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Exploring the links between alexithymia, empathy and schizotypy in college students using network analysis

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ABSTRACT

Introduction: Impaired empathy is one of the major dysfunctions commonly found in patients with schizophrenia, with alexithymia being one possible underlying factor. Schizotypy represents a set of psychotic-like manifestations, investigation of which may contribute to our understanding of psychosis while minimising the confounding effects of illness chronicity and medication exposure. Few studies have specifically examined the associations among alexithymia, empathy and schizotypy.

Methods: We investigated the relationships among alexithymia, empathy and schizotypy in college students using network analysis. The Interpersonal Reactivity Index (IRI), Toronto Alexithymia Scale (TAS), and Chapman Psychosis-Proneness scales were captured, and network based on the subscales were estimated in 552 participants. Strength, closeness and betweenness of nodes were calculated to measure the centrality.

Results: Network analyses revealed a pattern connecting alexithymia with empathy and schizotypy. Negative connections between empathy and physical/social anhedonia and positive edges linking alexithymia with empathy and social anhedonia were observed.

Conclusions: Network constructed in the study demonstrated alexithymia's role in empathic deficits. Our findings highlighted the connections between components of empathy, alexithymia and schizotypy.

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Introduction

Various complex and multifaceted definitions exist concerning the term "empathy" (see Singer & Lamm, 2011), but in short it entails the ability to perceive, understand and feel the emotional states of others (Derntl et al., 2012). Two components of empathy have been distinguished: cognitive empathy refers to the ability to understand others' emotions, while affective empathy refers to the ability to appraise an individual's emotional responses

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to others' emotions (Davis, 1983; Wang et al., 2013). Alexithymia, literately meaning "no words for mood", describes people who lack an ability to express their feelings verbally (Lesser, 1985). In recent years the association between alexithymia and empathy has been highlighted by several studies (Aaron et al., 2015; Jonason & Krause, 2013; Moriguchi et al., 2007). In a systematic review, Valdespino et al. (2017) depicted how alexithymia might lead to empathy deficits in the context of Goldman's introspection-centric simulation theory (Goldman, 1992; Shanton & Goldman, 2010). According to this theory, alexithymia may cause a disruption in the accurate interpretation and representation of one's own affective states, leading to impaired empathic ability. Previous studies evidenced the effect of alexithymia on both cognitive and affective empathy in healthy college students (Moriguchi et al., 2007) and patients with major depressive disorder (Banzhaf et al., 2018).

Schizotypy is originally defined as a set of personality traits that convey liability to develop schizophrenia (Meehl, 1962). It is suggested that schizotypal traits distributed in the general population with its extreme exhibited in patients with schizophrenia (Clardige & Beech, 1995; Nelson et al., 2013) and have multiple dimensions, such as negative schizotypy, which represents manifestation of social withdrawal and anhedonia; and positive schizotypy, which is considered to possess idiosyncratic cognitive styles similar to positive symptoms of schizophrenia (Mohr & Claridge, 2015). Consistently, previous studies suggested an association between high negative schizotypy and poor empathic ability measured by self-report scales (Bedwell et al., 2014; Henry et al., 2008; Wang et al., 2013, 2015) and behavioural tasks (Pflum & Gooding, 2018; Thakkar & Park, 2010). However, previous findings on positive schizotypy's association with empathy are quite different (Aghvinian & Sergi, 2018; Pflum & Gooding, 2018; Wang et al., 2013, 2015). These inconsistencies concerning the subcomponents of empathic impairment may be due, in part, to individual differences in alexithymia. It is suggested that individuals with schizotypy showed heightened levels of alexithymia (Aaron et al., 2015; Seghers et al., 2011) and different dimensions of schizotypy are associated with different subscales of alexithymia (Larøi et al., 2008). However, how alexithymia, schizotypy and their associations affect cognitive and affective components of empathic ability remains unclear.

Proposed by Borsboom and Cramer (2013), the network analysis approach has been applied to studies in psychiatry, psychology and social research. In network analysis, variables are categorised into "nodes" whereas interactions between nodes are represented by the "edges". Nodes and edges form a network that visually displays the overall structure, in which the edges represent putative associations between nodes. In order to advance our understanding of empathy impairments in schizotypy, the current research aimed to investigate the relationships among alexithymia, empathy and schizotypy using network approach. Based on the existing evidence, we hypothesised that negative schizotypy would be negatively correlated with empathy, positively correlated with alexithymia, while empathy would be negatively correlated with alexithymia.

