Metacognition and emotional regulation as treatment targets in binge eating disorder: a network analysis study

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Abstract

Background: This study aims to examine the underlying associations between eating, affective and metacognitive symptoms in patients with binge eating disorder (BED) through network analysis (NA), in order to identify key variables that may be considered the target for psychotherapeutic interventions.

Methods: One hundred and fifty-five patients with BED completed measures of eating psychopathology, affective symptoms, emotion regulation and metacognition. A cross-sectional network was inferred by means of Gaussian Markov random field estimation using graphical LASSO and extended Bayesian information criterion (EBIC-LASSO), and central symptoms of BED were identified by means of the strength centrality index.

Results: Impaired self-monitoring metacognition and difficulties on impulse control emerged as the symptoms with the highest centrality. Conversely, eating and affective features were less central. The centrality stability coefficient of strength was above the recommended cut-off, thus indicating the stability of the network.

Conclusions: According to present NA findings, impaired self-monitoring metacognition and difficulties on impulse control are the central nodes in the psychopathological network of BED while eating symptoms appear marginal. If further studies with larger samples replicate these results, metacognition and impulse control could represent new targets of psychotherapeutic interventions in the treatment of BED. In light of this, Metacognitive Interpersonal Therapy (MIT) could be a promising aid in clinical practice to develop an effective treatment for BED.

Plain English Summary

This study sought to examine the key symptoms for the psychotherapy of patients with binge eating disorder (BED). For this purpose, we applied a network analysis approach to examine the reciprocal association between clinical variables and how eating symptoms, metacognition, emotion regulation, depression and anxiety mutually interact. One hundred fifty-five outpatients with BED completed measures related to their eating behavior, affectivity, emotional regulation and metacognition. The central elements of BED resulted to be impaired metacognition and difficulty in impulse control; instead, affective and eating symptoms appeared to be marginal. Therefore, metacognitive alterations and emotional dysregulation should be considered important targets for the psychotherapy of patients with BED.

Background

Binge eating disorder (BED) is characterized by recurrent episodes of binge eating with a sense of loss of control over eating and accompanied by negative feelings [1]. To date, guidelines recommend cognitive behavioral therapy (CBT) as the first-line option treatment for BED [2,3]. Although CBT is quite effective in patients with BED, about 50% do not fully respond to treatment [4–6]. A possible explanation could be that the only a small portion of patients with BED report the overvaluation of body shape and weight, the

core of CBT protocol [7]. Other treatments such as dialectical behavioral therapy (DBT) [8,9] and interpersonal psychotherapy (IPT) [10,11] have shown promising results but failed to bridge the efficacy gap in treating BED. In other words, the available data do not favor one treatment over the other.

New therapeutic approaches able to target the core elements of the complex psychopathology of BED arise as a priority. Investigating the specific weight of each psychopathological dimension could help in developing more tailored psychological interventions for BED.

Network analysis (NA) emerged as a novel approach to conceptualize mental disorders [12]. According to the NA approach, symptoms of psychiatric disorders are distinct entities that can influence, maintain, and/or interact with other symptoms [13]. Mental disorders can be characterized as complex systems in which symptoms are represented as distinct nodes, connected by edges that represent the strength (e.g. strong/weak correlations) and direction (e.g. positive/negative correlations) between pairs of symptoms. NA allows the identification of the central symptoms (i.e. when a node has many strong associations with other nodes and strong correlations with other nodes within the network) [14].

The development of network approach over the past decade has provided a theoretical framework that was adopted to identify the central symptoms of different psychiatric disorders such as bipolar disorder [15], depression [16], obsessive compulsive disorder [17], or schizophrenia [18]. More recently, researchers in the field of eating disorders (EDs) have applied NA to examine the symptoms of Anorexia Nervosa [19–22] and Bulimia Nervosa [23–25].

To date, only three studies [26–28] dealing with binge eating disorder (BED) used the NA approach. In the first investigation, overvaluation of shape and weight emerged as central symptoms of BED while behavioral symptoms (i.e. binge eating, restriction, secret eating) were less central [26]. The study by Solmi et al. revealed affective symptoms, interoceptive awareness, ineffectiveness, interpersonal functioning and drive for thinness as the central variables among patients with BED [27]. Finally, the third research showed that CBT provides high integration and connectivity of the psychopathology network in BED, suggesting an improved patient understanding of associations between binge eating and other symptoms [28].

