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Paranoia and interpersonal functioning across the continuum from healthy to pathological – Network analysis

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Objective. Previous research has suggested that paranoia is associated with impaired social functioning in patients with schizophrenia and healthy individuals with high levels of paranoid ideation. This study analysed the relationship between paranoia and interpersonal functioning across the paranoia continuum using network analysis.

Method. Levels of paranoid ideation and interpersonal functioning were measured in a non-clinical sample (N = 853) and in patients with schizophrenia spectrum disorders (N = 226). Network analyses were used to examine the nature of paranoia's relation to interpersonal functioning in both populations.

Results. Although the most central characteristic of paranoia in both samples was the feeling of being talked about behind one's back, across samples, individual characteristics were differentially related to various aspects of interpersonal functioning. Among clinical individuals, difficulties in interpersonal functioning were related to perceived previous experiences of being treated poorly by others, whereas among the non-clinical sample, interpersonal functioning was related to negative beliefs about others.

Conclusions. The current results support previous findings linking paranoid ideation to interpersonal functioning in both clinical and non-clinical samples. Patterns of these relationships differed slightly across groups. Results in general support a continuum model of paranoia.

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Practitioner points

- Network analyses were used to identify central aspects of persecutory ideation in both clinical and non-clinical samples. Qualitative assessment of clinical and non-clinical networks revealed similar central symptoms and supported a continuum model of paranoia.
- Central aspects of paranoia, that is, feeling that others have talked about oneself behind one's back, being disappointed by others, and having distressing feelings of being watched by others, were associated with deficits in interpersonal functioning in both samples.
- Central aspects of paranoia may be beneficial targets for psychosocial interventions aimed at reducing paranoid ideation and improving interpersonal functioning.
- Demographic characteristics for this study differed between samples which may limit generalization of findings.
- Future research is needed to explore temporal associations and moment-to-moment dynamics between paranoid ideation and problems in interpersonal functioning.

Paranoia is a common symptom of mental disorders that is prominent in schizophrenia but also present in depression and bipolar disorder (Bentall *et al.*, 2009). In psychiatric rating scales, paranoid ideation is usually measured via single items like suspiciousness, or hostility (Kay, Fiszbein, & Opler, 1987; Overall & Gorham, 1962). Recently however, paranoia has been conceptualized not as a single construct, but rather as a hierarchy spanning from common emotional concerns like fear of rejection, social anxiety, and feelings of vulnerability to the most extreme forms of paranoia such as the persecutory delusions that can be seen in patients in acute stages of psychosis (Freeman *et al.*, 2005). Data from the British National Survey of Psychiatric Morbidity (Bebbington *et al.*, 2013) support this view, demonstrating that paranoia has a multidimensional structure consisting of the following four factors: interpersonal sensitivities, mistrust, ideas of reference, and ideas of persecution.

Mirroring the hierarchical nature of paranoia, empirical studies have demonstrated that paranoia exists on a continuum spanning both psychopathology and the general population (Bebbington *et al.*, 2013; Freeman, 2016; Freeman *et al.*, 2005). Indeed, conservative estimates indicate that 10–15% of individuals in the general population regularly experience paranoid thoughts (Freeman, 2007). While the degree of preoccupation, conviction, and associated distress tends to differentiate between non-clinical and clinical levels of persecutory ideation (Peters, Joseph, Day, & Garety, 2004; Peters, Joseph, & Garety, 1999), a growing body of literature suggests that paranoia is associated with impaired social functioning and reduced psychological well-being across this continuum (Martin & Penn, 2001; Olfson *et al.*, 2002; Rössler *et al.*, 2007). In the general population, overall higher levels of paranoid ideation are associated with greater social exclusion, lower social functioning, restricted social support, and less engagement in hobbies or activities of interest (Freeman *et al.*, 2005, 2011). In clinical samples, distress associated with persecutory delusions mediates the association between these delusions and aggressive behaviour towards others (van Dongen, Buck, & van Marle, 2012), and the presence of clinically significant levels of paranoid ideation appears to selectively exacerbate the social impairments that are seen in individuals with schizophrenia (Pinkham, Harvey, & Penn, 2016).