Material and methods

Participants

Eight hundred and twenty college students (524 males; mean age = 20.01 years, SD = 1.25) were recruited from North China Electric Power University in Beijing, China. Participants

who gave consent completed a battery of questionnaires in a group format with 30–100 participants per group. Lie tendency was detected using the Chapman Infrequency Scale (CIS, Chapman & Chapman, 1983), a 13-item questionnaire aimed at excluding effect of social desirability or random responses. Two hundred and sixty-eight participants (32.68%) were excluded due to high scores (>2) on the CIS. The final sample consisted of 552 participants (314 males, mean age = 19.84 years, SD = 1.16), with a mean length of education of 13.7 years. Each participant received 10 RMB (approximately equal to 2 dollars) as compensation for their time. Informed consents were obtained from all participants.

Measures

Interpersonal Reactivity Index (IRI) (Davis, 1983). The English version of IRI consists of 28 items, encompassing four subscales: Personal Distress, Perspective Taking, Fantasy, and Empathic Concern. Items are scored from 0 ("Doesn't describe me at all") to 4 ("Describes me very well"). Psychometric properties of the IRI have been established for the Chinese version, which has 22 items (Zhang et al., 2010). Since it is arguable whether the Fantasy subscale, which measures people's tendency to put themselves into fictional situations using their imagination, is adequate for assessing empathy (De Corte et al., 2007; Nomura & Akai, 2012), we excluded this subscale from our assessment of empathy. The Cronbach's alpha in the present sample was 0.66 for the whole scale, and 0.78, 0.65, 0.68 for IRI-PD (Personal Distress), IRI-PT (Perspective Taking), and IRI-E (Empathic Concern) respectively.

Toronto Alexithymia Scale (TAS) (Bagby et al., 1994) is the most commonly used self-report scale for assessing alexithymia (Leising et al., 2009). The scale comprises 20 items and each item is rated on a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Items are sorted into three subscales, namely Difficulty Identifying Feelings (TAS-F1), Difficulty Describing Feelings (TAS-F2), and Externally-Oriented Thinking (TAS-F3). In the present study, the Chinese version of the TAS was used, which has been validated in the Chinese setting (Yi et al., 2003). The Cronbach's alpha in the present sample was 0.70 for the whole scale, and 0.76, 0.59, 0.45 for TAS-F1, TAS-F2, TAS-F3 respectively.

Chapman Psychosis-Proneness scales (Chapman et al., 1976, 1978; Eckblad et al., 1982, 1983) include four subscales, the *Physical Anhedonia Scale* (CPAS), the *Revised Social Anhedonia Scale* (CSAS), the *Magical Ideation Scale* (MIS) and the *Perceptual Aberration Scale* (PAS). The CPAS is a 61-item scale that measures lack of pleasure derived from various sensory and aesthetic domains. The CSAS has 40 items that measure lack of pleasure in interpersonal relationships. The 30-item MIS scale assesses invalid beliefs about cause and effect. The PAS has 35 items and was designed to measure distortions in the perception of one's body image and perceptual distortions. The CPAS and the CSAS were designed to assess negative schizotypy, while the latter two measure positive schizotypy. The factor structure and reliability of the Chapman scales have already been validated in a relatively large sample of non-clinical Chinese young adults (Chan et al., 2016). Cronbach's alpha in the present sample was 0.84 for the whole scale, and 0.76, 0.85, 0.61, 0.51 for the MIS, PAS, CPAS, CSAS respectively.

Data analysis

Network analysis. We used the R software (version 3.5.0, available at https://cran.r-project.org/) for network analysis, including R packages qgraph (Epskamp et al., 2012), bootnet (Epskamp et al., 2017) and mgm (Haslbeck & Waldorp, 2016). The network model adopted in the present study was the Pairwise Markov Random Field (PMRF, van Borkulo et al., 2014). A PMRF is a well-defined network that has no other equivalent model to describe the same statistical relationships for the exact set of variables. Moreover, since our data was not binary but continuous in nature, the appropriate model for our dataset was the Gaussian Graphical Model (GGM). To regularise the edge weights produced by the GGM model, the Least Absolute Shrinkage and Selection Operator (LASSO) technique was also applied to build a conservative network (Epskamp et al., 2017). *Network accuracy and stability* were assessed, details can be found in the *Supplementary materials*.

