Background: Research in the field of psychosis broadly suggests that symptoms, neurocognitive deficits, social cognition, cognitive biases, and attachment experiences influence each other. However, little is known if any of these constructions play a more central role than others as they interact. *Method*: To clarify this issue, we conducted a "network" analysis to explore the interplay among a set of variables related to attachment, cognition domains, and psychotic symptoms in a small sample of outpatients with stabilised schizophrenia-spectrum disorders (*n* = 25). Eighteen participants (72 %) were first-episode patients. We assessed psychotic symptoms, attachment dimensions, neurocognitive performance, "theory of mind", emotion recognition, and "jumping to conclusions" bias using standardised instruments. *Results*: The study provides preliminary evidence about a network structure in which the secure attachment (SA) is the most central "node" within the interacting network considering all centrality measures, followed by general psychopathology. SA was closely connected to self-sufficiency (avoidant attachment) and child traumatism, as well as with neurocognition. Emotion recognition impairment was the most robust connection to positive symptoms and mediated the influence of SA on psychotic symptoms. *Conclusions*: Beyond the importance of symptoms, our results, although preliminary, suggest the need to assess attachment experiences and cognition domains to improve specific interventions that can promote recovery in outpatients with psychosis.

The centrality of secure attachment within an interacting network of symptoms, cognition, and attachment dimensions in persons with schizophrenia-spectrum disorders: A preliminary study.

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Introduction

Relevant studies in the field of psychosis broadly suggest that symptoms, neurocognitive deficits, social cognition, and cognitive biases influence each other (Pena-Garijo & Monfort-Escrig, 2020a; 2020b). It has been demonstrated that "theory of mind" (ToM), emotion recognition, and attributional biases influence clinical and social outcomes in psychosis-related disorders (Browne et al., 2016; Buck et al., 2016; Mallawaarachchi et al., 2019; Monfort-Escrig & Pena-Garijo, 2020) and neurocognition (Bora et al., 2017; Jirsaraie et al., 2018). More recently, some reasoning bias, such as the *jumping to conclusions* (JTC) bias, have been proposed as core mechanisms for developing delusional beliefs (e.g., Moritz et al., 2018) and are related to neurocognitive deficits (Garety et al., 2013). However, little is known about the paths these constructs take as they interact (Hasson-Ohayon et al., 2018).

Then again, attachment patterns and early life experiences are relevant to understand the role of environmental factors in the vulnerability and development of psychosis (Bailey et al., 2018; Sheinbaum et al., 2013). Attachment measures are related to social cognition as a mediator between insecure attachment and clinical outcomes in psychosis (Korver-Nieberg et al., 2014) and in individuals with psychotic-like experiences (PLE) (Gawęda et al., 2018). Recent studies on attachment highlight the risk of developing psychotic experiences (Bailey et al., 2018; Rössler et al., 2016) and deficits in social cognitive skills (Rokita et al., 2018).

Attachment is conceptualised as the "propensity to make intimate emotional bonds to particular individuals as a basic component of human nature" (Bowlby, 1988). Attachment theory suggests that early experiences with caregivers become internalised as cognitive-affective representations or internal working models of the *self* and *others*; these models serve as templates for future relationships across the life course (Bifulco & Thomas, 2012). Moreover, several works reveal that insecure attachment is also prominent in the family environment of schizophrenia, showing insecure attachment and impaired social cognition in the mothers of schizophrenia patients (Balikci et al., 2018a; 2018b).

Furthermore, an insecure attachment may be linked to cognitive impairments that contribute to the development of PLEs. Blair et al. (2018) cite several studies showing how individuals with a history of early trauma exhibit neuropsychological impairments that reflect those in psychosis patients, particularly in executive functions (e.g., cognitive control, working memory, decision making).

Other studies have also documented an increased incidence of insecure attachment and ToM deficits in individuals experiencing psychotic disorders (Hart et al., 2017). In contrast, a secure attachment may act as a protective factor against the development of psychosis when an underlying vulnerability exists (Hart et al., 2017).

Despite the large body of research exploring the associations between cognition, psychotic symptoms and attachment styles, more work is required to clarify how they relate to one another (Brown et al., 2014; Korver-Nieberg et al., 2014).

In this sense, "network" approaches improve the limitations of traditional research strategies, while offering promising methodological alternatives (Borsboom & Cramer, 2013). To date, the "network approach" has been used to explore different psychiatric disorders, including depression, social anxiety, personality disorders, and, more recently, psychosis (van Rooijen et al., 2017). A recent review of the literature revealed seven studies that were focused on psychosis-related symptoms (Contreras et al., 2019). We found two more studies that were not included in the review: one exploring the centrality of symptoms, neurocognition, social cognition, and metacognition (Hasson-Ohayon et al., 2018) and another one assessing the interplay among psychopathology, cognition, functional capacity, and real-life functioning (Galderisi et al., 2018). However, none of these studies included attachment dimensions in the network analysis.

