Write a short scientific essay on the network theory of mental disorders, answering the following questions.

What is the external field of a mental disorder and how do you think this would impact it in the common

cause framework and in the network framework? What is an implication that follows from the network

perspective towards the diagnosis and treatment of mental disorders?

Network theory of m

According to Borsboom (2017), the external field of a mental disorder refers to the conditions that encompass factors, which can affect the symptoms of mental disorder from outside of the system (i.e., network). It

When it comes to explaining mental disorder and its corresponding symptoms, the common cause framework used to be a dominant view, which states that symptom arises from a single underlying common cause. As an alternative, Borsboom (2008) proposed to apply the network framework, which conceptualizes mental disorders as a network of interacting symptoms that reinforce each other.

One of many implications of adopting network approach is that in network framework, we can naturally move our focus beyond the symptom network, considering the environmental factors that are relevant to symptoms in the context of the corresponding mental disorder. The conditions that encompass these environmental factors that our outside of symptom network, yet having influences on the symptoms, form the external fields. For example, adverse life events such as losing a loved one can activate a symptom (i.e., an initiating factor), which might propagate throughout the network system. It is very plausible and often aligned with the clinical evidences (ref), but under the common cause framework, we cannot incorporate these external factors as part of explanation on development of mental disorders, while the network frame allows us to do so.

Another implication of applying network approach to psychopathology concerns the diagnosis and treatment of mental disorders. Under the traditional common cause framework, the diagnosis tends to follow from the set of symptoms that are defined by DSM-IV(ref), after which the diagnosis is used to choose a treatment protocol. In the network frame, however, the mental disorder manifests itself by a cluster of symptoms that are strongly connected to each other and correspondingly the treatment can follow by identifying and targeting the central symptom node that may help breaking the strong connectivity of network system. Besides, not only that the network framework accords well with the comorbidity concept, where the causal relations between symptoms consists of some pathways that connect different disorders (i.e., bridge symptoms), but also allows to study individuals’ dynamics that may enable us to personalize interventions.

by identifying the structure, the treatment could be carried

social relations, and abnormal biological functioning may be part of one’s external fields. The network framework allows us to incorporate these external factors, which may be involved in development of mental disorders, while the common cause framework

as a long-established view conceptualizes symptoms as the effects of a common cause.

While a growing body of research highlights the limitations of the traditional latent variable model (i.e., common cause framework) for representing psychopathology, the complex systems perspective offers a useful alternative paradigm(Van Bork et al., 2019). One of the well-studied approaches of looking at psychopathology as a complex system is the network theory of mental disorder. In the network approach, psychopathology is conceptualized as a system of mutually reinforcing symptoms, which develops in an external field encompassing a broad spectrum of biological, psychological, and socio-cultural processes (Borsboom &Cramer, 2013; Borsboom, 2017). Previous research on the network model of mental disorder mainly focused on the single aspect of dynamics, namely the interactions between the symptoms, without considering their connections with the relevant factors in the external field (i.e., conditions that encompass factors, which can affect the symptoms of mental disorder from outside of the system) (Borsboom, 2017; Fried et al., 2016).

Recently, researchers suggest to move beyond the symptoms and integrate other relevant processes of psychopathology into the network (Fried & Cramer, 2017). This is a natural extension that can be made within the network framework, but

According to Pinto et al (2006), about 67.2% of obsessive-compulsive disorder (OCD) patients are diagnosed with major depression. Having observed that many (OCD) patients become depressed, Mcnally et al.(2017) investigated the comorbidity between OCD and depression using the method of network analysis. The aim of their study was to apply network analysis in order to characterize the functional relationships among symptoms of OCD and depression in the patients who are diagnosed with primary OCD. They collected data on the severity of OCD as well as depression symptoms from 408 OCD patients. To accomplish the study aim, they estimated a network based on a Gaussian graphical model (GGM) whereby the edges signify the partial correlations between the pair of nodes while controlling for all the other variables. In addition, they applied a regularization method via running graphical LASSO (glasso). After they obtained their network model, they computed the strength centrality and betweenness centrality to measure the importance of node (symptom) to the network. They found that some of the nodes had the greatest strength centrality as well as highest betweenness. Accordingly, they presumed that those symptoms would have high clinical relevance and thus important when it comes to the comorbidity between OCD and depression.

