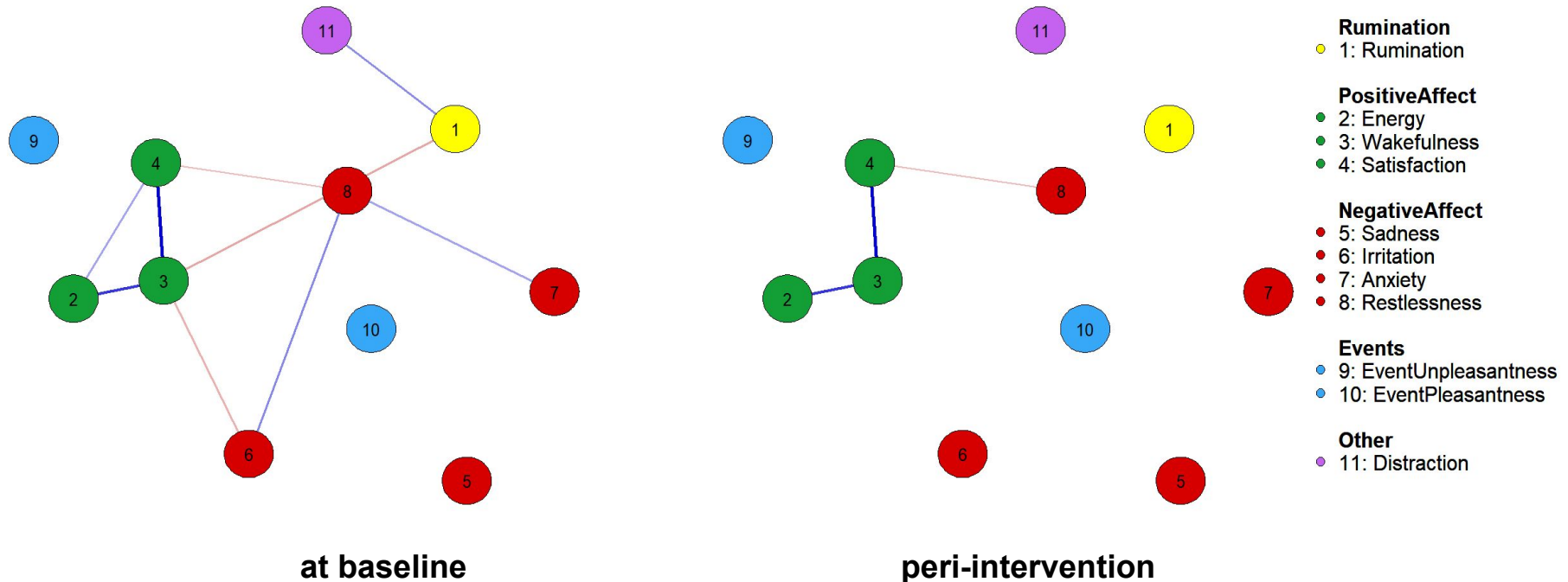
peri-intervention

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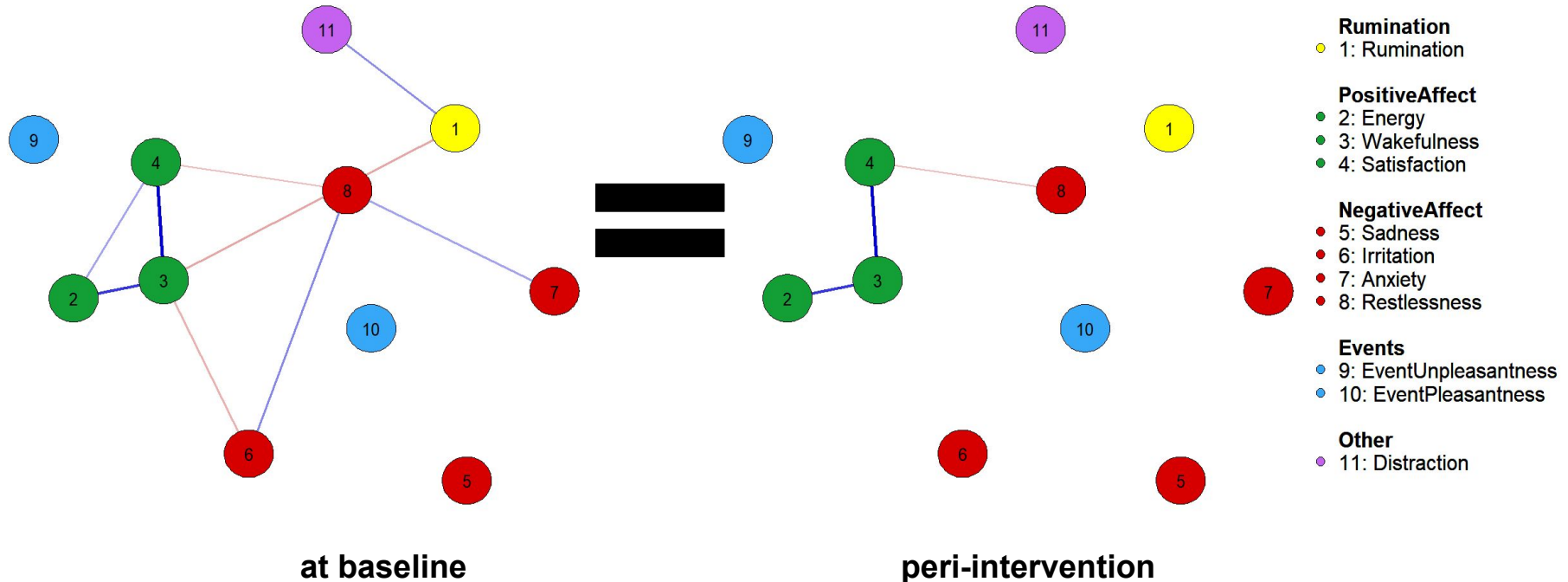