Our study aims to explore the relative associations among three constructs that have demonstrated that they influence psychosis: attachment dimensions, cognition (basic and social), and psychotic symptoms. For this purpose, we perform a network analysis in a small sample of outpatients with stabilised schizophrenia-spectrum disorders. Network analysis is a relatively novel approach and has been suggested as an adequate methodology to study mental health problems (Fried et al., 2017), even in small sample sizes (Jones et al., 2018). The inclusion of attachment dimensions in a network analysis is, as far as we know, a novelty in the field of psychosis.

Methods

Participants and procedure

Twenty-five adults diagnosed with a psychotic disorder according to the DSM-5 (APA, 2013) participated voluntarily in the study. Participants were recruited via public mental health centres from Castellon and Valencia (Spain). They were outpatients who were clinically stabilised, with a medication-stabilised condition and no history of drug abuse in the last 4 weeks. Eighteen (72%) participants were first-episode psychotic patients (FEP) and seven (28%) had a diagnosis of paranoid schizophrenia. Sixteen (64%) participants had spent less than 3 years since the onset of the disease; four (16%) between 3–10 yeas; and five (20%) had been diagnosed more than 10 years ago. The current study is part of a doctorate thesis project approved by Jaume I University (Castellon, Spain), and it complies with the Declaration of Helsinki ethical standards. The study's aim and conditions were described to participants verbally and in written form, and all of them provided written informed consent.

Measures

Attachment dimensions

We used the reduced Spanish version of CAMIR (from French; *Cartes, Models Individueles de Rèlation*; Pierrehumbert et al., 1996). Balluerka et al. (2011) developed the reduced version in the Spanish population (CAMIR-R). It is a self-report questionnaire aimed at measuring attachment cognitions. It is based on subjects' evaluations of past and present attachment experiences and family functioning. It evaluates seven factors: *Security* (availability of the attachment figures), *Family concern*, *Parental interference*, *Value of parental authority*, *Parental permissiveness*, *Self-sufficiency* and resentment against parents, and *Child traumatism*. These factors are related to three attachment styles: *secure*, *preoccupied*, and *avoidant*. In a previous study (*unpublished work*), Cronbach's *alpha* coefficients were calculated to test the instrument's adequacy in a psychotic sample. The results showed that CAMIR-R is reliable for use in persons with psychosis with *alpha'* coefficients between 0.63 and 0.90, except for the *value of parental authority* (a = 0.45). Thus, we did not use it in the analyses. Coefficients between 0.63 and 0.90 were considered appropriate for scales of less than eight items and were like those reported by Balluerka et al. (2011) with the Spanish population.

Symptoms

We used the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987; Peralta & Cuesta, 1994). The measure showed to be reliable with Cronbach's *alpha* coefficients of 0.73 for the Positive Syndrome Scale, 0.83 for the Negative Syndrome, and 0.79 for the General Psychopathology.

Neurocognition

The Screen for Cognition Impairment Psychiatric Scale (SCIP-S; Pino et al., 2008) is a neuropsychological test designed to screen cognitive impairments in psychiatric patients. It provides five scores: immediate and delayed verbal learning, working memory, verbal fluency, processing speed, and an overall score. To avoid an excess of variables, we used the overall score (percentile) to summarise neurocognitive performance.

Theory of Mind

The Hinting Task (Corcoran et al., 1995) was designed to assess the ToM in people diagnosed with schizophrenia and provides an overall score for ten or five stories. The Spanish version achieved good internal consistency with *alpha* coefficients of 0.64 for controls, and 0.69 for participants with psychosis (Gil et al., 2012).

Emotion recognition

The PERE (from Spanish; *Prueba de Evaluación de Reconocimiento de Emociones*) includes 56 pictures to evaluate the perception of six basic emotions: joy, sadness, anger, surprise, fear, disgust, and a neutral expression (Gil-Sanz et al., 2017). All photos had an accuracy higher than 89% and test-retest reliability between 0.80 and 1.32 for controls, and between 0.61 and 1.92 for outpatients. We used the total number of adequately recognised emotional expressions.

Jumping to conclusions bias (JTC)

The Beads Task is a probabilistic reasoning task in which the subject sees an image of two jars filled with balls of two different colours in different proportions (Dudley & Over, 2003). A computerised version with a ball's ratio of *60:40* was used. Participants are informed that one of the jars has been randomly selected and the balls will be extracted and displayed one by one on the screen. The task consists of deciding which jar the balls come from, seeing as many balls as necessary until they are sure of their decision. We used the total number of *draws to decide*. Less than two *draws to decide* was used as a threshold to consider a JTC bias (Garety et al., 2011).

Data analysis

Statistical analyses were conducted using the 23.0 version of SPSS, and the 0.13.1 version of JASP (JASP Team, 2020). JASP software included the R Package for network analyses (Rosseel, 2012).