However, no research used NA to investigate the complex connections between the eating (i.e. binge eating and eating psychopathology), affective (i.e. anxiety and mood) and psychological (i.e. metacognition and emotional regulation) features of patients with BED.

Prior research evidenced a significant relationship among negative affect, difficulties with emotional regulation and binge eating symptoms [29–33]. For example, binge eating can be the result of a dysfunctional strategy to avoid interpersonal difficulties and negative emotions [34], especially in individuals who experience difficulties with regulating their emotional state [32]. However, the role of metacognition in BED received less research attention. In the current study, we refer to metacognition as a psychological function that plays a key role in identifying mental states and ascribing them to oneself and others, reflecting and reasoning on mental states, and finally using this information to manage

interpersonal conflicts [35]. According to this model, metacognition is made up of different sub-functions that interact with each other and can be singularly impaired [35]. A previous study suggested that the severity of BED can worsen in relation to the impaired self-monitoring metacognition through the mediation of emotional dysregulation [36].

In the present study, we sought to extend the research on the clinical characteristics of BED by applying a network model to provide an examination of the pathways that underlie eating symptoms and their relations to metacognition, emotion regulation and distress. These network analysis results may lead to more nuanced insights regarding the core targets for psychotherapeutic interventions. Given the explorative nature of our study, no a priori hypotheses were formulated.

Methods

Procedure

We performed a consecutive sampling of male and female patients attending the Outpatient Unit for Clinical Research and Treatment of Eating Disorders in Catanzaro (Italy). Patients were invited to participate in the present study if they met the following criteria: a) age 18-65 years; b) current diagnosis of BED according to the fifth edition of Diagnostic and Statistical Manual of Mental Disorders (DSM-5) criteria; c) absence of current Axis I comorbid psychiatric disorders; d) capability to answer self-report questionnaires and to express valid consent.

Participants were deemed ineligible if: a) IQ < 70 [37]; b) drug dependence and/or abuse; c) severe mental illness that could interfere with clinical assessment (i.e. psychosis); d) history of chronic medical illness (i.e. chronic cardiovascular diseases) or neurological conditions (i.e. dementia) affecting cognitive functioning; e) other severe medical comorbidities (i.e. epilepsy); f) medical conditions that influenced eating/weight (i.e. diagnosis of diabetes mellitus); g) history of malignant disease.

Trained psychiatrists interviewed all participants using the Structured Clinical Interview for DSM-5 Disorders—Research Version [38] for diagnostic purposes and collected sociodemographic and clinical data. Researchers informed participants about the aims, procedures, anonymity and voluntary participation in this research. Participants gave their written informed consent to participate in accordance with the latest version of the Declaration of Helsinki [39] and the local Ethical Committee.

Measures

The Eating Disorders Inventory-2 (EDI-2) [40,41] is a self-report questionnaire made up of 91 items, which evaluates ED psychopathology and symptomatology. The EDI-2 provides 11 subscale scores and a global measure of ED severity obtained from the sum of all the items (ranging from 0 to 273). Higher scores indicate more severe ED symptoms. Cronbach’s alpha for the total score in this study was good (.840).

Binge Eating Scale (BES) [42] measures the severity of BED. It consists of 16 items that describe the behaviors, feelings and cognitions associated with binge eating. Total BES scores <17, 17-27 and >27 respectively indicate improbable, possible and probable BED. The internal consistency in this study was .880.

Metacognition Self-Assessment Scale (MSAS) [43] is an 18 items Likert-type (1 = never to 5 = almost always) self-report questionnaire that evaluates the metacognitive functioning. The raw score ranges from 18 to 90 and lower scores indicate impaired self-evaluation of metacognitive function. Specifically, the MSAS measures four abilities of metacognition: 1) monitoring; 2) differentiation/decentration; 3) integration; 4) mastery. In this study, Cronbach's alpha ranges from .820 to .840.

Difficulties in Emotion Regulation Scale (DERS) [44]. The DERS consists of 36-items 5-point Likert-type and assesses emotion dysregulation across six subscales: (a) non-acceptance of emotions, (b) difficulties in pursuing goals when having strong emotions, (c) difficulties in controlling impulsive behaviors when experiencing negative emotions, (d) lack of emotional awareness, (e) limited access to emotion regulation strategies, and (f) lack of emotional clarity. Higher scores indicate more problems in emotional regulation. In the current study, the internal consistency ranges from .870 to .895.