Network centrality was evaluated by calculating strength, closeness and betweenness of nodes. Strength quantifies how well a node is directly connected to other nodes, closeness indicates how well a node is indirectly connected to other nodes, betweenness quantifies how important a node is in the average path between two other nodes. Taken together, centrality denotes a node's connectedness with other nodes in the network by standardised *z*-scores, thus representing the relative importance of a node in the whole network. Also, the expected influence (EI, Robinaugh et al., 2016) of nodes were also calculated to assess the strength of a node's influence within the network accounting for the presence of negative edges. In addition, the predictability (Haslbeck & Fried, 2017) of nodes were estimated to measure the degree to which a given node can be predicted by all remaining nodes in the network.

Results

Network estimation

Figure 1(A) illustrates the estimated network. Overall, subscales within each questionnaire showed positive correlations. From a cross-scale perspective, the negative connections were found between social anhedonia and IRI-E, between physical anhedonia and IRI-PT; positive edges were observed between TAS-F1 and IRI-PD, between TAS-F1 and MIS, between TAS-F2 and social anhedonia.

Centrality estimation

Figure 1(B) displays the standardised centrality estimates of the network. TAS-F1 had the highest standardised strength in the network, followed by social anhedonia and MIS. Social anhedonia had the highest closeness, followed by TAS-F1 and IRI-PD, suggesting that they had the shortest path connecting them to other nodes in the network. In addition, the TAS-F1 showed high EI (one-step EI is 1.14, two-step EI is 1.96) and high predictability (0.56), see Table 1.

Discussion

In this study, we applied network analysis to investigate the relationship among alexithymia, empathy and schizotypy in a non-clinical sample. First, empathy was found to be negatively

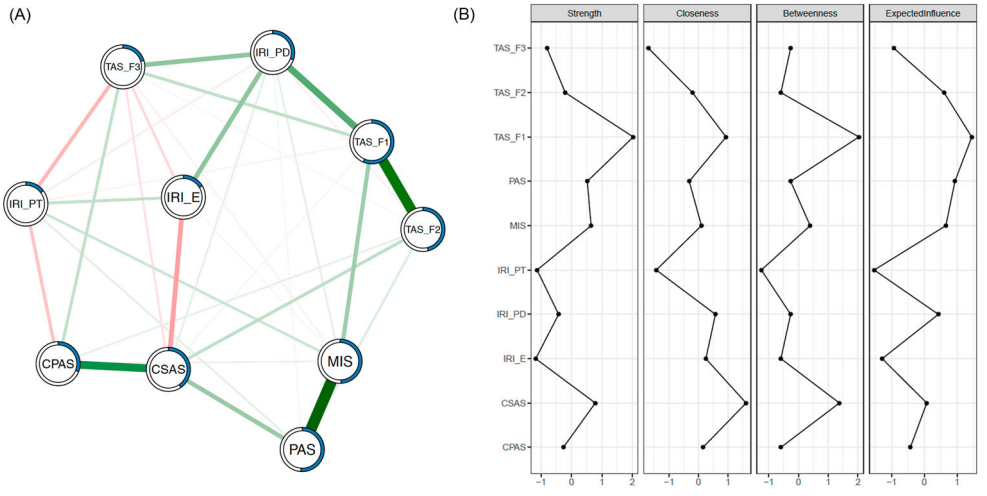

Figure 1. (A) Regularised partial correlation network: Network structure of the Chapman psychosis-proneness scales, the Interpersonal Reactivity Index and the Toronto Alexithymia Scale, based on the whole sample ($n = 522$). Each subscale is represented by a node. Green connections represent positive associations, whereas red connections represent negative associations (only for online colored figure). Thicker edge (positive and negative) signify stronger partial correlations. The blue ring around each node represents its predictability. (B) Centrality plot for the regularised network: Centrality indices are shown as standardised z-scores. Strength measures the weighted number of connections of a focal node, Closeness measures how close the focal node is to other nodes, whereas Betweenness measures the degree to which the central node acts as a bridge that connects different parts of the network. Nodes: CPAS, Chapman Physical Anhedonia Scale; CSAS, Chapman Revised Social Anhedonia Scale; PAS, Perceptual Aberration Scale; MIS, Magical Ideation Scale; IRI_PD, Personal Distress; IRI_PT, Perspective Taking; IRI_E, Empathetic Concern; TAS_F1, Difficulty Identifying Feelings; TAS_F2, Difficulty Communicating Feelings; TAS_F3, Externally-Oriented Thinking.

correlated with negative schizotypy and positively related to positive schizotypy, which is in line with previous studies across different measurements of schizotypy and empathy (Bedwell et al., 2014; Henry et al., 2008; Wang et al., 2013, 2015). Discrepant connections between positive and negative schizotypy to empathy might be partly explained by our

Table 1. Centrality, predictability, and expected influence of nodes.