Network analysis

The partial correlation network shows the remaining association between two *nodes* after controlling for all other associations (Hasson-Ohayon et al., 2018). The net associations between every two nodes are like regression coefficients (Epskamp et al., 2018). Partial correlations threshold was turned into "0" to allow more edges to be estimated. Such estimations tend to include spurious correlations. To minimise it, we used a regularisation technique called LASSO: "least absolute shrinkage and selection operator" (Friedman et al., 2010). LASSO type of network involves the estimation of the model with an extra penalty for complex models. It has been used to meet the challenges of small samples in psychology research. The LASSO tuning parameter is typically set between 0 and 0.5. The tuning hyperparameter γ of Extended Bayesian Information Criteria was set manually to 0, to increase the sensitivity of the procedure. It controls the *sparsity* of the estimated network. Setting it to 0 will cause the regular Bayesian Information Criteria to be used. As some variables were non-normally distributed, we first applied the nonparanormal transformation to make all data normally distributed and then use Pearson correlations.

To examine the relative centrality of each construct within the network, we calculated standardised centrality measures. "Betweenness" is measured by calculating how often a variable lies on the shortest path between any combination of two nodes. "Closeness" is the average distance from the node of interest to all other nodes. "Strength" (degree) is the sum of the weighted number and strength of all connections of a specific node to all other nodes (Epskamp et al., 2018).

Finally, to test the reliability of our model, we used some new methods recommended by Epskamp et al. (2018) for estimating psychological networks and their accuracy.

Network construction

We included three clusters of variables:

Symptoms: positive, negative, and general psychopathology.

Attachment dimensions: security, family concern (preoccupied style), self-sufficiency (avoidant style), and child traumatism.

Cognition: neurocognition, ToM, emotion recognition, and beads task (number of *draws to decide*).

We removed parental interference and permissiveness from the analysis because they did not correlate with the other variables after controlling for all other associations.

The layout of the network was generated via the Fruchterman-Reingold algorithm (Fruchterman & Reingold, 1991).

Results

Table 1 shows the characteristics of the participants. The sample was mostly made up of men, but no differences between gender exist, except for family concern ($F = 5.20$; $p < 0.05$).

Figure 1 represents the estimated network model. Secure attachment (SA), self-sufficiency and general psychopathology resulted in the most central *nodes*, considering all centrality measures. **Table 2** shows the weights matrix among the variables included in the network.

Figure 2 shows the centrality measures. These measures are based on the pattern of the connections in which the node of interest plays a role.

Figure 3 represents the *network's edge stability* using the Confidence Intervals (95%) after *bootstrapping* method (1000 replications). It compares the bootstrap mean with the original sample.

Figure 4 represents the centrality stability of the network. It shows the correlations between the original centrality indices in the whole sample and those estimated in subgroups obtained by dropping increasing percentages of subjects. Centrality indices (*strength*) have an average correlation with the original indices of at least 0.70 with the randomly defined subgroups up to 70% of case-dropping (i.e., sampled people = 30%).

The results should not be interpreted as significance tests, but only as a method to estimate the accuracy of the network generated from the current sample (Epskamp et al., 2018).

Discussion

Network approaches offer promising methodological alternatives to traditional research strategies and possibilities to guide and evaluate therapeutic interventions (Borsboom & Cramer, 2013).

The SA and self-sufficiency appear to be closely connected and are the most central nodes within the interacting network, followed by general psychopathology. SA could be defined as the way in which people experience availability and support from their attachment figures. A secure attachment may act as a protective factor against the development of psychosis when an underlying vulnerability exists (Hart et al., 2017).

Moreover, we have found a negative connection between childhood trauma and SA. Attachment patterns and early life experiences are relevant factors in the vulnerability and development of psychosis (Bailey et al., 2018) and are associated with network symptoms in schizophrenia (Galderisi et al., 2018; Isvoranu et al., 2017). Persons with psychosis tend to have an insecure attachment style, but the associations with symptom dimensions are not clear (Chatziioannidis et al., 2019). In this report, family concern (preoccupied attachment) is linked to negative symptoms and general psychopathology, being the only "direct path" from attachment to symptoms. In contrast, our study finds self-sufficiency (avoidant style) to be positively related to ToM. Pos et al. (2015) demonstrate that an anxious (preoccupied) attachment is associated with worse ToM performance in patients. However, their results also suggest a potential protective role of higher levels of avoidant attachment on ToM.

According to previous literature, emotion recognition and ToM deficits correlate to positive symptoms and general psychopathology (Browne et al., 2016; Buck et al., 2016; Mallawaarachchi et al., 2019).

