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Mental disorders as networks: some cautionary reflections on a promising approach

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Fried and colleagues (Fried, et al., in press) provided a clear overview regarding the theoretical background of the network perspective to psychopathology and empirical studies that use network techniques in the field. According to the network perspective, mental disorders arise as a result of a complex network of interacting symptoms and mental states. As summarized by Fried and colleagues (Fried, et al. 2017) this perspective has gained popularity in the past years and opens new opportunities for understanding the concept and development of comorbidity and particularly for predicting the future course of symptoms. Furthermore, it has led to the hypothesis that such networks will provide insight into patient-specific psychological mechanisms underlying the development of mental disorders. The network perspective may therefore hold great promises for use in clinical practice (Kroeze et al). For example, personal network structures could be used as an add-on diagnostic tool, which may optimize personalized targets for intervention. In short, the network perspective has helped the field to become aware of novel scientific approaches and tools and is stimulating a philosophical discussion on the matter of psychopathology: what is it and what

should we look for in the search for the smallest elements that contribute to the development of psychopathology.

As the popularity of the network approach grows and many researchers have started applying network techniques to their data, the question arises: where do we go from here? Below we put forward some considerations for research in this field and we start with some notes of caution.

As with all things that become popular, it is tempting to indiscriminately apply network techniques to data available in the field, simply because these are new and exciting techniques in the field. However, we should not give in to this temptation, but use network techniques only if they fit the specific research question we have in mind. Questions for which one may want to use network techniques are, for example, those where one is specifically interested in assessing direct connections between variables, but only if that assumption is a valid one. Social networks with connections between people, are a good example hereof. Other examples are questions regarding the centrality of certain variables, or regarding causal dynamics between variables.

Thus, many different sorts of research questions can be answered using network analytic techniques. However, not all of those research questions have relevance to the proposed theoretical ideas behind the network perspective as formulated earlier. Vice versa, there have been empirical studies that did not use specific network techniques, but nevertheless provided support for the network theory (Wigman, Collip et al. 2013). Therefore, it is important for this field to clearly distinguish between studies that support the network theory on the one hand, and on the other hand studies applying analytic network techniques for other reasons.

We now continue reflecting upon some issues that relate to the theoretical assumptions behind the network perspective of psychopathology (Borsboom and Cramer 2013, Wichers 2014). The core argument that stimulated the use of 'network thinking' in the field of psychopathology is that the traditional model wrongly conceptualizes a mental disorder as a latent factor that is responsible for the presence of a combination of symptoms, whereas the network theory assumes no latent factor,

but only direct causal connections between symptoms (Cramer, Waldorp et al. 2010). The question is whether the reality of psychopathology is this clear cut or actually consists of a combination of those two possibilities. For some symptoms there is a clear logic in assuming that one symptom may cause the other (e.g. sleep problems → feeling tired). However, for other symptom relations it may also be logical to assume a latent factor underlying multiple complaints. For example, if a patient experiences a loss of pleasure in daily activities and also a loss of appetite, it may be very likely that these symptoms co-occur because of an underlying alteration in this patient's reward processing function. Symptoms may thus also co-occur because of an underlying latent factor at another (biological) level of measurement. Whether a latent or a causal connection can be assumed may thus depend on specific symptom combinations, which requires a next level of complexity in our thinking about causes of psychopathology. It also emphasizes that decisions on what combinations of symptoms or mental states can be included together in a network model need extensive thought.

However, the fact that both causal and latent connections between symptoms can be assumed does not mean that the network theory as proposed is not valuable. It is, in our opinion, a very promising approach, not so much because of the removal of latent connections between symptoms from our conceptualization of psychopathology, but more because it stimulates the change in thinking from a static towards a dynamic view on psychopathology. The most important questions in the field of psychopathology concern 'dynamic' questions: "Why do people *develop* psychopathology?" and "How do they *recover* from it?" It is important to understand how these dynamic processes occur over time. Surprisingly, there is a clear lack of research that has examined such dynamic processes in detail. There is thus a great need for theories and study designs that take dynamic effects into account. The theoretical network perspective can support the paradigm shift towards studying dynamic processes, as it emphasizes the presence of dynamic effects between symptoms, provides theoretical predictions and thereby also stimulates researchers to use designs that are fit to capture dynamic change processes. This shift from static ways of conceptualizing psychopathology towards

dynamic conceptualizations of psychopathology is important, as it brings us a lot closer to clinical reality.

Currently, however, there have been no convincing research designs that were able to test the theoretical assumptions derived from the network perspective directly. For example, no study has yet tested prospectively whether dynamic symptom connections indeed predict, better than mean levels of symptoms, towards what direction psychopathology develops. Also, no randomized controlled trials have been done testing whether insights into a patient's network dynamics can significantly improve clinical decision-making and patient outcomes. Thus, although various studies so far used network analytic procedures and related those results to the theoretical ideas behind the network perspective on psychopathology, no study has yet provided direct evidence that this theory is correct.

The lack of such studies has two main reasons. First, studies as mentioned above, which are needed to directly test the network theory, require time-consuming study designs. These studies simply have not been carried out yet. Second, with the entrance of novel network-based theoretical ideas regarding the structure of psychopathology, new methodology needed to be developed. This development has made incredible progress in the past years, resulting in multiple procedures for estimating network connections, as developed and used by different research groups. Examples are VAR specified multilevel models (Bringmann, Vissers et al. 2013), Ising models (van Borkulo, Borsboom et al. 2014), Sparse time series chain graphical models (Abegaz and Wit 2013), and models derived from the complex dynamic systems literature. And relatedly, methodological standards are lacking, leading to a large variation between studies in the precise statistical procedures that are used for data cleaning, handling of (variable distribution) violations of the model and for defining the significance of network connections and centrality indices. It has been shown that differences in these mathematical procedures can result in disturbingly different conclusions (Bulteel, Tuerlinckx et al. 2016). Currently, it is thus of high importance to execute such time-intensive studies and sort out

which of these procedures should be used to best approximate the theoretical assumptions that can be derived from the network theory.

A final point of discussion is whether network techniques should or should not already be implemented within clinical practice. Implementation is stimulated by enthusiasm, not only of scientists but also of mental health care professionals. Given the above considerations we should take extreme caution and ensure transparent communication with patients in research that does implement clinical network analysis as feedback to patients. On the other hand, this type of research might be necessary to be able to empirically test its worth for clinical use in terms of prediction of symptom course, patient improvement and patient empowerment.

In short, the network perspective on psychopathology is promising and provides a novel vision on psychopathology that may open new and interesting scientific leads to come closer to the essence of psychopathology. It is important, however, that the enthusiasm in the field is canalized towards the setup of study designs that can actually test the theoretical assumptions as hypothesized, and thus allow for empirical validation of the network theory of psychopathology.

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