Subscales (nodes)	Mean (SD)	Strength	Closeness	Betweenness	Predictability	EI_1	EI_2
CPAS	14.85 (7.54)	0.77	0.012	2	0.31	0.35	0.64
CSAS	9.57 (5.50)	0.97	0.014	8	0.40	0.56	1.04
PAS	8.24 (6.03)	0.92	0.012	3	0.51	0.92	1.60
MIS	13.56 (5.15)	0.95	0.012	5	0.49	0.81	1.50
IRI-PD	14.25 (3.78)	0.74	0.013	3	0.30	0.71	1.13
IRI-PT	17.98 (2.95)	0.60	0.010	0	0.15	−0.11	−0.13
IRI-E	21.85 (3.36)	0.60	0.012	2	0.16	−0.01	−0.03
TAS-F1	15.68 (4.76)	1.21	0.013	10	0.56	1.14	1.96
TAS-F2	12.48 (3.36)	0.78	0.012	2	0.46	0.78	1.52
TAS-F3	10.38 (0.48)	0.67	0.010	3	0.20	0.14	0.44

Notes. IRI, Interpersonal Reactivity Index; TAS, Toronto Alexithymia Scale; CPAS, Chinese version of Physical Anhedonia Scale; CSAS, Chinese version of Revised Social Anhedonia Scale; PAS, Perceptual Aberration Scale; MIS, Magical Ideation Scale; IRI-PD, Personal Distress; IRI-PT, Perspective Taking; IRI-E, Empathetic Concern; TAS-F1, Difficulty Identifying Feelings; TAS-F2, Difficulty Communicating Feelings; TAS-F3, Externally-Oriented Thinking; EI_1, one-step expected influence; EI_2, two-step expected influence. The Strength, Closeness and Betweenness in this table are unstandardised values.

result of alexithymia, which positively contributed to both negative and positive schizotypy, but negatively related to empathy. Specifically, difficulties in *expressing* one's feelings is associate with negative schizotypy, and contributes to failure on cognitive and affective empathy; while difficulties in *identifying* one's felling is associated with positive schizotypy and may contribute to understanding others' thoughts and feelings. Henry et al. (2008) found that higher level of positive schizotypy is related to higher scores on self-reported scale of cognitive empathy similar as our finding but associated with poorer performance on behavioural task and they suggested that this incongruence may indicated cognitive biases in individuals with delusional thinking. In our study, positive association between magical ideation and cognitive empathy remained even if after controlling negative schizotypy. This finding provide evidence for diverse mechanisms related to alexithymia underlying empathic ability for negative and positive schizotypy.

Starting from the assumption that empathy requires an intact ability to detect and express one's feelings, many previous studies have identified alexithymia as a potential mediator between empathy and other neurological disorders (Aaron et al., 2015). This issue has been addressed in autism by Bird et al. (2010), who in their study found that empathic brain responses are modulated by levels of alexithymia. In addition, some neuroimaging evidence supports an overlap between the neural bases of alexithymia and empathy (Goerlich-Dobre et al., 2015). The affective components of alexithymia encompass "Difficulty Identifying Feelings" and "Difficulty Describing Feelings". It has been argued that this is an important consideration because only "Difficulty Identifying Feelings" within alexithymia may account for the predicted relationship between empathy and schizotypal traits (Grynberg et al., 2010). In our study, the node representing "Difficulty Identifying Feelings" had high centrality, high EI and predictability, which supports Shanton and Goldman's theory that puts alexithymia at the centre of empathy (Shanton & Goldman, 2010).

In our study, some nodes (e.g., TAS-F3) were based on subscales that had relatively low internal reliability, which may have affected the accuracy of measurement and therefore how accurately the network estimated the network structure in the population. However, how the reliability of the subscales may affect the network model still need further clarification.

Taken together, our results suggest important roles of alexithymia and schizotypy in the relationship with empathy and provide insights on how alexithymia may interact with empathic alterations and negative schizotypy.

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