Interestingly, emotion recognition is the most robust connection from cognition domains to positive symptoms and mediates the association between SA and positive and general symptoms. This path suggests that low levels of SA influence symptoms through emotion recognition deficits, indicating the shortest pathway from SA to psychotic symptoms. Emotion recognition impairment is present early on and stable throughout the course of schizophrenia (Comparelli et al., 2013); it is also a predictor of transition to a psychotic disorder in ultra-high-risk individuals (Allot et al., 2014). Furthermore, our study shows a negative association between neurocognition and general psychopathology. Likewise, Lindgren et al. (2020) found that neurocognition and social cognition predict one-year outcomes in FEP. Our results may be significant, given that most participants within our sample are FEP.

Regarding cognitive biases, the beads task relates to neurocognition. González et al. (2018) show a relation between neuropsychological functioning and the JTC bias in FEP. The beads task is often used to assess the JTC bias regarding its predictive role in forming delusional beliefs (Garety et al., 2013), but not exclusively in relation to schizophrenia (e.g., Moritz et al., 2018). Nevertheless, according to previous literature (Dudley et al., 2016), 32% of our participants exhibited a JTC bias.

Finally, SA correlates with neurocognition. This is in line with prior studies that suggest how the association between insecure attachment and cognitive impairments may contribute to the development of PLEs (Blair et al., 2018).

Limitations and future research

First, although this is a preliminary report, the small sample size was the main limitation of our study and restricted the number of variables to analyse. We tried to improve this by focusing the study specifically on FEP outpatients or outpatients with paranoid schizophrenia. Moreover, network analysis has been suggested as a good approach to study mental health problems, even using small sample sizes (Jones et al., 2018). Second, the cross-sectional study design prevents the determination of causal relationships because it is difficult to know whether cognition or attachment experiences that patients relayed preceded the onset of the symptoms or, on the contrary, if the clinical condition modified the cognition and attachment-related memories. Lastly, given the novelty of network models in psychopathology, rigorous methods for assessing the reliability of the estimated networks are required. We used some procedures recommended by Epskamp et al. (2018). Results should be interpreted with caution due to the relatively wide confidence intervals in edge stability. However, the results in the stability of some centrality measures are acceptable. Nevertheless, there is still no agreement on the best indicators of centrality in psychopathology (Bringmann et al., 2019).

To improve these limitations, future research should attempt to include more ecological measures; rigorous methods for assessing the reliability of the models; larger, homogeneous, and equal samples; relationships with daily-life skills; and a broader set of clinical variables.

Clinical implications

Our findings add evidence to the "attachment-developmental-cognitive" hypothesis of schizophrenia (Rajkumar, 2014). He suggests how the attachment might represent a construct capable of bridging different levels of analysis in psychosis.

If secure attachment, emotion recognition, or general psychopathology are *nodes* through which other variables interact, specific interventions on them could influence the entire network as they are expected to affect the related nodes (Hasson-Ohayon et al., 2018).

Furthermore, some investigations show that secure adult attachment is related to how persons with psychosis engage with mental health services (McGonagle et al., 2019) and how it may be a protective factor to develop psychotic experiences (Hart et al., 2017). These are important clinical issues.

Conclusions

Recently, the conceptualisation of the dynamic system of psychopathology has gained ground, leading to the development of "network models" (van Rooijen et al., 2017).

This report provides preliminary evidence about a network structure in which secure attachment is the most central *node* within an interacting network of symptoms, attachment dimensions, and cognition domains, considering all centrality measures. Secure attachment is also closely connected to self-sufficiency and child traumatism, as well as neurocognition. Importantly, emotion recognition impairment has the strongest connection to positive symptoms and mediates the association of secure attachment with positive symptoms and general psychopathology.

Beyond the importance of symptoms, our results, although preliminary, suggest the need to assess attachment experiences and cognition domains to improve specific interventions that can promote recovery in outpatients with psychosis.

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Table 1. Demographic and clinical characteristics of the sample (*N* = 25).

Table 2. Weights matrix among the variables included in the network model.

Figure 1. The network model of symptoms, cognition, and attachment dimensions. Each *edge* within the network corresponds to a partial correlation between two individual items. The thickness of an edge represents the absolute magnitude of the correlation (the thicker the edge, the stronger the connection). Green lines represent positive relations, whereas red ones represent a negative relation. Weights values are shown in Table 2.

Figure 2. Centrality Plot. Secure attachment is the most influential *node*, following by self-sufficiency and PANSS general psychopathology.

Figure 3. Edge stability. It represents the edge stability of the network using the CIs after *bootstrapping* method. It compares the bootstrap mean with the original sample. The bootstrapped CI is the variation that covers 95% of the cases (1000 replications). Redline represents the original sample. Blackline is the bootstrap mean. The grey area shows the CIs.

Figure 4. Centrality Stability. Correlations between the original network centrality indices in the whole sample and those estimated in subgroups obtained by dropping increasing percentages of subjects. Average correlations are reported in the *y*-axis and percentages of sampled people in the *x*-axis.