Beck Depression Inventory II (BDI-II) [45] assesses depressive symptoms through 21 items on a Likert scale (0 – 3); scores between 0–9, 10–16, 17–29, and ≥ 30 indicate minimal, mild, moderate, and severe depression, respectively. Cronbach's α in present research was .820.

State-Trait Anxiety Inventory (STAI) consists of 20 items that assess state (STAI-St) and 20 items that measure trait (STAI-Tr) anxiety [46]. The present study only included the STAI-Tr for statistical purposes. Cronbach's α was 0.795.

Network estimation and accuracy

NA was performed using R, version 3.6.2, using *qgraph* and *bootnet* packages in accordance with Epskamp and colleagues [47].

The network has been inferred by means of Gaussian Markov random field estimation, applying "Least Absolute Shrinkage and Selection Operator" (LASSO) regularization was applied to limit the number of spurious associations [48]. Moreover, the Extended Bayesian Information Criterion (EBIC) [49], a tuning parameter that sets the degree of regularization/penalty applied to sparse correlations, was set to 0.20 in the current study (values between 0 and 0.5 are typically chosen). Network estimation was performed using the *estimateNetwork* routine of the *bootnet* package [50].

The centrality of a node is used to infer its influence, or structural importance, in the network. Three main indices estimate the centrality: *betweenness*, how a node influences the average path between other pairs of nodes; *closeness*, how a node is indirectly connected to the other nodes; and *strength*, how a node is directly connected to the other nodes. The centrality Plot function in *qgraph* was used to calculate indices of centrality.

According to recommendations of Epskamp et al. [51], in order to assess the internal reliability of the network, we calculated the Correlation Stability (CS) coefficient, which is the maximum proportion of the population that can be dropped so that the correlation between the re-calculated indices of the obtained networks and those of the original network is at least 0.7. It is recommended that the minimum cut-off to consider a network stable is 0.25 for *betweenness, closeness and strength* [51]. The CS coefficient was computed using case-drop bootstrapping (nboots = 2000). Then we estimated the accuracy of edge-weights by drawing bootstrapped confidence intervals calculated using nonparametric bootstrapping (nboots = 2000). Both for case-drop and nonparametric bootstrapping, network stability analyses were performed using the *bootnet* function in the *bootnet* package.

Visual inspection of the network reveals that thicker edges indicate stronger associations between symptoms, with positive associations typically illustrated in blue and negative associations typically represented in red.

Results

Sample Characteristics

In total, 155 BED patients (86.5% females), 41.2±13.2 years old and 37.9±10.4 kg/m^2 (body mass index) took part in the current study. Table 1 displays the clinical characteristics of the sample.

Table 1
Clinical characteristics of the sample.

		Mean	SD
EDI-2 Total		83.9	60.2
BES		23.4	9.3
STAI Trait		52.8	12.1
BDI		23.2	11.3
DERS	Non acceptance	16.3	6.2
	Goals	15.6	5.4
	Impulse	15.8	6.2
	Awareness	17.4	5.3
	Strategies	22.1	8.8
	Clarity	11.8	4.8
MSAS	Self monitoring	18.4	5.0
	Differentiation/Decentration	18.9	4.3
	Mastery	16.5	4.2
	Others monitoring	10.3	2.8

EDI-2: Eating Disorder Inventory-2; BES: Binge Eating Scale; STAI: State and Trait Anxiety Inventory; BDI: Beck Depression Inventory; DERS: Difficulties in Emotion Regulation Scale; MSAS: Metacognition Self-Assessment Scale; SD: Standard Deviation.

Network Analysis

Figure 1 illustrates the network of BED symptoms. Nodes belonging to each domain (i.e. eating symptoms, emotion dysregulation and metacognition) are generally associated and close to each other. There is a strong negative connection between self-monitoring and DERS-Clarity, and a strong positive connection among self-monitoring, differentiation and mastery. The associations between BED symptoms and depression and, between EDI-2 total score, depression and anxiety are moderately strong. The psychopathologic variables (BES, EDI-2 total score, STAI-Tr and BDI) and emotion regulation (DERS) are moderately connected. BED symptoms node (BES) has a direct connection with non-acceptance of emotions, whereas the depression node (BDI) connects both with difficulties in controlling impulsive behaviors and lack of emotional clarity. Figure 2 displays the strength centrality index of the variables included in the network. The CS coefficient is 0.301 for *strength* that is above the recommended cut-off

value (i.e. 0.25); instead, the CS coefficients for *betweenness* and *closeness* are below 0.25. Therefore, we decided to choose the strength index as main CS coefficient. This choice is not surprising, because the interpretation of betweenness and closeness in networks is somewhat unclear [52] and the strength index is considered a more stable centrality index than betweenness and closeness [53]. Further, since we aimed to understand the core symptoms to target with psychological treatment, we relied on the strength index because it performs exactly this function. The Additional File 1 (Figure S1) shows the accuracy of CS indices.