Despite these strong links between paranoia and social impairment, it is currently unclear which aspects of paranoia have the greatest impact on social functioning. Recent advances in psychopathological research have suggested that psychiatric disorders can be modelled as complex dynamic networks of interrelated symptoms (Kendler, Zachar, & Craver, 2011). This can be done via network analysis (NA), which differs from traditional

psychometric approaches based on the assumption of latent variables that influence symptom expression (e.g., common-cause model). NA enables investigators to model symptom to symptom interactions (Borsboom, 2008; Borsboom & Cramer, 2013), and in extreme cases, associations between symptoms constitute disorders. The NA approach has been used to model networks of symptoms in psychotic disorder (Isvoranu *et al.*, 2016), depression (van Borkulo *et al.*, 2015; Hajdúk, Heretik, & Pečeňák, 2017), post-traumatic stress disorder (McNally *et al.*, 2015), and substance abuse (Rhemtulla *et al.*, 2016). Some studies have also utilized NA for modelling psychiatric comorbidity (Cramer, Waldorp, van der Maas, & Borsboom, 2010; McNally, Mair, Mugno, & Riemann, 2017), but it is also possible that NA can be used to examine links between multidimensional symptoms (i.e., paranoia) and outcomes (i.e., social functioning; Jones, Heeren, & McNally, 2017).

The overall goal of this study is therefore to analyse the relationships between elements of paranoid ideation and interpersonal functioning using a NA approach. The aims of this study are following: (1) identify the associations between specific dimensions of paranoia and various aspects of interpersonal functioning, (2) qualitatively assess the identified relationships in clinical and non-clinical samples to determine whether the relationships are consistent across the paranoia continuum.

Methods

To examine the continuum of paranoia, data were pooled across two larger studies conducted in our laboratory. The first study involved only non-clinical individuals and was administered via an online survey as part of a screening assessment for undergraduate research participants. Clinical participants were drawn from the Social Cognition Psychometric Evaluation project (SCOPE; Pinkham, Penn, Green, & Harvey, 2016; Pinkham *et al.*, 2014), in which data were collected via in person assessments. The same primary measure of paranoia was used across studies; however, the measures of social functioning differed to allow informant reports of functioning for the clinical participants. Both studies were approved by the Institutional Ethical Review Board, and all participants provided informed consent.

Participants

Non-clinical sample

The non-clinical sample was comprised of undergraduate students who completed the online screening assessment in exchange for course credit. After excluding participants who demonstrated careless responding (i.e., participants who did not complete the survey or gave the same item response across all questionnaires, $n = 87$), the final sample consisted of 853 students. Demographic characteristics are presented in Table 1.

Clinical sample

Clinical participants were individuals with diagnoses of schizophrenia or schizoaffective disorder. One hundred and seventy-nine patients were from the initial psychometric study phase of SCOPE (Pinkham, Penn, *et al.*, 2016), and 51 patients were from the modification phase (Buck, Pinkham, Harvey, & Penn, 2016; Cornacchio, Pinkham, Penn, & Harvey,

Table 1. Demographic characteristics of samples

	Non-clinical sample		Clinical sample	
Characteristic	*N*	%	*N*	%
Gender				
Male	198	23.2	144	63.7
Female	652	76.4	82	36.3
Race				
Caucasian	347	40.7	94	41.6
African American	64	7.5	119	52.7
Asian	337	39.5		
Other	105	12.3	13	5.7
Diagnosis	–	–		
Schizophrenia			118	52.2
Schizoaffective disorder			108	47.8
	M	*SD*	*M*	*SD*
Age	21.36	4.36	42.25	11.96
PANSS	–	–		
Positive			16.15	5.59
Negative			13.51	4.93
General			30.92	7.94
Paranoia scale	39.35	12.39	47.46	19.22
SFS			–	–
Social engagement	10.85	2.26		
Communication	8.12	1.10		
Prosocial	27.90	10.86		
SLOF	–	–		
Interpersonal relationships			3.32	0.90
Social acceptability			4.33	0.58

Note. *M* = mean; PANSS = Positive and Negative Syndrome Scale; *SD* = standard deviation; SFS = Social Functioning Scale; SLOF = Specific Level of Functioning Scale.