Figure 1

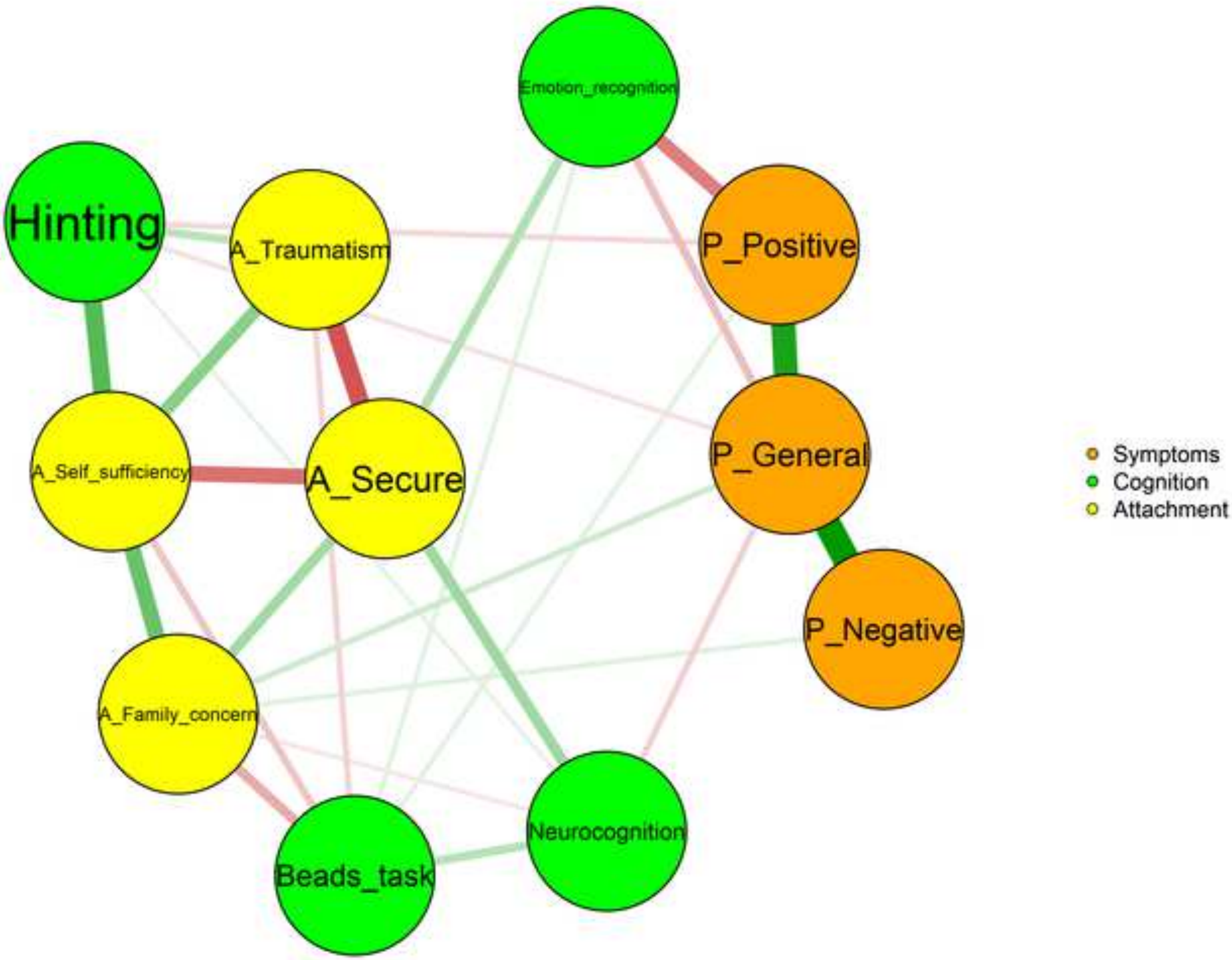
Emotion_recognition
Hinting
A_Traumatism
P_Positive
A_Self_sufficiency
A_Secure
P_General
P_Negative
A_Family_concern
Neurocognition
Beads_task
Symptoms
Cognition
Attachment