The nodes with the highest strength centrality are MSAS Self-monitoring (M = 1.98) and DERS Impulse (M = 1.27) (Figure 2). The strongest connections of MSAS Self-monitoring are with MSAS Mastery (0.352) and DERS Clarity (-0.350). The strongest connections of DERS Impulse are with DERS Goals (0.38) and DERS Strategies (0.318). The Additional File 2 (Figure S2) reports the bootstrapped confidence intervals of estimated edge-weights.

Discussion

This is the first study to investigate the associations between the eating (i.e. binge eating and eating psychopathology), affective (i.e. anxiety and depression) and psychological features (i.e. metacognition and emotional regulation) through the NA method among patients with BED.

Our results showed that impaired self-monitoring metacognition and difficulties on impulse control were the nodes with the highest centrality strength and, thus, the nodes most directly connected to the other nodes in the network [53]. According to NA approach, the activation of a node may cause the development of the connected symptoms; therefore, the most central nodes have been conceptualized as core symptoms [54]. Our findings suggest that impaired self-monitoring metacognition and difficulties on impulse control may be important clinical characteristics among patients with BED. Although the high centrality of a node may be the effect of connections with other symptoms [55] and a cross sectional study cannot allow causal associations, metacognitive and emotional regulation dysfunctions may represent potential targets for treatment; surely, these outcome variables of BED warrant further research.

This finding is in line with our previous study where low self-monitoring lead BED-obese patients to express the worsening of binge severity through the mediation of emotional dysregulation [36]. Consistent with this hypothesis, other researchers found that difficulties in emotion recognition could play a key role in the development and maintenance of BED [56,57].

Another important finding of the current NA was the strong correlation of the Self-monitoring node with mastery strategies. According to the metacognitive theory, high level of self-monitoring allows the use of functional mastery strategies. More in detail, the mastery is "*the ability to work through one's representations and mental states, with a view to implementing effective action strategies, in order to accomplish cognitive tasks or cope with problematic mental states*" [35,58]. So, it could be inferred that

enhancing metacognitive abilities could lead to reduce dysfunctional strategies among patients with BED that usually manage intense emotions with binges [8,59].

It is worth noting that both dysfunctional eating (i.e. BES and EDI-2 total scores) and affective symptoms (i.e. BDI and STAI-Tr) were peripheral to the network structure of patients with BED, indicating that they had less connections to the rest of the network as compared with other nodes. Regarding eating psychopathology, in the current study the lowest strength was found for BES (M=−1.39) and EDI-2 total score (M=−1.22). Although the weak centrality of eating symptoms in the network structure, our findings suggest that BES score is connected to non-acceptance of emotions, whereas EDI-2 total score to a poor metacognitive ability to distance from own thoughts and evaluate them critically. Overall, our results confirm recent data of the literature on NA in BED that binge eating was not central to the psychopathology [26,28], and contrast the typical approach to diagnosing BED by relying upon the presence of binge eating behaviors.

Consistently to the present findings, we could argue that clinical constructs such as the impaired self-monitoring, the difficulties in impulse control and lack of emotional clarity could be the vulnerability factors of BED while the consequent pathological eating behavior (i.e. binge eating) itself seems the consequent behavior. This observation is in line with recent literature that investigated predisposing and precipitating factors in BED [32,60,61].

Further, depressive and anxious symptoms were not either central nodes in our network model; conversely, anxiety and depression had high centrality in Solmi and colleagues' model [27]. This discrepancy could rely on the use of different psychometric instruments. Solmi and colleagues used the symptom checklist - 90 (SCL-90), that is not so specific and only takes into consideration the prior week; instead, the BDI-II and the STAI-Tr are more specific for diagnostic purposes and consider a longer temporal range of assessment (i.e. two weeks for BDI following DSM-5 temporal criterion for major depressive episode; "usually feeling" for STAI-Tr). Therefore, their study could have overestimated the weight of anxious and depressive symptoms in BED.