2017). Two patients from the initial psychometric study and two from the modification phase were dropped due to missing data on Specific Level of Functioning Scale. The final sample therefore consisted of 226 patients. Diagnoses were confirmed with the Mini International Neuropsychiatric Interview (Sheehan *et al.*, 1998) and the Structured Clinical Interview for DSM Disorders-Psychosis Module (First, Spitzer, Gibbon, & Williams, 2012). Symptom severity was assessed with the Positive and Negative Syndrome Scale (PANSS: (Kay *et al.*, 1987). Information regarding full inclusion and exclusion criteria for the clinical population can be found in Pinkham, Penn, *et al.* (2016). Basic demographic characteristics are presented in Table 1.

Measures

Paranoia scale

Paranoid ideation was evaluated with the Paranoia Scale (PS), which consists of 20 items that measure subclinical levels of paranoid ideation (Fenigstein & Vanable, 1992).

Participants were asked to read each statement and indicate how much each statement applies to him/her. Each item is scored on a 1–5 Likert scale with total scores ranging from 20 to 100 and higher scores indicating greater paranoid ideation. A recent factor analysis demonstrates that the scale consists of three factors: Self-depreciation, Mistrust Thoughts, and Persecutory Ideas (Carvalho *et al.*, 2017). The PS is often used in non-clinical samples for measuring subclinical levels of paranoid ideation (Combs, 2004; Martin & Penn, 2001) but has also been used validly in clinical samples (Craig, 2004; Pinkham *et al.*, 2012).

Social functioning scale

In the non-clinical sample, social functioning was assessed with the Social Functioning Scale (SFS; Birchwood, Smith, Cochrane, Wetton, & Copestake, 1990). The SFS is a self-report measure of seven domains of social adjustment. Three subscales (i.e., Communication rated 0–9, Social Engagement/Withdrawal rated 0–15, and Prosocial Activities rated 0–66) were utilized in the current analyses as these scales assess interpersonal social functioning. Other subscales measuring independence and vocational activities were not assessed here. Higher scores on the three subscales indicate better social functioning (e.g., more competent behaviour or higher frequency behaviour). The original scale has been demonstrated to be a reliable, valid, and sensitive instrument for patients with schizophrenia and has been successfully used in non-clinical samples (Iffland *et al.*, 2015).

Specific level of functioning

Among patients, objective real-world social functioning was assessed using informant reports on the Specific Level of Functioning Scale (SLOF; Schneider & Struening, 1983). The SLOF consists of 30 items assessing four domains: Interpersonal Relationships, Social Acceptability, Involvement in Activities, and Work Skills. An additional item assesses how well the informant knows the participant. Responses were gathered from informants who were high contact clinicians, family members, or close friends identified by the participants. Items are scored on 5-point Likert scale. Higher scores represent better functioning. To focus specifically on interpersonal aspects of social functioning, the present analyses utilized only items from the Interpersonal Relationships (seven items) and Social Acceptability (six items) subscales. Supporting this decision, previous work comparing paranoid to non-paranoid patients found that these subgroups of patients differed only on these two subscales but not Work Skills or Involvement in Activities (Pinkham, Harvey, *et al.*, 2016).

Network analysis – construction and analysis

We constructed independent networks for clinical and non-clinical samples, using the 20 items of the Paranoia Scale and measures of social functioning, SLOF and SFS, as 'nodes' in the network. Specifically, the items from the SLOF interpersonal relationships and social acceptability subscales were used for our clinical sample, and the total scores for the SFS Communication, Social Engagement/Withdrawal, and Prosocial Activities subscales were used for our non-clinical sample. For the SFS, total subscale scores were used instead of individual item scores to improve interpretability and reliability of NA. Specifically, item scores on this scale are diverse, and we do not propose direct relationships to paranoid

ideation for individual items. For example, Prosocial Activities consists of 22 individual prosocial behaviours (e.g., playing sports with others, visiting relatives, eating out in restaurants), and Social Withdrawal contains an item asking at what time a person wakes in the morning. Using these items as individual nodes may be problematic due to an increased number of parameters being estimated, as well as decreasing interpretability of relationships between individual items and paranoid ideation. Thus, subscale scores were deemed more suitable for this exploratory analysis to ensure easily interpretable networks. Table 2 details the nodes and their abbreviations displayed in each of the networks' figures.

