Inferring Causality Using a Network Analysis Approach
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Abstract
The present study utilized intraindividual time-series data from a comorbid case to examine idiosyncratic relations among symptoms via a network analysis (NA) approach. Relations among depression and anxiety symptoms were examined through four networks. The networks build upon each other by determining symptom covariation, establishing temporal precedence, controlling for other possible causal variables, and examining the identified causal mechanisms. These steps are crucial for determining causality (Haynes et al., 2011) and the ability to make inferences based on the available information changes with each step of analysis. Determining causality is a crucial component for treatment intervention as it guides the clinician towards specific variables or symptoms that may be most impactful in an individual’s symptom network.

Method
PARTICIPANTS
- Single individual, female, 44 years old, diagnosed with major depressive disorder, dysthymia, social phobia, and anxiety disorder NOS.

PROCEDURE
- Over the course of 122 days, she completed 90 daily ratings, at the same time each day.
- Ratings of items were based on the Mood and Anxiety Symptoms Questionnaire (MASQ) & assessed depression, anxiety, and mixed distress (depression + anxiety).
- 3 networks (Figures 1-3), and their corresponding centrality indices, were created from concurrent and lagged bivariate correlation matrices utilizing the Fruchterman-Reingold algorithm in R graph.
- Only edges representing at least a small effect size (r ≤ 0.10; Cohen, 1988) were included.
- Networks show direction (green arrows indicate positive, red arrows indicate negative relations) and strength of relations between items (thickness of the arrow).

Central Symptom
- Indegree: estimates how much information a symptom receives directly from other symptoms.
- Outdegree: estimates how much information a symptom sends directly to other symptoms.
- Betweenness: quantifies how much information passes through a given symptom by calculating the number of times it lies on the shortest path between two nodes.

Results
Figure 1. Concurrent Association Network
Figure 2. Intraindividual Lead-Lag Association (Bivariate) Network
Figure 3. Intraindividual Lead-Lag Relative Importance Network

Table 1. Centrality Indices

Conclusions
- These intraindividual NA results from time series data of a single comorbid case present a detailed visualization of those symptoms that affect other symptoms the most, and how they symptoms differentially relate at each level of analysis, thereby indicating which symptoms are associated with the most distress.
- Each level of analysis builds upon each other, providing more information in inferring causality (Haynes et al., 2011).
- Once information is gathered from each network and causality is assessed, intervention can be tailored to address the most prominent and highly intercorrelated symptoms, thus potentially increasing treatment efficacy.

Example “Feeling Uneasy”
- Determining Covariation using the Concurrent Association NA (Fig. 1): Feeling Uneasy covaries with other symptoms on a typical day and is highly central to the network.
- Establishing Temporal Precedence using the Lead-Lag Association NA (Fig. 2): For today predicting tomorrow, feeling uneasy is strongly predicted by other symptoms yesterday (InDegree) and its level today relatively strongly predicts level of other symptoms tomorrow (OutDegree).
- Controlling for Other Symptoms in the Network using the Lead-Lag Relative Importance NA (Fig. 3): Even after controlling for time and other symptoms, feeling uneasy remains an influential and central symptom in the network.

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