Figure 2

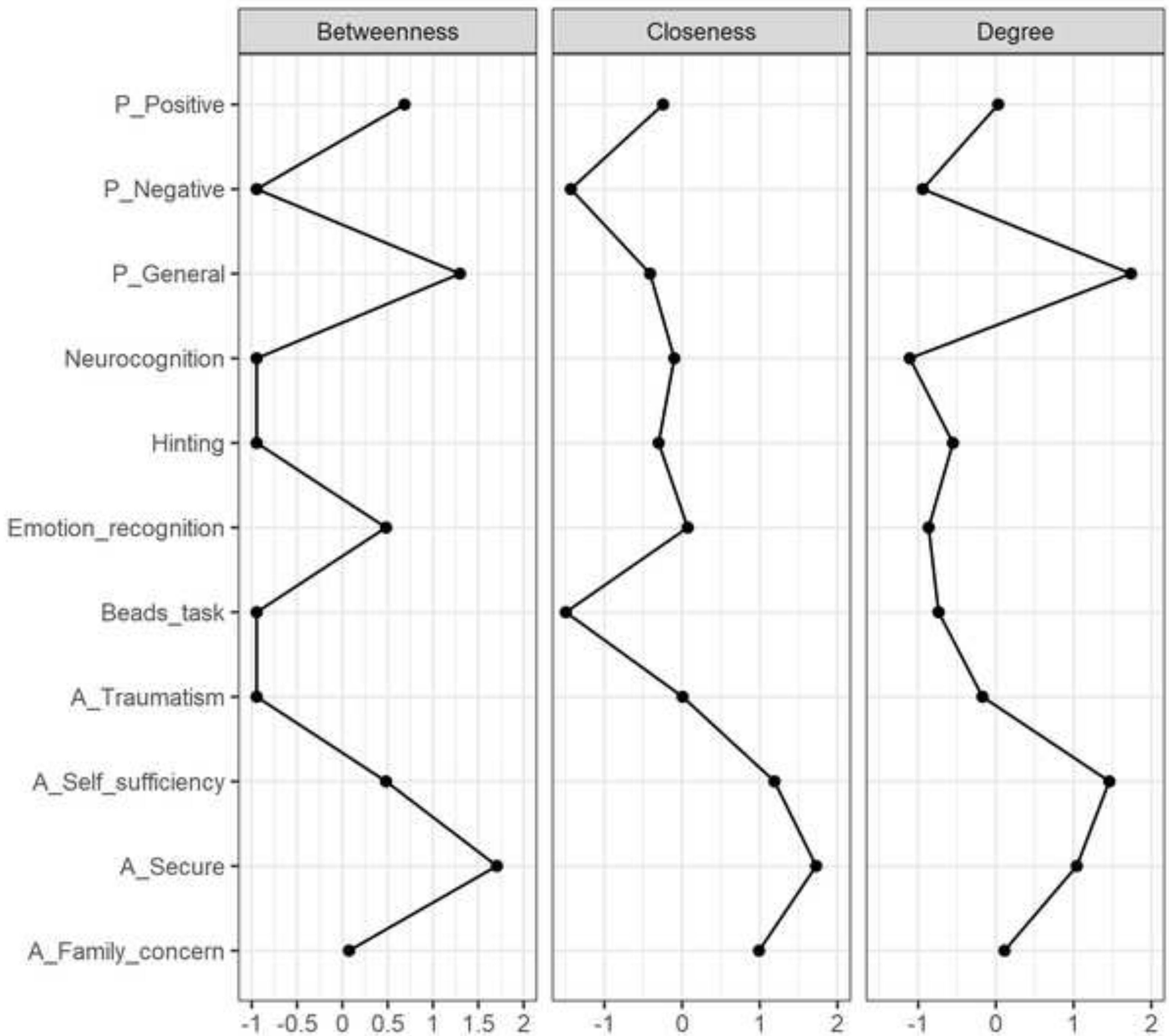
Betweenness
Closeness
Degree
P_Positive
P_Negative
P_General
Neurocognition
Hinting
Emotion_recognition
Beads_task
A_Traumatism
A_Self_sufficiency
A_Secure
A_Family_concern
-1 -0.5 0 0.5 1 1.5 2
-1 0 1 2
-1 0 1 2