Network structures were estimated with R-packages *qgraph* (Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012) and *bootnet* (Epskamp & Fried, 2017). Regularized Gaussian graphical models (GGM) were used to fit data. In the network, associations between nodes are displayed as edges, representing the partial correlations between these two nodes after controlling for all other relationships in the network, and the thickness of the edges indicate strength of these relationships. *Glasso* procedure was used for estimation of the network. Positive relationships are presented as solid lines; dashed lines represent negative relationships. To control for spurious connections within the network, least absolute shrinkage and selection (*lasso*) operator was used, identifying a stable, parsimonious, and easily interpretable network. Lasso is a form of network regularization based on Extended Bayesian Information Criterion (Chen & Chen, 2008) and shrinks small regression coefficients, to zero. The remaining number of edges is used to explain the covariation structure in the data. To assist with visual interpretation of nodular significance, nodes with stronger and more numerous edges were moved to the centre of the network using the Fruchterman–Reingold algorithm (Epskamp, Borsboom, & Fried, 2018).

Several indices are estimated to evaluate the importance of each node in the network. In the present analysis, we used the following centrality estimates: (1) Strength – indicates the magnitude of direct relationships with other nodes in network, (2) Betweenness – indicates the probability that a node lies along the shortest path between other nodes in the network, and (3) Closeness – indicates the magnitude of indirect relationships with other nodes in the network.

Accuracy of networks was evaluated using an estimation of the accuracy of edge weights, utilizing a bootstrap with 95% confidence interval on edge weights. Furthermore, we investigated the stability of the centrality measures by subsetting participants, that is, re-estimating the networks after dropping participants. Estimates are considered stable if there is a strong association (correlation above 0.70) between original estimates and estimates from a subset of the sample. In both samples, estimation of accuracy and stability analyses were performed on 1,000 bootstrap samples (Epskamp *et al.*, 2018). Stability, expressed as the CS coefficient, should be at least 0.25 for centrality measures to be considered stable, and ideal values should be above 0.50 (Epskamp *et al.*, 2018). Supporting information (Figures S1–S4) about NA results can be found in online version of article.

Results

Non-clinical sample

The stability coefficient for our primary measure of interest, Strength (CS [0.70] = 0.517), was over the recommended minimal threshold, as was the stability coefficient for Closeness (CS [0.70] = 0.284). The stability coefficient for Betweenness (CS [0.70] = 0.128) were below threshold and therefore should be interpreted with care.

Table 2. Explanation of nodes abbreviations

P01	Someone has it in for me
P02	I sometimes feel as if I'm being followed
P03	I believe that I have often been punished without cause
P04	Some people have tried to steal my ideas and take credit for them
P05	My parents and family find more fault with me than they should
P06	No one really cares much what happens to you
P07	I am sure I get a raw deal from life
P08	Most people will use somewhat unfair means to gain profit or advantage, rather than lose it
P09	I often wonder what hidden reason another person may have for doing something nice for you
P10	It is safer to trust no one
P11	I have often felt that strangers were looking at me critically
P12	Most people make friends because friends are likely to be useful to them
P13	Someone has been trying to influence my mind
P14	I am sure I have been talked about behind my back
P15	Most people inwardly dislike putting themselves out to help other people
P16	I tend to be on my guard with people who are somewhat more friendly than expected
P17	People have said insulting and unkind things
P18	People often disappoint me
P19	I am bothered by people outside, in cars, in stores, etc., watching me
P20	I have often found people jealous of my good ideas just because they had not thought of them first
IR01	Accept contact with others
IR02	Initiates contact with others
IR03	Communicates effectively
IR04	Engages in activities without prompting
IR05	Participates in groups
IR06	Forms and maintains friendships
IR07	Asks for help when needed
SA01	Regularly argues with others
SA02	Has physical fights with others
SA03	Destroys property
SA04	Physically abuses self
SA05	Is fearful, crying, clinging
SA06	Takes property from others without permission
COM	SFS – Communication
PRO	SFS – Prosocial behaviour
ENG	SFS – Social Engagement

Figures for network accuracy analysis for edge weight are in the online supplement of the manuscript. Inspection of the network reveals that the most central nodes in terms of strength in the non-clinical sample were within the PS, specifically items PS14 (*I am sure I have been talked about behind my back*), PS09 (*I often wonder what hidden reason another person may have for doing something nice for you*), and PS03 (*I believe that I have often been punished without cause*). The node with highest betweenness and closeness was item PS10 (*It is safer to trust no one*) indicating connections with a larger number of nodes in the network. Within network, the strongest association was found within the PS scale between nodes PS14 (*I am sure I have been talked about behind my back*) and P17 (*People have said insulting and unkind things about me*). The second strongest relationship was found between items PS04 (*Some people have tried to steal my ideas and takes credit for them*) and PS20 (*I have often found people jealous of my good*