The networks do not differ from each other significantly



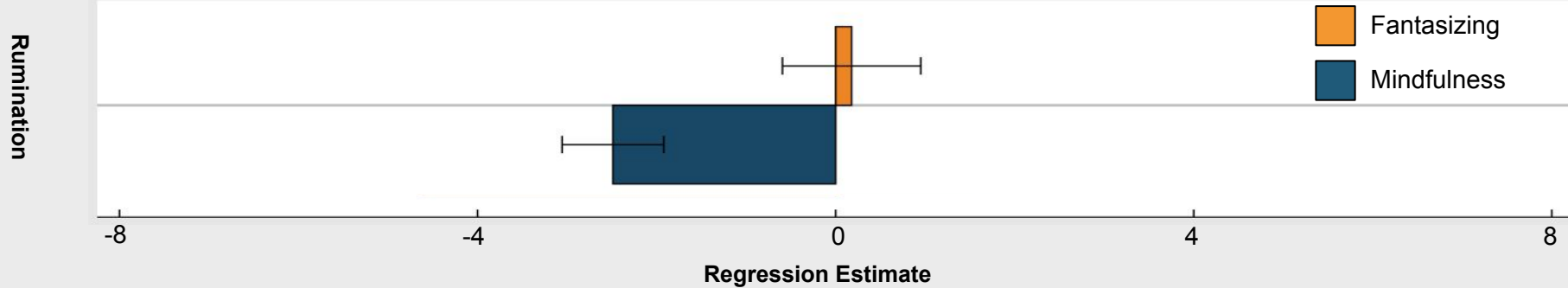
What influence does **mindfulness** have on the network?