Figure 3

Click here to access/download;Figure;Figure 3. Edge stability.tiff

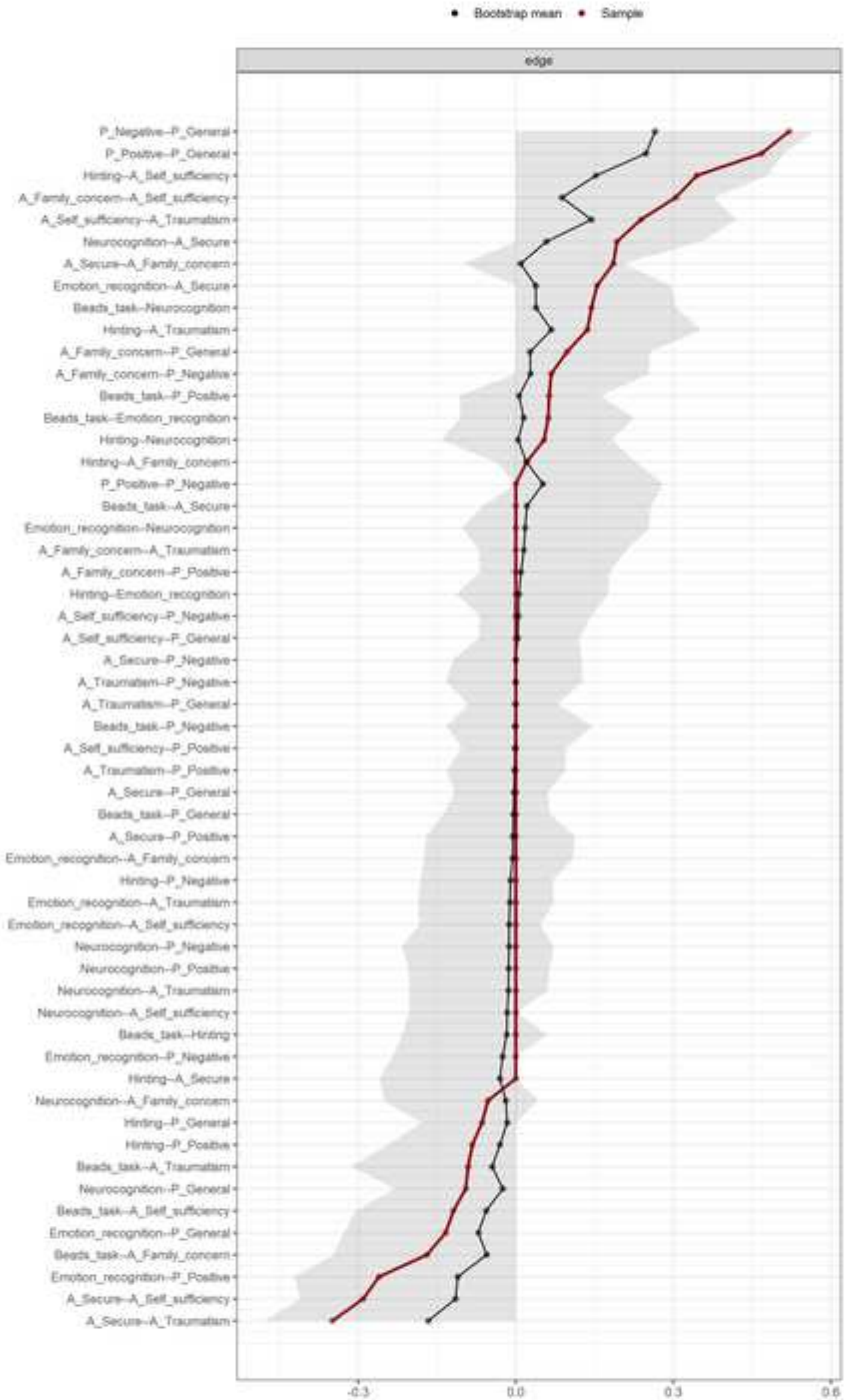

Figure 4

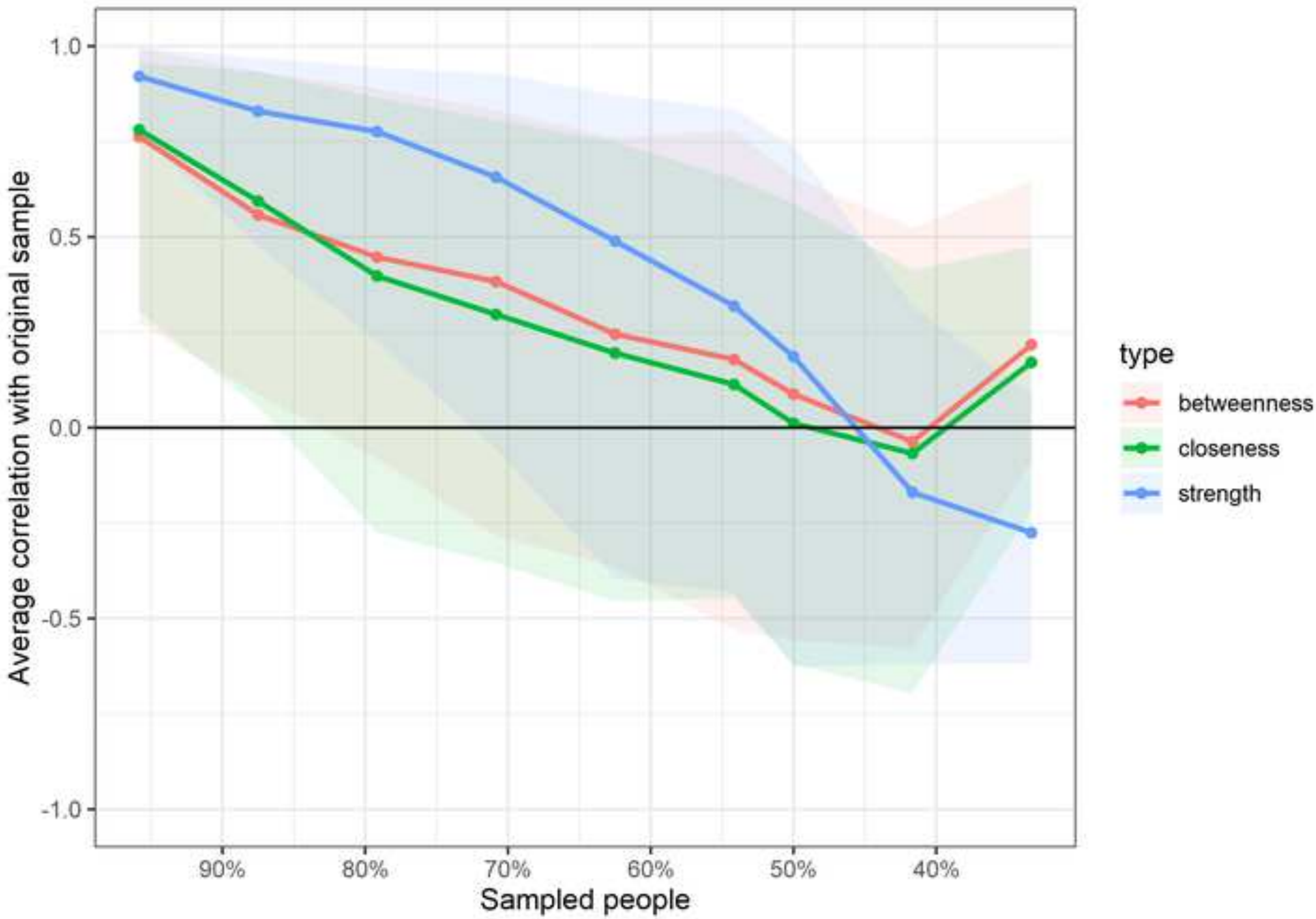
1.0
0.5
0.0
-0.5
-1.0
Average correlation with original sample
90%
80%
70%
60%
50%
40%
Sampled people
type
betweenness
closeness
strength