ideas just because they had not thought of them first). Additionally, the total scores for the three SFS subscales, Communication (COM), Social Engagement/Withdrawal (ENG), and Prosocial Activities (PRO) were strongly associated with each other. Across measures, the SFS Communication subscale was negatively associated with items PS06 (*No one really cares much what happens to you*) and PS10 (*It is safer to trust no one*). A higher level of Social Engagement was associated with lower scores on items related to self-depreciation, PS06 (*No one really cares much what happens to you*) and PS05 (*My parents and family find more fault with me than they should*). Social Engagement was also negatively associated with persecutory ideas as measured by item PS19 *(I am bothered by people outside, in cars, in stores, etc., watching me*). Estimated network and centrality estimates are presented in Figures 1 and 2.

Strength indicates the magnitude of direct relationships with other nodes in network; Betweenness indicates the probability that a node lies along the shortest path between other nodes in the network; Closeness indicates the magnitude of indirect relationships with other nodes in the network.

Clinical sample

As with the non-clinical sample, the stability coefficient for our primary measure of interest, strength, was over the recommended minimal threshold (CS [0.70] = 0.518). The stability coefficients for Closeness (CS [0.70] = 0.204) and Betweenness (CS [0.70] = 0) were below threshold. As our intent with this analysis is to describe the relationships between individual items, and in line with recommendations from Epskamp *et al.* (2018), the presented analysis only interprets the strength centrality measure. Figures from network accuracy analysis for edge weight are available in the online supplement of the manuscript. The network of paranoia and interpersonal functioning for the clinical sample is presented in Figure 3. As expected, relationships between nodes within the measures are stronger than those between measures, and the two subscales of the SLOF formed separate subclusters in the network. The most

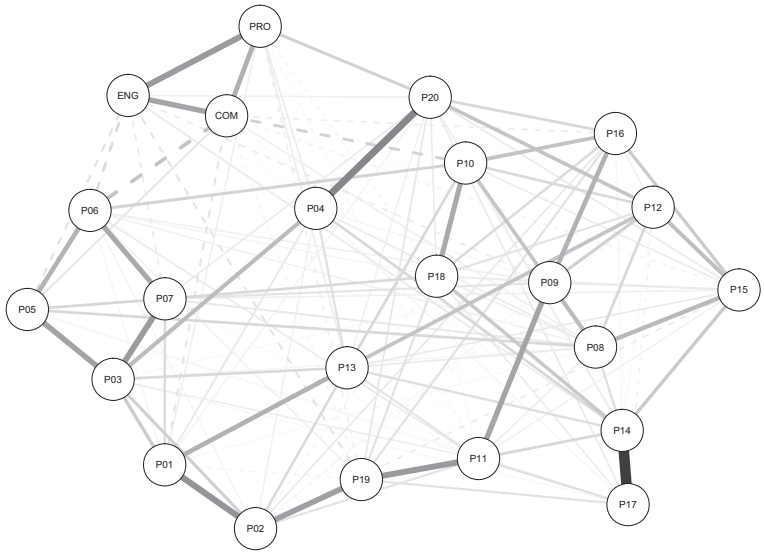

Figure 1. Estimated network on non-clinical sample.