Overall, I agree with the analytical methods that authors used: fitting graphical LASSO network and computing the centrality/betweenness measures. Fitting a GGM aligns with the type of data they used (i.e., cross-sectional) and I do think that using glasso algorithm was appropriate given that they had quite many variables (i.e., 26 nodes), which are likely to result in false-positive edges.

as it helped with estimating a sparse network that can account for the crucial relations between the nodes by omitting trivially small partial correlations. (See the estimated network below in case you are interested).

Provided that they had many variables (i.e., 26 nodes), which are likely to result in false-positive edges,

Regularization helps with estimating a sparse network that accounts for the crucial relations between the nodes and yet parsimonious by omitting trivially small partial correlations. After they obtained their network model, they computed the strength centrality and betweenness centrality to measure the importance of node (symptom) to the network, assuming that the highly central symptoms would have clinical relevance. Lastly, they tested the stability of network by computing 1000 bootstrapped networks, where they estimated stability of centrality measure as well as the confidence intervals for the strength of each edge using the R package `bootnet`.

analyzed symptoms of OCD and depression in 408 patients

I believe that the network theory has promoted pioneering psychological research, especially in psychopathology since Borsboom first introduced in 2008. The claim that the mental disorders emerge from causal interactions among symptoms (borsboom cramer) has gained a substantial amount of attention over the last two decades as it aligns so well with the intuition on how mental disorder develops. A lot of empirical researchers have tried fitting statistical network models to gain insight into these dynamics between symptoms as per the network theory posits. Even though the network theory and network model are not equivalent, it is unfortunately often the case that researchers tend to use two terms interchangeably and draw causal inferences based on the estimated network model structure. One of the limitations of the statistical network model is that the edges in the network only represents the statistical relations, and they cannot be directly translated into causal relations. However, due to the confusion between two concepts, it has been observed that some unjustified causal interpretations were made based on statistical network models (ref). Recently though, there has been active research going on estimating causal network graphs, which actually estimate causal relations (Lourens). I expect that with a set of methodologies to discovering causal relations that are currently studied, there will be soon an important extension to the network analysis tool that can validate inferring causal relations. As a conclusion, I think that the network theory is indeed worth the hype. It has created a great momentum in psychological research and despite some confusion and limitations on network model interpretation, I believe that there will come additional tools soon to improve the application of network analysis.

In fact, it has been shown that statistical network models are likely to perform poorly for discovering causal relationships, since relations in the network can be produced by unwittingly conditioning on common effects between other variables in the network (Ryan et al., 2022). Ryan et al. (2022) suggest that network models could in principle be replaced by using purposebuilt

causal discovery (CD) algorithms developed in the field of graphical causal modeling (Spirtes

& Glymour, 1991).

In addition, there has been some concerning voices over the generalizing findings in cross-sectioanl network to the level of individual (bringman).

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However, I think it is a bit concerning when it comes to drawing inferences based on the estimated network models.

To gain insight into these network systems, empirical researchers have relied on fitting statistical models to a variety of different data types such as cross-sectional data, gathered from many individuals at a single point in time

when it comes to understanding the mental disroders as dynamical system/

Over the last two decades, many areas of psychological science have moved towards understanding psychological phenomena as systems that evolve over time within an individual

See how the edge thickness is specified. And see what groups 🡪 decide color and legend… explain!!

As explained above, regularization is applied to this final model using `EBICglasso` function from `qgraph` package and visualized using `qgraph` function from the same package, as I wanted to suppress spurious relations.

I used gamma value of 0.6, as I find it the most appropriate (see Figure..) resulting sparsity.

I used `layout=”spring”` to use force-embedded layout (place the pair of nodes closer of further from each other while attempting to find an equilibrium). Then, I used `colorblind` theme for the edges and specify the nodes color manually. I grouped the nodes for depression and OCD, respectively using `groups` argument so that nodes can have color as per their grouping. Then, I add the legend for the nodes using `nodeNames` argurment.