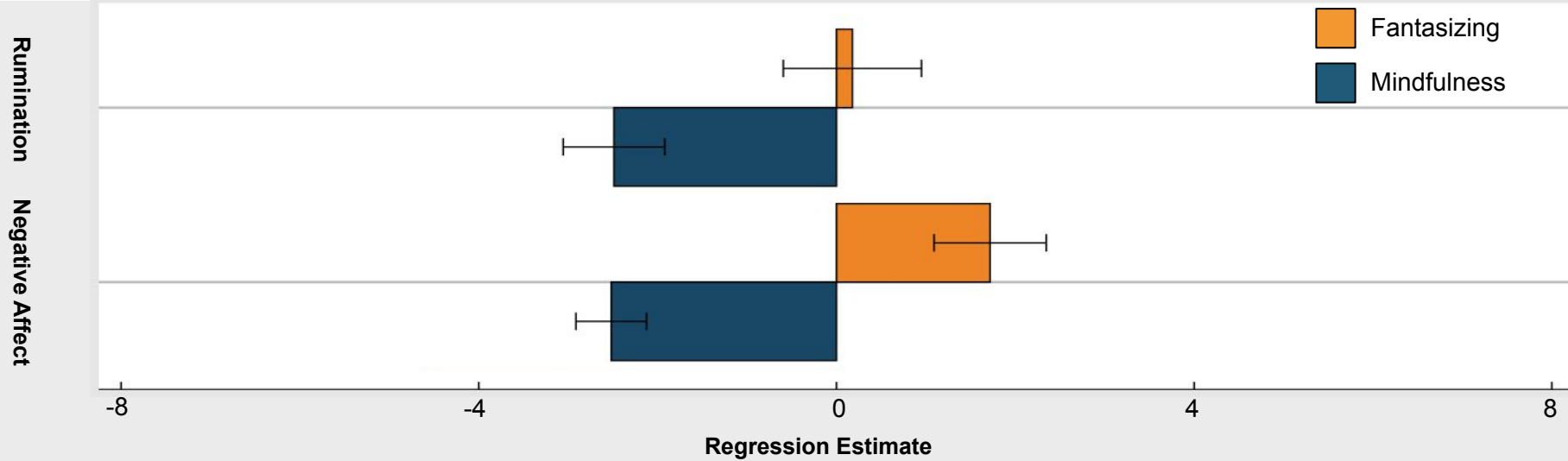
There is no statistically significant difference



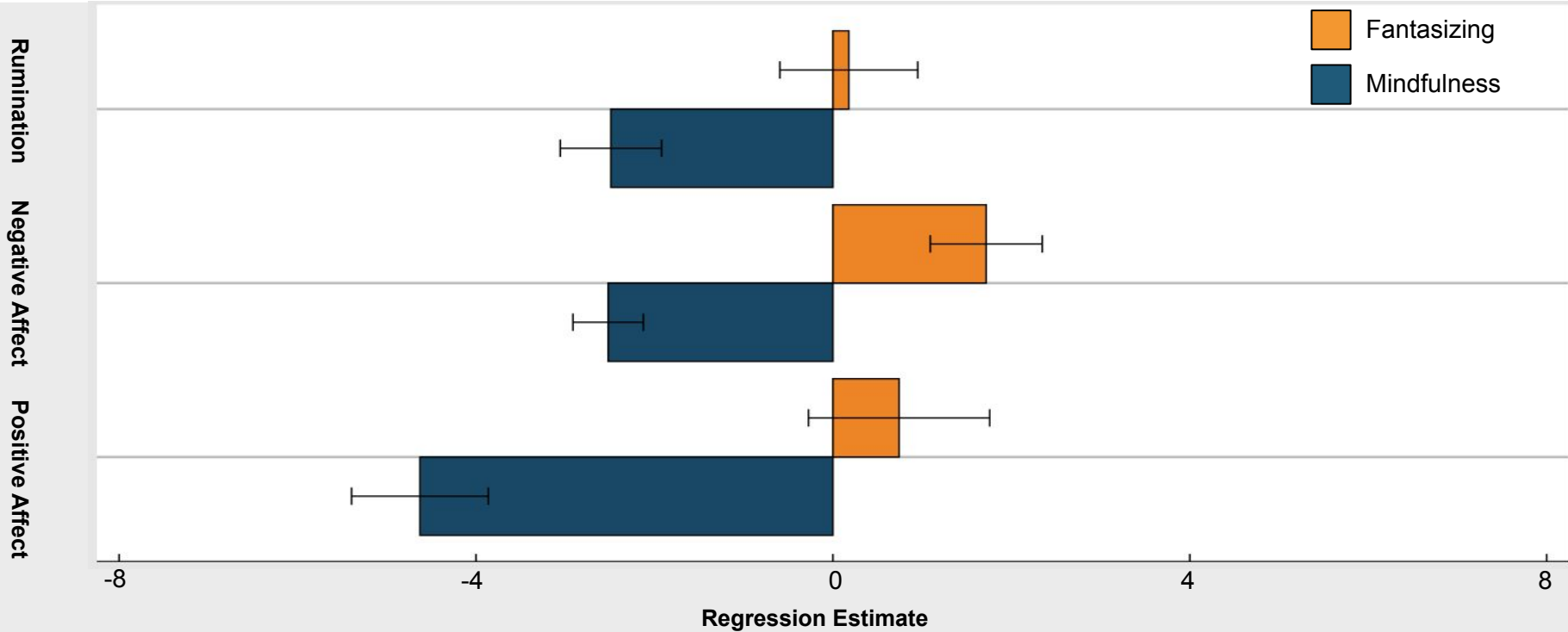
Mindfulness significantly reduces rumination...