Table 1. Demographic and clinical characteristics of the sample (N = 25)

		N	%	χ^2	
Gender	Male	17	68.0	3.24	
	Female	8	32.0		
Education	Elementary	3	12.0		
	Middle	18	72.0	16.88***	
	University	4	16.0		
Marital status	Single	18	72.0		
	Partner	5	20.0	17.36***	
	Separated	2	8.0		
Employment	Active/student	10	40.0		
	Unemployed	8	32.0	0.56	
	Pensioner	7	28.0		
		Median	*Mean*	*SD*	*z*
Age		25	29.64	10.30	0.20*
PANSS Positive		13	13.64	4.50	0.12
PANSS Negative		15	15.96	6.68	0.20**
PANSS General Psychopathology		26	26.76	7.54	0.18*
Total PANSS		54	57.00	15.48	0.15
Secure attachment		40	38.72	11.71	0.16
Family concern		51	48.20	9.44	0.15
Parental Interference		56	56.89	8.18	0.22**
Parental Permissiveness		57	56.66	10.57	0.18*
Self-sufficiency		55	54.65	8.10	0.13
Child traumatism		68	69.29	12.85	0.18*
SCIP-S (neurocognition)		40	45.32	24.17	0.13
Hinting Task (ToM)		15	15.08	2.61	0.21**
Beads Task (draws to decision)[1]		4	4.40	2.94	0.12
PERE (emotion recognition)		46	45.64	4.51	0.13

PANSS: Positive and Negative Syndrome Scale. SCIP-S: Screen Cognitive Impairments in Psychiatry-Scale (overall percentile score). *SD*: Standard Deviation. χ^2: chi-squared test. *Z*: Kolmogorov-Smirnov test (Lilliefors significance correction).

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

[1]A JTC bias (draws to decision ≤ 2) was observed in 8 (32.0 %) participants.

Table 2. Weights matrix among the variables included in the network model

	Beads	Hinting	Emotion	Neuro	Secure	Family	Self-suf	Trauma	Positive	Negative
Beads task										
Hinting task	0.000									
Emotion recognition	0.062	0.000								
Neurocognition	0.144	0.054	0.000							
Secure	0.000	0.000	0.155	0.193						
Family concern	-0.169	0.021	0.000	-0.053	0.186					
Self-sufficiency	-0.119	0.344	0.000	0.000	-0.290	0.304				
Child Traumatism	-0.091	0.136	0.000	0.000	-0.349	0.000	0.238			
Positive	0.064	-0.083	-0.260	0.000	0.000	0.000	0.000	0.000		
Negative	0.000	0.000	0.000	0.000	0.000	0.067	0.000	0.000	0.000	
General symptoms	0.000	-0.064	-0.133	-0.095	0.000	0.097	0.000	0.000	0.468	0.520

NOTE: Values are standardised coefficients. The partial correlation network shows the remaining association between two *nodes* after controlling for all other associations.

Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Author Statement

All authors are equally participated in the development of the paper.