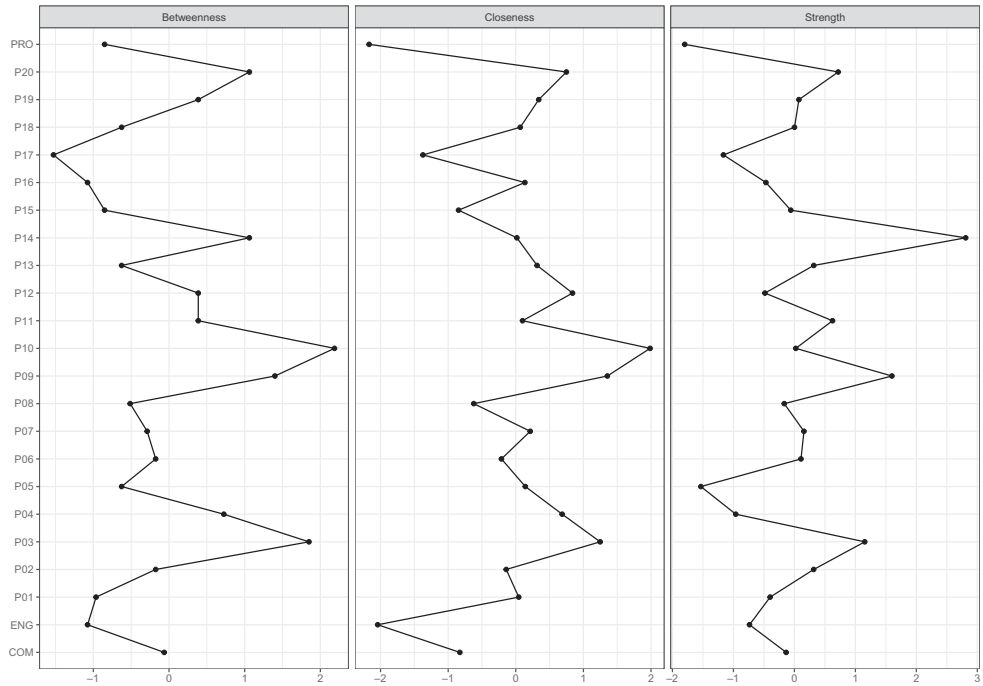

Figure 2. Centrality estimates for non-clinical sample network.

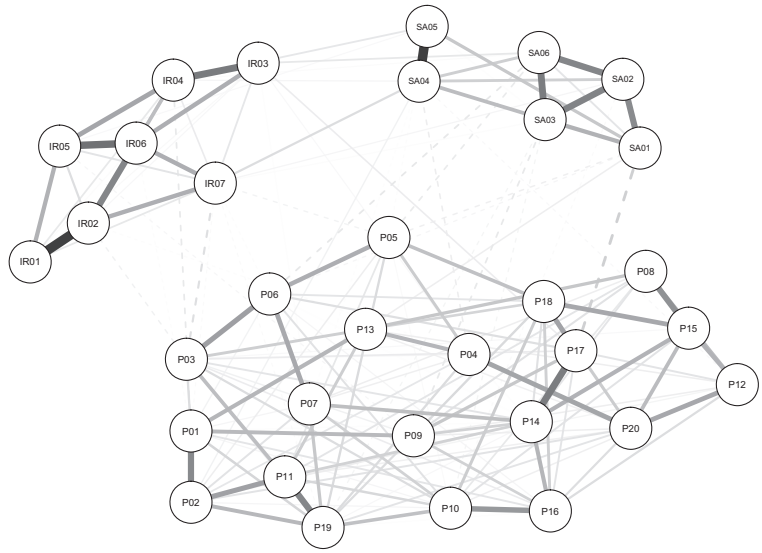

Figure 3. Estimated network on clinical sample.

central nodes in terms of strength indices in the whole network were as follows: PS14, PS19, PS18, PS11. Centrality values for strength, closeness, and betweenness are presented in Figure 4. Within the nodes from PS, the strongest associations were found between nodes PS14 (*I am sure I have been talked about behind my back*) and PS17

(*People have said insulting and unkind things about me*). Additionally, two other pairs of strongly associated nodes were noted within the network, that is, items PS1 (*Someone has it in for me*) and PS2 (*I sometimes feel as if I am being followed*), as well as items PS11 (*I have often felt that strangers were looking at me critically*) and PS19 (*I am bothered by people outside, in cars, in stores etc. watching me*). This relationship is consistent with previous factor analysis stating that these items load on a single, persecutory ideation factor (Carvalho *et al.*, 2017). In terms of the whole network, the strongest associations were found within SLOF domains (ÌR01 and IR02; SA04 and SA05). Across measures, item SA01 (*Regularly argues with others*) from the SLOF social acceptability subscale was uniquely and negatively associated with PS17 (*People have said insulting and unkind things about me*). Additionally, the strongest negative association between the PS and the SLOF Interpersonal relationships subscale was between item IR07 (*Asks for help when needed*) and PS03 (*I believe that I have often been punished without cause*).

Strength indicates the magnitude of direct relationships with other nodes in network; Betweenness indicates the probability that a node lies along the shortest path between other nodes in the network; Closeness indicates the magnitude of indirect relationships with other nodes in the network.