... 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



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
- 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



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



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



Conclusion

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



References

- Borsboom, D., & Cramer, A. O. (2013). Network analysis: an integrative approach to the structure of psychopathology. *Annual review of clinical psychology*, 9(1), 91-121.
- Borsboom, D., Deserno, M. K., Rhemtulla, M., Epskamp, S., Fried, E. I., McNally, R. J., ... & Waldorp, L. J. (2021). Network analysis of multivariate data in psychological science. *Nature Reviews Methods Primers*, 1(1), 1-18.
- Diener, E., & Emmons, R. A. (1984). The independence of positive and negative affect. *Journal of personality and social psychology*, 47(5), 1105.
- Hasin, D. S., Sarvet, A. L., Meyers, J. L., Saha, T. D., Ruan, W. J., Stohl, M., & Grant, B. F. (2018). Epidemiology of adult DSM-5 major depressive disorder and its specifiers in the United States. *JAMA psychiatry*, 75(4), 336-346.
- Hjartarson, K. H., Snorrason, I., Bringmann, L. F., Ögmundsson, B. E., & Ólafsson, R. P. (2021). Do daily mood fluctuations activate ruminative thoughts as a mental habit? Results from an ecological momentary assessment study. *Behaviour Research and Therapy*, 140, 103832.
- Kessler, R. C. (2012). The costs of depression. *Psychiatric Clinics*, 35(1), 1-14.

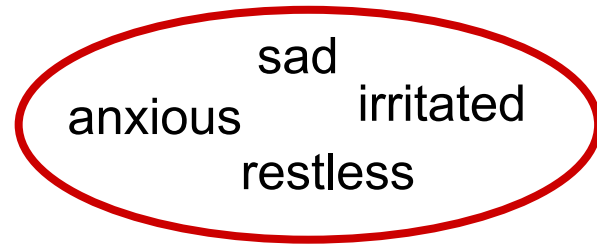


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Appendix

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?

