Using the OASES-A to illustrate how network analysis can be applied to understand the experience of stuttering

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\textbf{ABSTRACT}

\textbf{Purpose:} Network science uses mathematical and computational techniques to examine how individual entities in a system, represented by nodes, interact, as represented by connections between nodes. This approach has been used by Cramer et al. (2010) to make “symptom networks” to examine various psychological disorders. In the present analysis we examined a network created from the items in the Overall Assessment of the Speaker’s Experience of Stuttering-Adult (OASES-A), a commonly used measure for evaluating adverse impact in the lives of people who stutter.

\textbf{Method:} The items of the OASES-A were represented as nodes in the network. Connections between nodes were placed if responses to those two items in the OASES-A had a correlation coefficient greater than $\pm 0.5$. Several network analyses revealed which nodes were “important” in the network.

\textbf{Results:} Several centrally located nodes and “key players” in the network were identified. A community detection analysis found groupings of nodes that differed slightly from the subheadings of the OASES-A.

\textbf{Conclusions:} Centrally located nodes and “key players” in the network may help clinicians prioritize treatment. The different community structure found for people who stutter suggests that the way people who stutter view stuttering may differ from the way that scientists and clinicians view stuttering. Finally, the present analyses illustrate how the network approach might be applied to other speech, language, and hearing disorders to better understand how those disorders are experienced and to provide insights for their treatment.

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\textbf{1. Introduction}

\textbf{1.1. Network science}

\textit{Network science} refers to an emerging discipline that uses mathematical and computational techniques developed in mathematics, sociology, physics, computer science, and other fields to study complex systems. \textit{Nodes} are used to represent

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an individual entity in the system, and connections are placed between nodes that are related in some way, forming a web-like structure, or network, of the entire system. For example, to study a social system, a node would represent each person in that system, and connections might be placed between people who are friends with each other.

The structure of the network that emerges influences the dynamics of that system. That is, a process may operate very efficiently in a network that is structured one way, but if the network is structured in a slightly different way the same process may become less efficient. For instance, the topology or structure of social networks affects the way information spreads within the network (i.e., the dynamics of the system; Strogatz, 2001). A social network could be structured in a way that allows information to be spread rapidly among people (i.e., a more efficient process), or it could be structured in a way where it takes a long time for information to be transmitted (i.e., a less efficient process).

The network approach has been used to examine economical, biological, social, and technological systems (Barabási, 2009), as well as the cognitive systems associated with language processing (e.g., Vitevitch & Castro, 2015; Vitevitch, 2008). Instead of looking at a social system containing people connected by friendship ties, Vitevitch (2008) examined the mental lexicon—that portion of memory that stores information about the words a speaker knows—using nodes to represent word-forms and connections between words that were phonologically similar to each other. In experiments using a variety of psycholinguistic tasks, certain aspects of the structure of the network that emerged were shown to influence the production of spoken words (Chan & Vitevitch, 2010), the recognition of spoken words (Siew & Vitevitch, 2016), the acquisition of novel words (Goldstein & Vitevitch, 2014), and how speakers recover when lexical retrieval fails (Vitevitch, Chan, & Goldstein, 2014).

The network approach has also been used to examine how psychological disorders such as major depressive disorder or generalized anxiety disorder might arise from the relationship found among various psychological and behavioral symptoms (Cramer, Waldorp, van der Maas, & Borsboom, 2010). In these “symptom networks,” the psychological and behavioral symptoms that are used in the Diagnostic and Statistical Manual of Mental Disorders (DSM) to define various disorders are represented as nodes, and connections are placed between symptoms that tend to co-occur (for an application of network science to bulimic disorders see Forbush, Siew, & Vitevitch, 2016).

From such analyses one can find symptoms that are unique to major depressive disorder and to generalized anxiety disorder, as well as symptoms that act as a “bridge” to connect symptom nodes that are unique to the two disorders. When such bridge symptoms are experienced, there is an increased likelihood that an individual will experience co-morbidity of major depressive disorder and generalized anxiety disorder, suggesting that some symptoms are more predictive of a disorder being observed than other symptoms. In addition, network analyses can identify nodes that are centrally located in the network. The identification of such nodes could provide clinicians with some guidance on which symptoms to prioritize during treatment in order to optimize the therapeutic intervention.

Another advantage of using network analyses over other analysis techniques such as exploratory and confirmatory factor analyses to examine various psychopathologies is that the latter approaches assume that the symptoms of a disorder (e.g., major depression) are the result of a single, underlying (latent) cause. Unfortunately that single underlying cause has not been discovered yet, suggesting that alternative approaches may be required to further our understanding of the underlying causes of psychopathologies. In the network science approach symptoms are causally related to each other and disorders arise from the interplay between connected symptoms (Borsboom & Cramer, 2013). With respect to the experience of stuttering, methods such as factor analysis would assume that varied experiences related to stuttering map onto a single latent factor, whereas the network science approach emphasizes the pattern of associations among the different kinds of experiences associated with stuttering, without necessarily assuming the presence of an underlying latent factor.

1.2. Network analysis of stuttering

In the present work, we applied the network approach in a slightly different way. Rather than examine the symptoms associated with a psychological disorder, we applied this established approach to the communication disorder of stuttering as reflected by the Overall Assessment of the Speaker’s Experience of Stuttering for Adults (OASES-A; Yaruss & Quesal, 2006, 2010). The OASES-A is a multidimensional assessment designed to describe the consequences of stuttering in terms of: (a) a speaker’s general perceptions about his or her stuttering and speech as a whole; (b) the speaker’s affective, cognitive, and behavioral reactions to stuttering; (c) the functional difficulties the speaker may have with communication in key situations; and (d) the negative impact that stuttering may have on the speaker’s quality of life. Just as Cramer et al. (2010) found that not all psychological and behavioral symptoms of major depressive disorder and generalized anxiety disorder are equal, we predict that not all experiences related to stuttering will be equal. That is, certain factors may affect one’s perceptions and reactions to stuttering more than others. Importantly, the tools of network science enable us to identify which factors are more or less influential.

A clearer understanding of the client’s own experiences of stuttering has important implications for clinical practice, given that the overall impact of stuttering on people involves more than the production of observable speech disfluencies (Van Riper, 1982; Yaruss & Quesal, 2006). Treatment should not only address the physical aspects of stuttering, but also the less observable aspects of stuttering, such as the speaker’s feelings about stuttering and perceived impact on quality of life (Plexico, Manning, & DiLollo, 2005; Quesal, 1989; Yaruss & Quesal, 2006). The results of the network analysis of the stuttering experience network could have important implications for clinical practice. For instance, analyzing the pattern of associations among various experiences of stuttering could reveal important “experiences” by virtue of their central location.
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