Present results should be read in light of some limitations. First, the sample size is smaller than in other studies that used NA in BED. Nevertheless, according to the recommendations of Levinson and colleagues [62] about the use of NA in the field of eating disorder ("*to date, the best recommendation is to use the largest sample size possible and make sure that your network is stable*") our model demonstrated to be stable. Second, it was not possible to evaluate the differences in NA according to sex; however, a recent NA study among patients with eating disorders showed more similarities than differences between men and women [63]. Finally, the cross-sectional design does not allow the investigation of causality in the associations between dimensions; so future longitudinal research could explore whether psychotherapeutic interventions that target metacognitive and impulsive dimensions may be more effective in treating BED.

Conclusions

The current study suggests the link between a reduced ability to identify and describe mental states and the lack of emotion awareness and clarity among patients with BED. Moreover, according to the present NA findings, impaired self-monitoring metacognition and difficulties on impulse control are the central nodes in the psychopathological network of BED, whereas eating symptoms seem to be marginal.

These results could lead to rethink the current conceptualization of BED and to consider new targets of psychotherapeutic interventions, if confirmed in larger samples. If so, approaches focused on the improvement of metacognitive dysfunctions could be considered. At this aim, Metacognitive Interpersonal Therapy (MIT) [64] could be a promising aid in clinical practice to develop an effective treatment for BED.

List Of Abbreviations

BED: Binge eating disorder; BES: Binge eating scale; BDI-II: Beck Depression Inventory II; CBT: Cognitive behavioral therapy; CS: Correlation stability; DBT: Dialectical behavioral therapy; DERS: Difficulties in Emotion Regulation Scale; DSM-5: Diagnostic and Statistical Manual of Mental Disorders - 5; EBIC: Extended Bayesian Information Criterion; ED: Eating disorder; EDI-2: Eating Disorders Inventory-2; IPT: Interpersonal psychotherapy; LASSO: Least Absolute Shrinkage and Selection Operator; MIT: Metacognitive Interpersonal Therapy; MSAS: Metacognition Self-Assessment Scale; NA: Network analysis; SCL-90: Symptom checklist – 90; STAI-Tr: State-Trait Anxiety Inventory-Trait.

Declarations

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Authors’ contributions

MA and CSG designed the study; MA, MR, EAC, GC, MC collected the data; PZ and CC analysed the data; MA wrote the first draft of the manuscript; CSG, GLC, GN, AC made the first critical review and participated to write the final manuscript. All authors approved the final manuscript.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The local Ethical Committee approved this study. Informed consent was obtained from all participants included in the study.

Consent for publication

Not applicable.

Competing interests

All the authors declare that they have no conflict of interest.