Discussion

The current article provides the first network analysis of the relationship between paranoia and interpersonal functioning across the paranoia continuum. Overall, results supported associations between interpersonal functioning and paranoid symptoms both

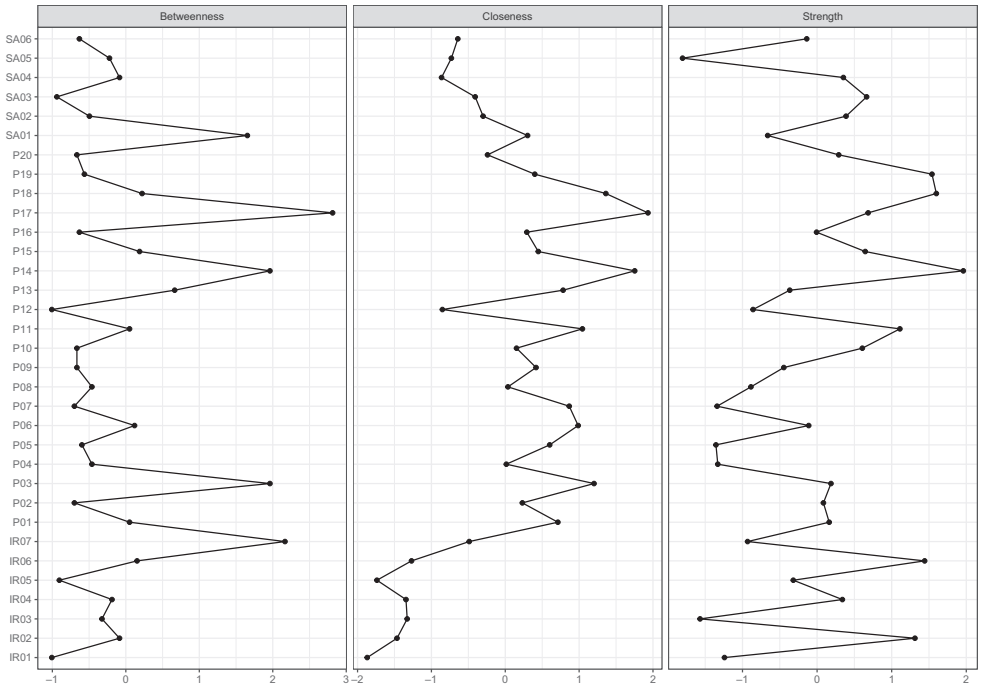

Figure 4. Centrality estimates for clinical sample network.

within the normative population and among individuals with severe mental illness. However, unique and distinct associations were observed between patients with schizophrenia and a healthy, non-clinical sample in both the relationships between different aspects of paranoia and how these aspects of paranoia are related to interpersonal functioning. A major benefit of network analysis is that high centrality nodes can be considered proxy indicators of clinical importance, and thus those nodes, or in this case specific aspects of paranoia, represent potential key targets of therapeutic intervention. These results therefore indicate that remediation of the particular elements of paranoia identified here could improve interpersonal functioning. Further, as aspects of paranoia appeared to be differentially related to functioning across samples, the current results suggest that targets of intervention should vary slightly pending the clinical status of the individual.

Consistent with previous factor analysis, the most central symptoms in our networks were aspects of persecutory ideations, such as feelings that others had talked about oneself behind one's back, being disappointed by others, and distressing feelings of being watched by others. Furthermore, feeling that others talked about oneself behind their back was most central in both clinical and non-clinical networks. This finding is consistent with previous research noting that worries about being criticized or rejected in social situations is a central symptom of paranoia in general populations (Bell & O'Driscoll, 2018). In our clinical sample, item PS17 (*People have said insulting and unkind things about me*) had the highest value of betweenness, indicating that this sensitivity for criticism could play an important role in triggering and maintaining paranoid ideation.

Differences between samples were also evident in the relationships between paranoia and social functioning. In the clinical sample, lower quality of interpersonal relationships was associated with more feelings of being punished without cause (ideas of persecution). Additionally, beliefs that others are saying unkind or insulting things (persecutory ideation) were associated with less socially acceptable behaviour (arguing with others). In our non-clinical sample, social engagement and quality of interpersonal communication were associated with interpersonal sensitivity and mistrust. Some of these differences may be partially due to methodological differences between samples. As self-report measures of social functioning for patients with schizophrenia may not accurately estimate true levels of functioning (Ermel *et al.*, 2017; Sabbag *et al.*, 2011), our analyses utilized ratings of interpersonal functioning as assessed by high contact informants who know the patient well. Network analyses may differ when using only self-reported measures of functioning, as self-report measures may inflate the degree of relationships simply due to the fact that the same person is making ratings (i.e., shared method variance). Therefore, using an impartial assessment of interpersonal functioning may lead to fewer connections, but should result in a less biased network.