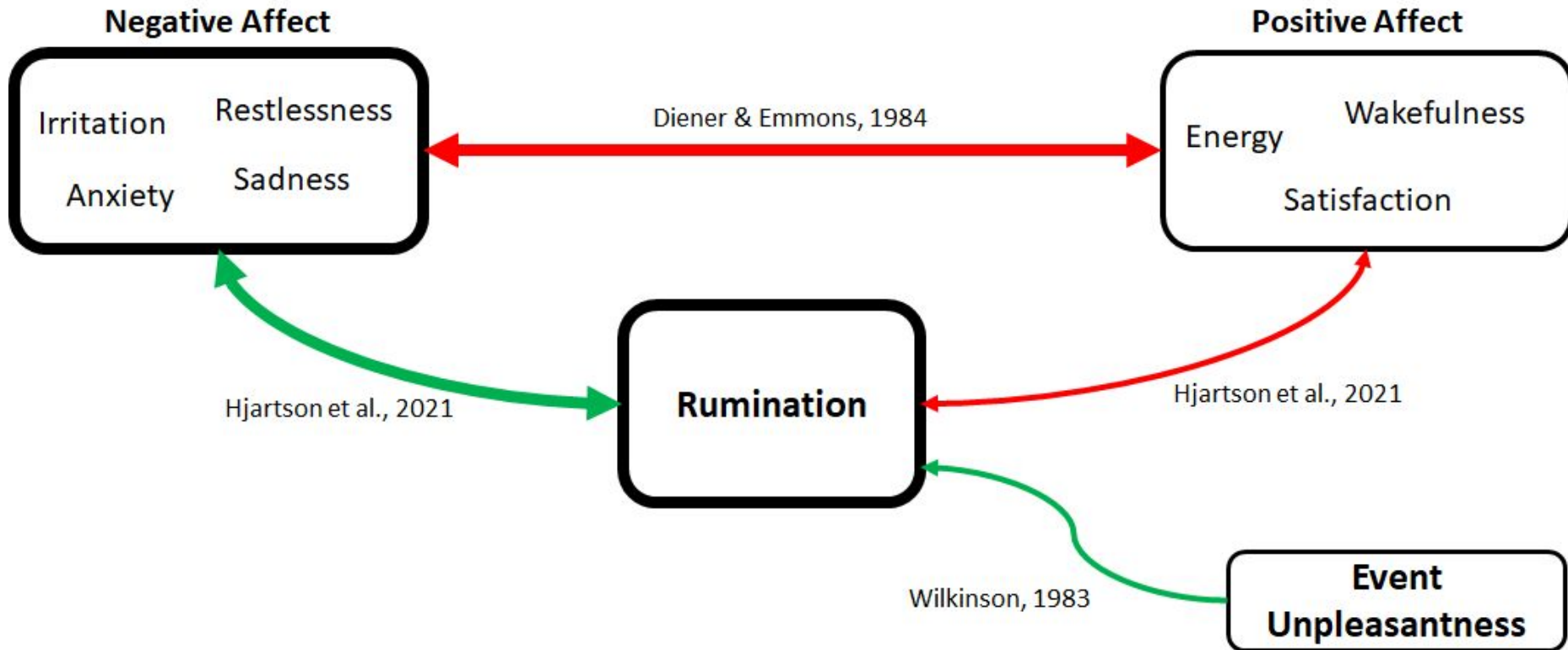
Research Questions

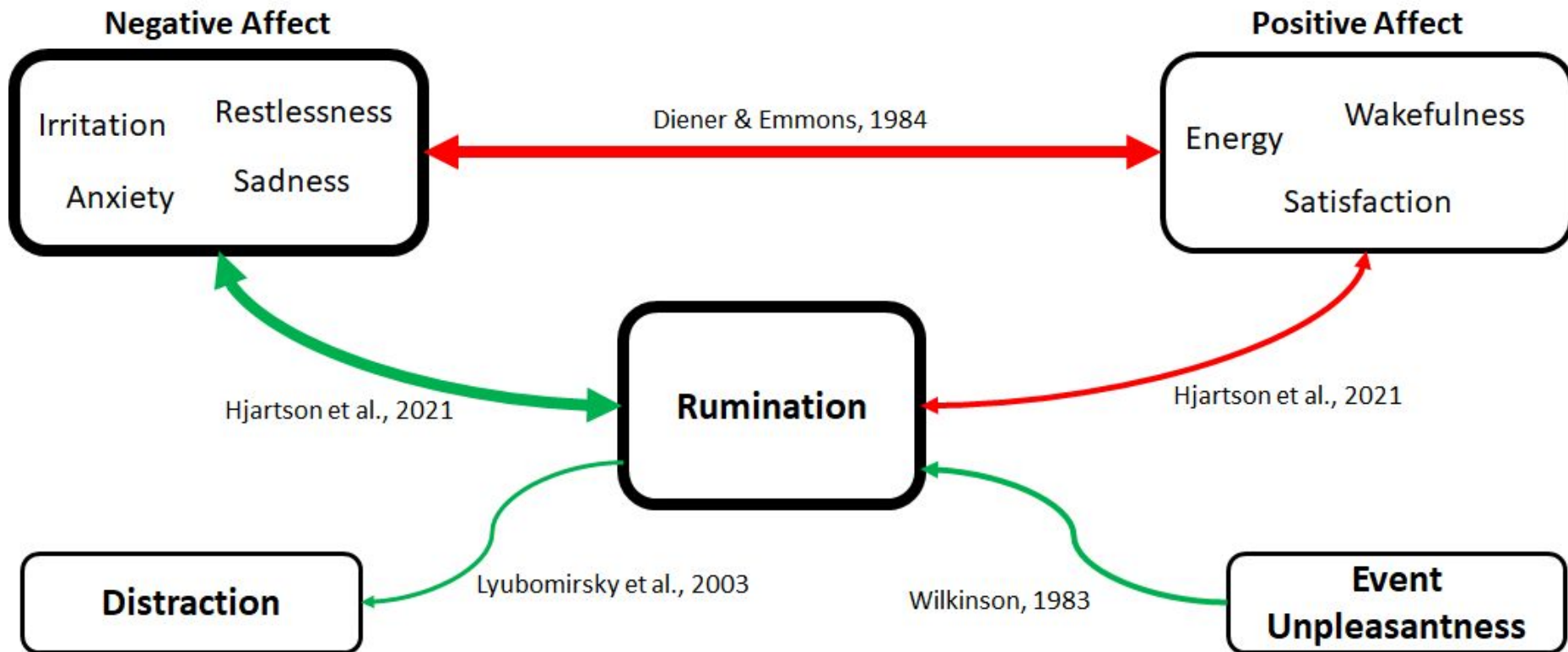
Question 1

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?





