

# Intraindividual Network Analysis: Using Centrality Indices for Personalized Treatment Planning



Sarah Jo David, Andrew J. Marshall, Emma K. Evanovich, Noelle Cavalier, & Gregory H. Mumma  
Texas Tech University, Department of Psychological Sciences

## Abstract

- The network analysis approach to psychopathology postulates that symptoms are causally connected.
- The present study conducted a network analysis of lead-lag relations in an individual with comorbid mood and anxiety disorders. The resulting network display directional relations of depressive, anxious, anhedonic, and positive affect symptoms.
- These results and similar networks may be helpful in selecting specific treatment components that may be effective for an individual with a complex symptom presentation or comorbid disorders.

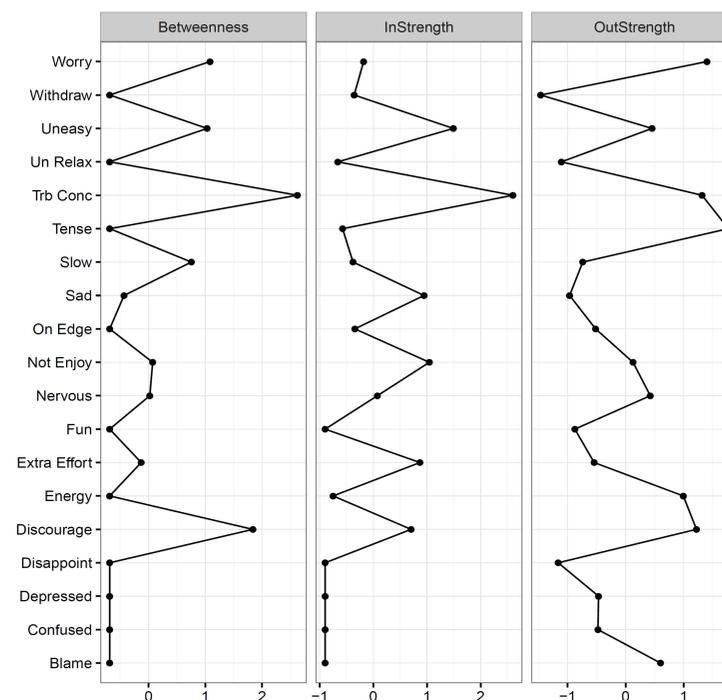
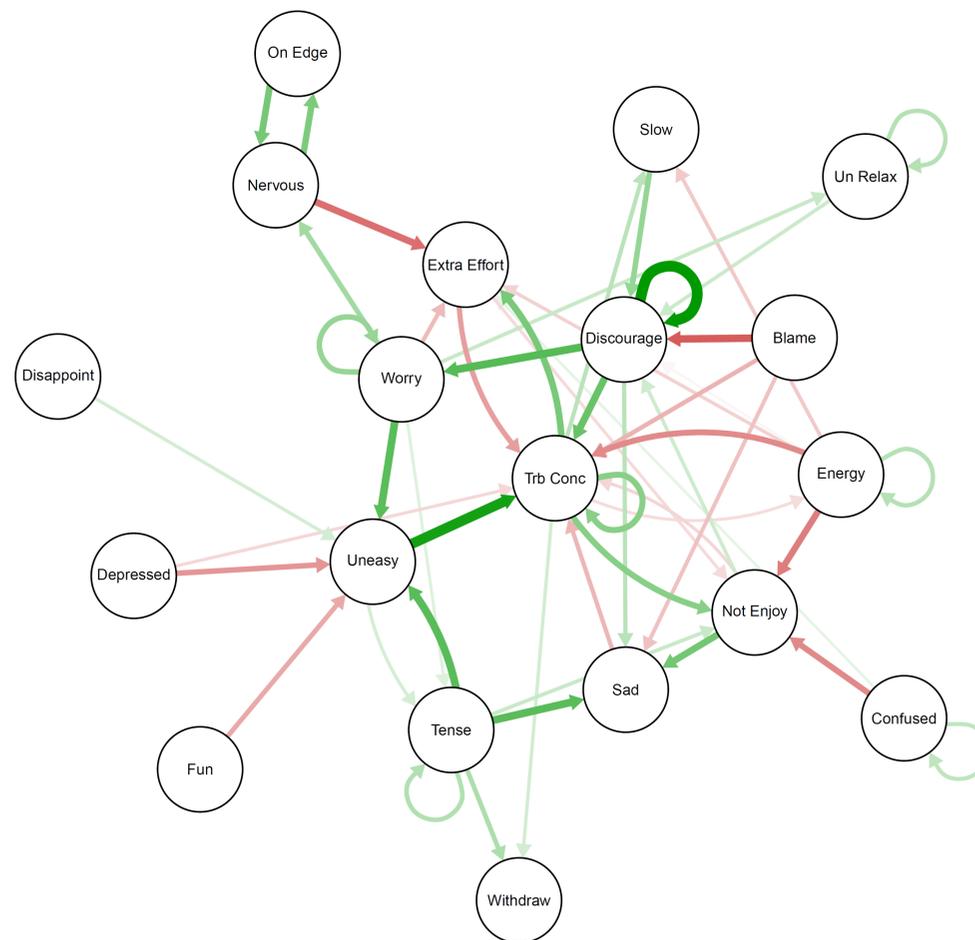
## Introduction