Not surprisingly, interpersonal functioning in our non-clinical sample seems to be predominantly associated with lower paranoia severity in contrast to our clinical sample. However, this demonstrates that levels of subclinical paranoid ideation may have a meaningful impact on daily functioning. Socially stressful situations are associated with increased negative emotions, predicting the onset of paranoia in psychosis (Myin-Germeys, van Os, Schwartz, Stone, & Delespaul, 2001; Veling, Pot-Kolder, Counotte, van Os, & van der Gaag, 2016), and in subclinical individuals, social conflict may lead to increased paranoid ideation, or vice versa. In our clinical sample, lower frequency and quality of social contact may be explained as a safety behaviour that patients utilize to reduce the perceived threat of others (Freeman *et al.*, 2007). Future studies are needed to examine the causal mechanisms of social conflict and isolation in seeking social support

and how these, along with other confounding symptoms of schizophrenia such as negative symptoms, play a role in paranoid ideation and social functioning.

Limitations and future directions

The male–female ratio, age, and proportion of each race differed across samples, which partially limits direct comparisons of networks. The non-clinical sample was also more diverse than our clinical population. As being a member of a minority group and migration are well known risk factors of psychotic disorder (Morgan, Charalambides, Hutchinson, & Murray, 2010), future studies should match clinical and non-clinical groups on demographic factors to perform direct comparisons.

Another limitation of this study is our measure of paranoia. Despite the fact that the Paranoia Scale is widely used in research, the 20 items do not sufficiently cover all relevant aspects of paranoid ideation. As such, the networks presented do not account for other dimensions of paranoid ideation, namely degree of conviction and level of associated distress. These dimensions may play a vital role in social functioning and analysing these aspects may provide a more comprehensive understanding of how paranoid ideation is related to interpersonal functioning across the continuum.

Furthermore, our study utilized different measures of interpersonal functioning in the clinical and non-clinical samples, which further limits direct comparison of estimated networks. In our clinical sample, we used SLOF items as assessed by independent raters, which we feel is more appropriate to reveal fine grained relationships in a clinical population. However, this measure may not be sensitive enough to measure variability in a non-clinical sample. Thus, for our non-clinical sample, we utilized the SFS, which allowed for more variability, but limited the interpretability of individual items within the network analysis. Although SLOF items assess generalized behaviours such as whether a participant engages in activity without prompting and with self-sufficiency in daily tasks, the individual items on the SFS measure distinct activities, such as how often a participant goes to the movies or attends evening classes. This limits the ability to interpret a network analysis on an item by item basis with the SFS, and subscale totals must be utilized. This reduced our ability to assess associations between paranoia and specific behaviours in our non-clinical sample.

Although the aim of the current study was to observe the network structure of paranoid ideation and social functioning in each of our two groups, and not to fully examine the structure of paranoia itself across groups, future research should compare clinical samples with matched healthy controls to better examine whether the structures of these paranoia networks are the same in across the continuum.

Longitudinal studies are also needed to evaluate how positive or negative social events cause changes in levels of paranoid ideation. Experience sampling methods may reveal whether changes in network are only in terms of overall connectivity or in the structure of paranoia. Future studies should also address the impact of other important variables outside social functioning such as positive and negative emotions and negative symptoms.

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Conflict of interest declaration

P.D.H serves as a consultant/advisory board member for Boeheringer Ingelheim, Lundbeck, Otsuka Digital Heath, Roche, Sanofi, Sunovion, and Takeda. M.H. reported receiving a fee from Lundbeck Slovakia as a speaker at an education grant conference. Other authors report no conflict of interests.

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Supporting Information

The following supporting information may be found in the online edition of the article:

Figure S1. Non-clinical sample. Bootstrap results for edge – weights.
Figure S2. Non-clinical sample. Stability of centrality indices.
Figure S3. Clinical sample, Bootstrap results for edge – weights.
Figure S4. Clinical sample. Stability of centrality indices.