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?

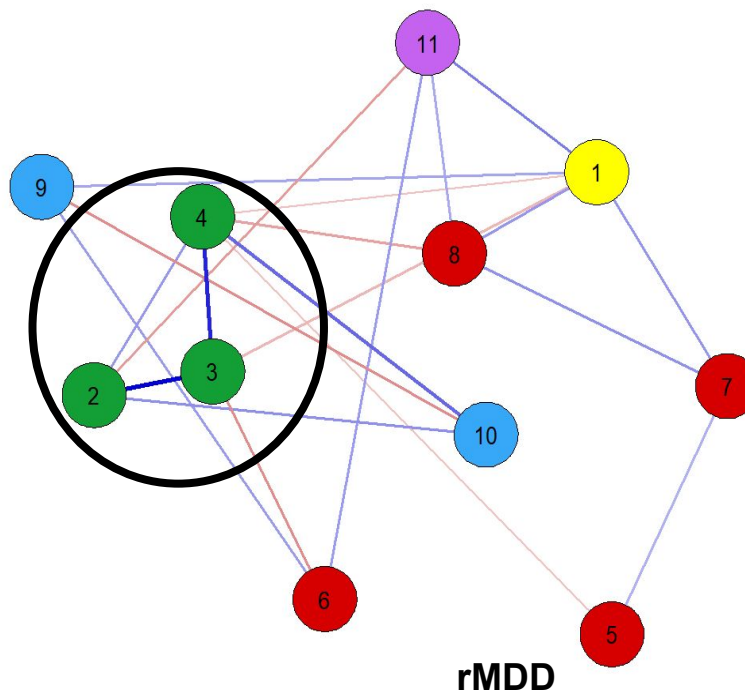
Network Statistics

Edge Weights

Strength

Positive Affect Strength

Negative Affect Strength



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



Some nodes failed to reach statistical significance

Stability Analysis*

Strength: 9/11 nodes

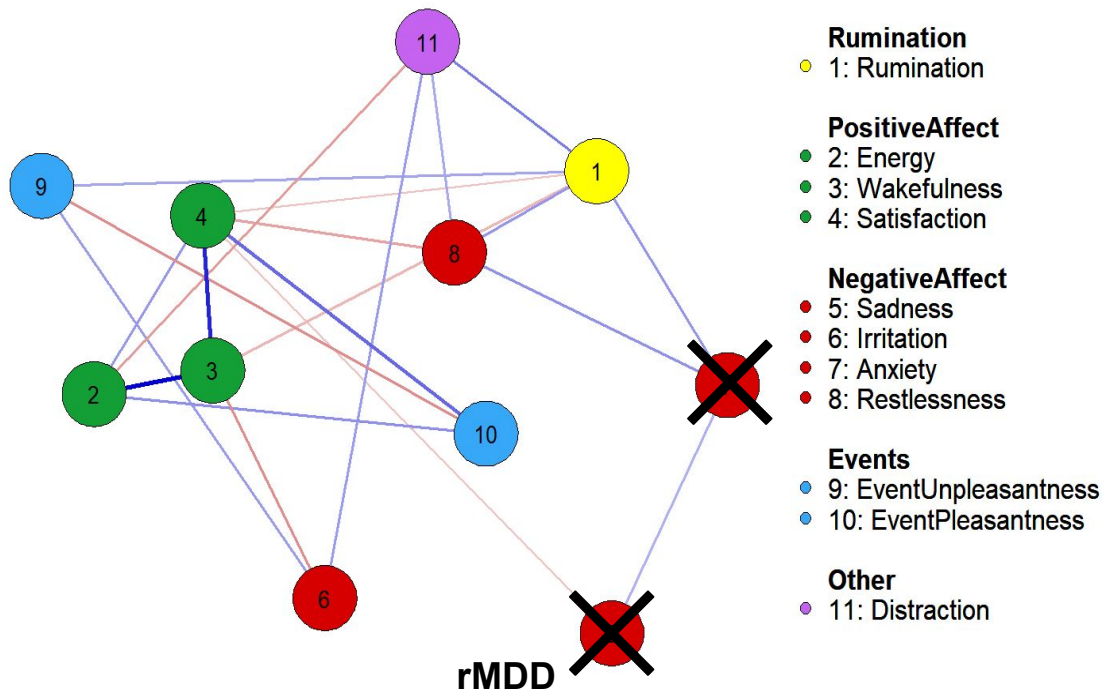
Weight:

PA Strength:

NA Strength:

Global Strength:

* $\alpha = 0.025$





Not all edges are significant either

Stability Analysis*

Strength: 9/11 nodes

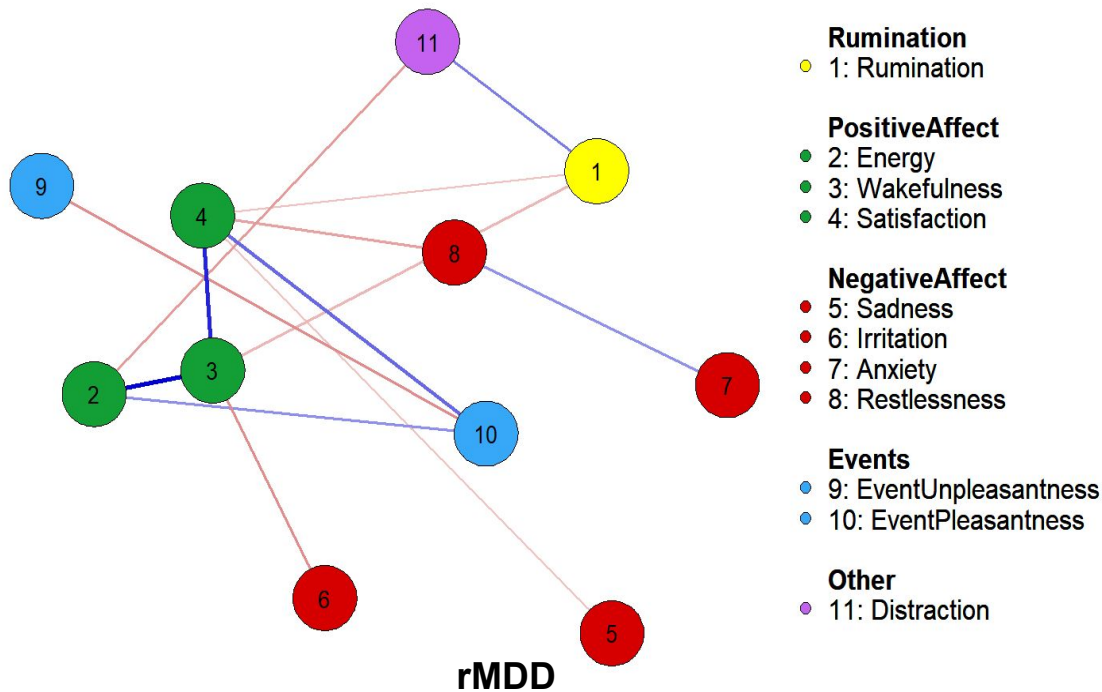
Weight: 13/25 edges

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

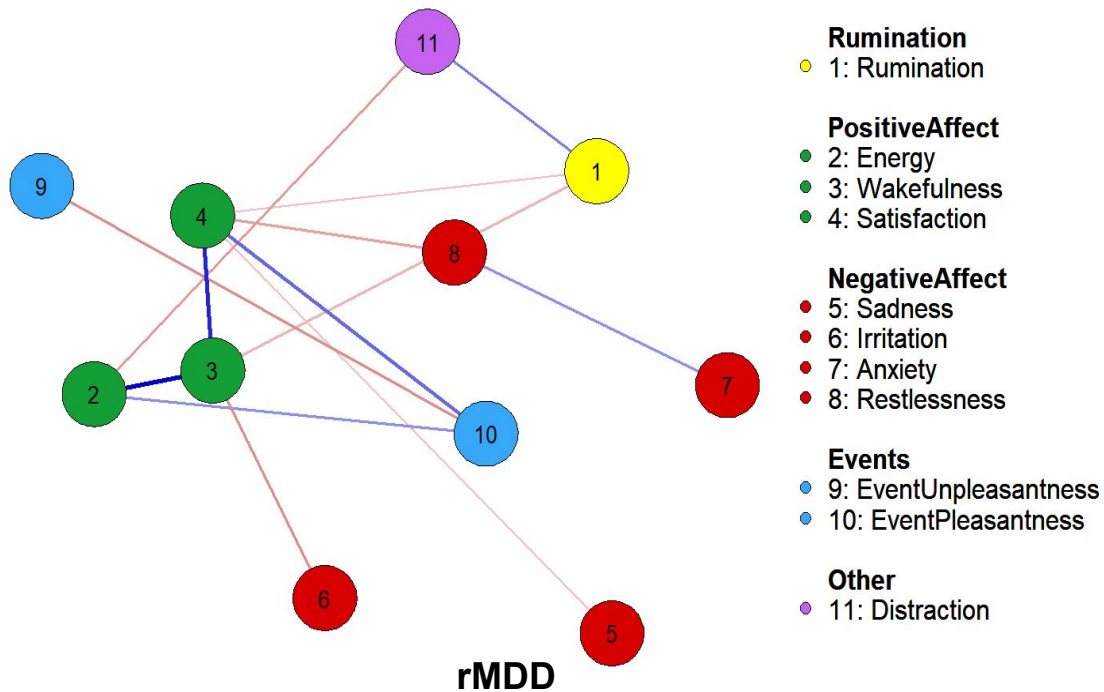
Weight: 13/25 edges

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

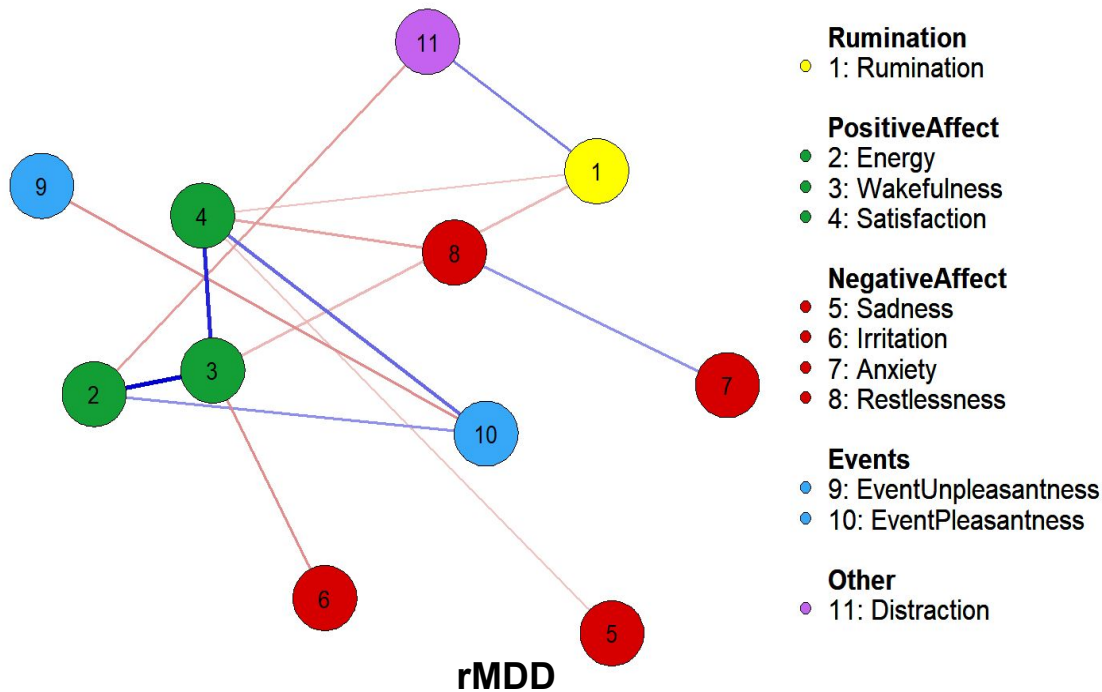
Weight: 13/25 edges

PA Strength: 1.00

NA Strength: 1.00

Global Strength: 3.08

* $\alpha = 0.025$



Network Structure Estimation

- 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)

Network Structure Estimation

- Node Selection
- Edge Selection



Network Description

- Node Centrality
- Network Topology
- Network Comparison

**Network Structure
Estimation**



Network Description

- Node Selection
- Edge Selection
- Node Centrality → Strength
- Network Topology
- Network Comparison

**Network Structure
Estimation**



Network Description

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

**Network Structure
Estimation**



Network Description

- Node Selection
- Edge Selection

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

Network Structure Estimation

- Node Selection
- Edge Selection

Network Description

- Node Centrality
- Network Topology
- Network Comparison

Stability Analysis

- Node Centrality
- Network Topology
- Network Comparison

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