- Within a causal systems modeling approach, symptoms are not a result of a disorder or a manifestation of a latent variable (e.g., depression), but rather mutually interacting components of a multifaceted network (Borsboom & Cramer, 2013).
- A network analysis of lead-lag relations in the time-series data of a single individual may reveal dynamic, functional, and potentially causal relations between symptoms occurring within that individual over time. Although Borsboom & Cramer (2013) described the basic structure of an intraindividual network analysis, their description was limited to a hypothetical example.
- The present study conducted an intraindividual network analysis of lead-lag relations in a participant (age 44 years) diagnosed with major depressive disorder, dysthymia, and social anxiety disorder.

## Method

- Daily data was collected during the assessment and initial treatment phases of tailored, case-formulation based, cognitive-behavioral treatment (CBT) over a period of four months.
- Items included those based on the Mood and Anxiety Symptom Questionnaire (MASQ) related to depression, anxiety, anhedonia, and positive affectivity. The participant was instructed to fill in the questionnaire at approximately the same time every day, and completed 90 questionnaires.
- All items were detrended. Next, each symptom at time  $t$  was regressed on all other symptoms, including itself, at time  $t - 1$ . The partial correlation matrix was regularized using LASSO (least absolute shrinkage selection operator) regularization.
- Regularization provides for a parsimonious network in which statistically unreliable parameters are shrunk to zero.
- The resulting network was created utilizing the *qgraph* package in R.

## Lead-Lag Partial Network



Abbreviation	Symptom Item
	<i>Depression Items</i>
Sad	Felt sad.
Depressed	Felt depressed.
Discourage	Felt discouraged.
Disappoint	Was disappointed in myself.
Blame	Blamed myself for a lot of things.
	<i>Mixed Distress Items</i>
Worry	Worried a lot about things.
Trb Conc	Had trouble concentrating.
Confused	Felt confused.
	<i>Anxiety Items</i>
Nervous	Felt nervous.
Tense	Felt tense or "high strung".
Uneasy	Felt uneasy.
Un Relax	Was unable to relax.
On Edge	Felt keyed up, "on edge".
	<i>Anhedonia Items</i>
Not Enjoy	Felt like nothing was very enjoyable.
Withdraw	Felt withdrawn from others.
Extra Effort	Took extra effort to get started.
Slow	Felt slowed down.
	<i>Positive Affect Items</i>
Fun	Was having a lot of fun.
Energy	Felt like I had a lot of energy.

## Results

- Of 484 possible lag-1 relations, 433 were reduced to zero due to LASSO regularization. The resulting network display the lead-lag relations of the participant's symptoms across time.
- The strength of the relation between items is indicated by the thickness of the arrows. Green arrows indicate positive relations and red arrows indicate negative relations. The direction of the arrow indicates that an item at time ( $t$ ) is predicted by an item the previous day ( $t - 1$ ).
- Indegree estimates for this person indicated that variability in "today's" Troubling Concentrating (2.60) and feeling Uneasy (1.49) were most strongly influenced by variability in the other symptoms "yesterday", when controlling for all other symptoms.
- Outdegree estimates indicated that "today's" Tension (1.77), Worry, (1.40), Trouble Concentrating (1.31) and feeling Discouraged (1.22) had the greatest influence on other symptoms "tomorrow", when controlling for all other symptoms.
- Trouble Concentrating (2.62) and feeling Discouraged (1.84) had the highest betweenness estimates, indicating these symptoms bridge the shortest lagged connections between other pairs of symptoms in the network when controlling for other symptoms.

## Conclusion

- These networks of lead-lag relations provide a detailed map of the dynamic (over time) relations between symptoms in an individual with a complex, comorbid symptom presentation.
- These results allow for the determination of symptoms most central to an individual's dynamic network of distress and dysfunction.
- Targeting the participant's tension, worry, and trouble concentrating with muscle relaxation and mindfulness exercises may help to alleviate symptoms. Trouble concentrating and uneasiness are likely to be particularly sensitive indicators of change.
- The analysis of lead-lag relations provides information about the directionality and dynamic interrelations among symptoms that can aid therapists in determining a person's symptom paths most relevant to treatment planning.

Please feel free to contact Sarah Jo David at [sarah.jo.david@ttu.edu](mailto:sarah.jo.david@ttu.edu) or Gregory H. Mumma, Ph.D. ([g.mumma@ttu.edu](mailto:g.mumma@ttu.edu)) with any questions.

## Centrality Indices

- Indegree*, a centrality index, estimates how much information a symptom receives directly from other symptoms (i.e., number of edges arriving at the node).
- Outdegree*, another centrality index, estimates how much information a symptom sends directly to other symptoms (i.e., number of edges departing from the node).
- Betweenness* indexes how often a symptom lies on the shortest path between two other symptoms over time.