Figure \@ref(fig:finalnetwork) shows the final network model of OCD and depression symptoms. The network represents the regularized partial correlations between the symptom variables. What stands out at the first peak of this network model is the cluster of symptoms. The OCD symptoms seem to cluster together so do the depression symptoms. And there is seemingly a sub-cluster in the depression symptoms including the symptoms `inc`, `wghtg`, `wghtl` and `dcp`. Some of the strong edges are observed between `cmpr` & `obr`, `inc` & `wghtg`, `obd` & `obn`, meaning that difficulty resisting compulsion and difficulty resisting obsessions, increased appetite and weight gain, and distress caused by obsession and interference due to obsessions are likely to correlated positively. Given this undirected partial correlation network, the directionality between the symptoms cannot be inferred. In addition, another interesting thing that can be found from this network is the connections between the OCD cluster and depression cluster. Even though each edge is not evidently strong, there are quite a lot of edges between them. Especially the node `obn` (interference due to obsessions) has a lot of connections with the depression symptoms, which may indicate that it is perhaps a critical node that might explain the comorbidity between OCD and depression.

As explained above, regularization is applied to this final model using `EBICglasso` function, as I wanted to suppress spurious relations. I used gamma value of 0.6, as it gives the optimal density in my perspective (see Figure \@ref(fig:tunegamma)). As my input is a symmetrical correlation matrix (weight matrix), `qgraph` automatically spits out undirected network, which is appropriate in this case as I don't know the directionality in relations. I used `layout="spring"` to use the force-embedded layout (i.e., place the pair of nodes closer or further from each other while attempting to find an equilibrium), which improves the interpretability of my network compared to the default `circular` layout setting. Then, I used `colorblind` theme for the edges to represent the positive/negative edges in blue and red respectively such that it is colorblind-friendly. I specify the `groups` for the symptoms as per its belonging disorder so that the nodes can be colored correspondingly, which thus helps to interpret the possible clusters. As the original symptom names are quite long, I let `qgraph` use the abbreviation and specify the `nodeNames` so that the full names can be shown in the legend. In addition, I used `cut = 0` to disable the cutoff such that all edges can vary in width and color (saturation) depending on their weights, because this enhances interpretation of the edges. Lastly, I used `maximum = 0.44`, which is the default setting, that is the strongest edge weight in the network. I did not change to 1, which is the possible maximum (partial) correlation, as I am mostly interested in the relative strength of relations in this network, not necessarily comparing it to the absolute maximum strength. There are some other minor arguments that I used for aesthetic reasons (e.g., node size, color choice, legend text size).

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One of many implications of adopting network approach is that in network framework, we can naturally move our focus beyond the symptom network, considering the environmental factors that are relevant to symptoms [@deboer\_2021]. The conditions that encompass these environmental factors that our outside of symptom network, yet having influences on the symptoms, form the external fields [@borsboom\_2008]. For example, adverse life events such as losing a loved one can activate a symptom, which might propagate throughout the network system. It is very plausible and often aligned with the clinical evidences [@borsboom\_2013], but under the common cause framework, we cannot incorporate these external factors as part of explanation on developing mental disorders, while the network frame allows us to do so.

Another implication of applying network approach to psychopathology concerns the diagnosis and treatment of mental disorders. Under the traditional common cause framework, the diagnosis tends to follow from the set of symptoms that are defined by DSM-V, after which the diagnosis is used to choose a treatment protocol. In the network frame, however, the mental disorder manifests itself by a cluster of symptoms that are strongly connected to each other and correspondingly, the treatment can follow by identifying and targeting the central symptom nodes that could help breaking the strong connectivity of network system [@borsboom\_2013]. Besides, the network framework accords well with the comorbidity concept, where the relations between symptoms consist of some pathways that connect different disorders (i.e., bridge symptoms). And these so-called bridge symptoms could be a promising treatment target. Lastly, network approach also allows to study individuals’ dynamics that may enable us to personalize interventions [@piccirillo\_2019].