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Figures

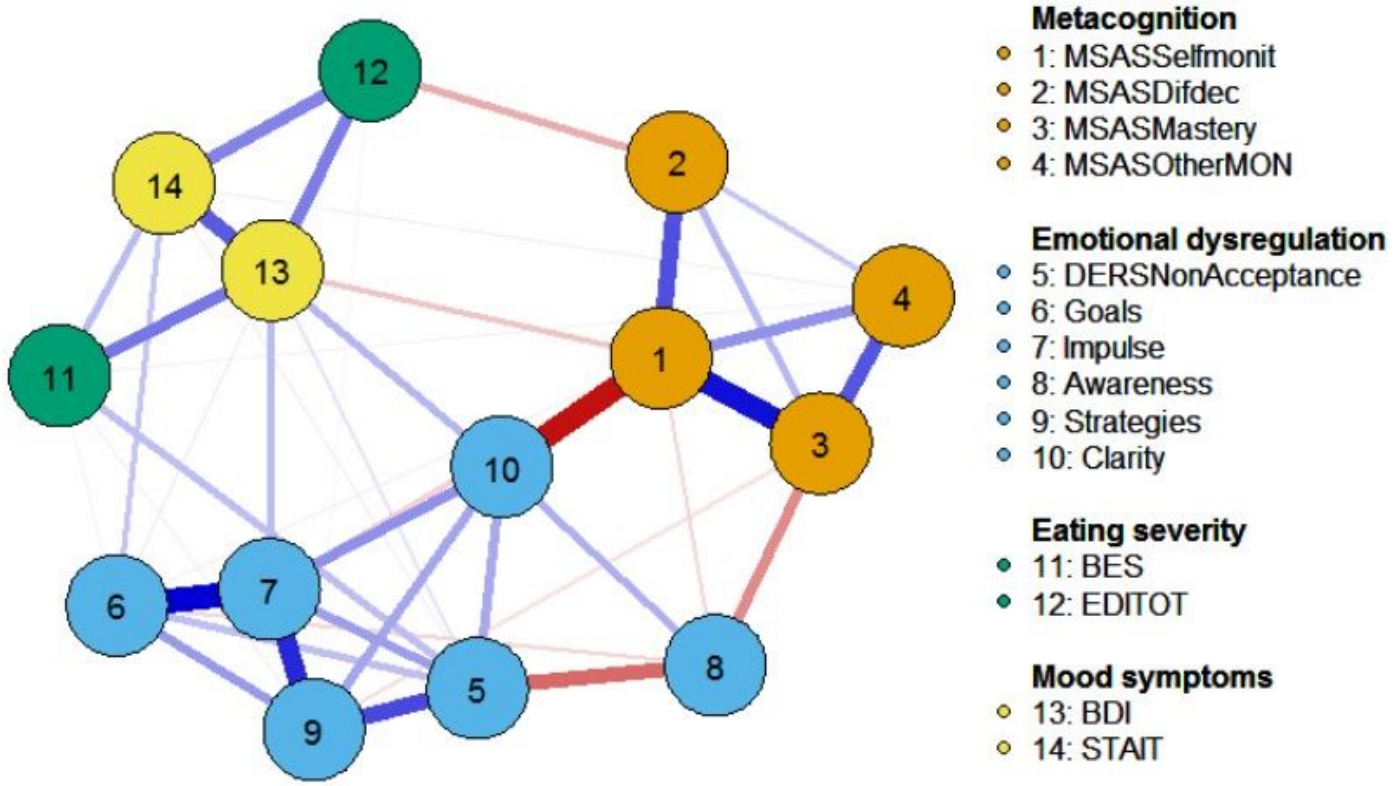

Figure 1

The network structure estimated from the graphical EBIC-LASSO in patients with binge eating disorder. Blue lines represent positive correlations, and red lines represent negative correlations. Thicker edges represent stronger correlations.

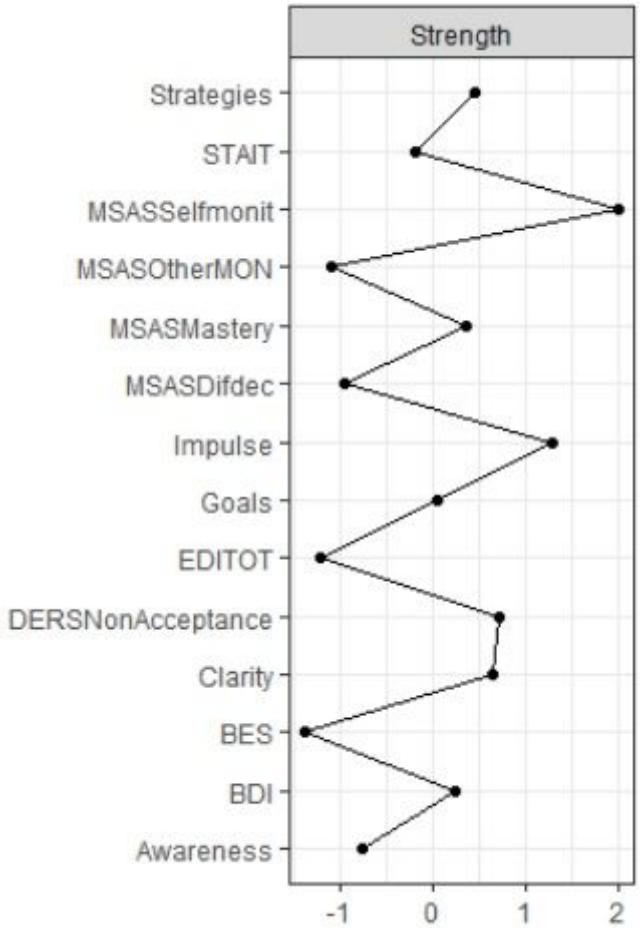

Figure 2

Plot of strength centrality index of the network for each node.

Supplementary Files

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- Additionalfile1.FigureS1.docx
- Additionalfile2.FigureS2.docx